Long Paper Assignment

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International Environmental Policy
William Moomaw

Intensive Livestock Production and the Environment
Global Lessons from U.S. Practice

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> You have just dined, and however scrupulously the slaughter-house is concealed in the graceful distance of miles, there is complicity, expensive races -- race living at the expense of race.
>
> -Ralph Waldo Emerson (from "Fate")

I. Global and U.S. Intensive Livestock Practices

Livestock's Long Shadow, a joint 2006 report of the Food and Agriculture Organization (FAO) and the Livestock, Environment and Development Initiative (LEAD), reveals that global livestock production's environmental consequences range from climate change and land degradation to water depletion, air pollution and eutrophication. Ammonia from ruminant livestock—64% of the global total—contributes to acid deposition in the air. Agricultural wastes, antibiotics, hormones, fertilizers, and pesticides contribute to water pollution and eutrophication. Overgrazing and feed crop irrigation disrupts water systems and aquifers, and the creation of new pastures contributes to deforestation and biodiversity loss.

A structural change, termed the "livestock revolution," is taking place around the world (with particular intensity in East Asia), in which multinational supermarket and fast food chain expansion creates demand for streamlined intensive meat production. As the global population grows larger and wealthier over the next half-century, global meat and milk production are expected to double;[*] if left unchecked, animal agriculture will grow ever more unsustainable.

Although this study uses the U.S. intensive livestock industry as a template, the focus is on transnational and global environmental concerns. The condition of the U.S. industry is the end result of a worrisome global trend towards increasing intensification of animals per plant and geographical condensation of plant location. In the U.S., the

[*] Meat production, 229 million tons in 1999/2001, is expected to reach 465 million tons in 2050, with milk production rising from 580 to 1043 million tons. (FAO 2006)

location of concentrated animal feeding operations (CAFOs), generally determined by land and labor price, creates disproportionate burdens on the rural poor and intensifies the environmental harm from ammonia, hydrogen sulfide, particulate matter, and methane.

I. A. Intensive Livestock's Human and Environmental Toll

Intensive livestock also raises animal health and welfare concerns, contributes to public health dangers, and creates an inefficient feeding system in lock-step with industrial crop agriculture. CAFOs expose workers and nearby communities to a wide range of health risks. Workers in confined plants risk chronic respiratory infection. Animal pathogens such as cryptosporidia cause community outbreaks. (Donham) Airborne pollutants near CAFOs create foul odors and cause fatigue and respiratory problems, and the preventative antibiotics required by the animals' close mutual proximity grants resistance to transferable airborne bacteria. (Chapin)

Because feedlot livestock require, in addition to antibiotics, a constant source of food and various other external inputs, CAFOs are an integral part of industrial agriculture: 37% of the world's grain, and 66% of U.S. grain, is fed to livestock.[*] (Harrington) To provide the soy protein and corn energy required, industrial agriculture requires: fossil fuel and water expenditure, topsoil degradation, chemical pesticides and fertilizers, and crop monocultures. The relative inefficiency of consuming meat effectively multiplies crop agriculture's environmental harm twofold for poultry, fourfold for pork, and sevenfold for beef.

[*] By contrast, in 1991 India and sub-Saharan Africa apportioned just 2% of their grain harvest to livestock. (Durning and Brough)

Additionally, industrial crop and livestock production *both* cause eutrophication and water system pollution. Traditional, synergistic livestock systems helped to recycle nutrients and built soil fertility; CAFOs replace traditional farming's closed loop with an external input model. As a result, the U.S. meat industry produced 1.4 billion tons of waste in 1997, or 5 tons per citizen. (Horrigan *et al*).

Even though human and environmental hazards are compounded by the concentration of production, the primacy of market concerns has led U.S. producers to increase CAFO size while decreasing the total number of farms. Thus, between 1967 and 1997, the number of swine farms plummeted from over a million to 157,000, the top 3% of which produce 60% of U.S. hogs. (Horrigan *et al*) In 2000, operations with 5,000 or more hogs comprise 50% of U.S. production. (Speir *et al*) The poultry and beef industries show similar intensification.

I. B. The Global Livestock System

Livestock's Long Shadow, an exhaustive report conducted by the Livestock, Environment and Development (LEAD) Initiative with World Bank, EU, USAID, FAO and other support, reports similar intensification in the developing world. Each of the countries analyzed—Brazil, France, Mexico, Thailand, and Vietnam—demonstrates continuing concentration and intensification of cattle, chicken and pigs. Industrial production systems account for 80% of estimated growth in today's livestock sector. (FAO/LEAD)

Burgeoning populations and rapid urbanization increase affluence and, with it, the demand for meat and dairy products. Developing countries overtook developed countries

in meat production around 1996, and are expected to produce 2/3rds of global meat products by 2030. (FAO/LEAD)

Economic growth and urbanization in the developing world is creating the necessary infrastructure to move CAFOs from peri-urban areas near the location of demand (cities) to rural areas with lower land and labor prices. Between 1992 and 2000, LEAD found a large decrease in poultry density within 100 km of Bangkok.

Beyond the direct hazards outlined above, intensive livestock causes indirect global harm in the form of market demand for grain. Greenpeace documents an illegal port Cargill built in the Brazilian Amazon to export Soya to European fast-food and supermarket chickens. (Greenpeace) World grain supply has increased by 43% from 1980 to 2004. (LEAD) Although the nature of the international trading system makes it hard to place specific blame for demand-driven market activities, increasing deregulation combined with global livestock intensification creates myriad dangers for forest, biodiversity and ecosystem preservation.

I. C. Summary of Concerns

This study focuses only on intensive livestock production, and thus does not address rangeland degradation and other problems specific to extensive pasture systems. Following *Livestock's Long Shadow*, the agriculture intensification upon which CAFOs are predicated can have negative local, regional and global effects.

- Local: increased erosion, lower soil fertility, and reduced biodiversity
- Regional: pollution of ground water and eutrophication of rivers and lakes
- Global: impacts on atmospheric constituents, climate and ocean waters.

Although CAFOs pose significant challenges to public health, disease vector control, water use, and many other areas of concern, special focus is given to the regional and global effects of chemical emissions. Priority is given to ammonia (NH4) and nitrogen's impact on acid rain and eutrophication. Another area of global concern is CO2, methane (CH4) and nitrous oxide emission's impact on climate change.

I. C. i. NH4 and Transboundary Acid Rain

A report from the U.S.-Canadian International Air Quality Advisory Board (IAQAB) to the International Joint Commission (IJC) points out that NH4 levels are inseparable from international agreements to reduce industrial sulfur dioxide emissions. U.S. intensification and concentration of CAFOs has increased NH4 over the last 20 years. Livestock is also a major contributor to ammonia volitization—in which ammonia is nitrified in the soil after deposition—a major cause of acidifying wet and dry atmospheric deposition. (FAO/LEAD)

Whereas European regulations to control acidifying pollutants target the combined effects of SO2, NOx, and NH3, U.S. scientific understandings of acidification in the 1980s has directed American efforts, under Title IV of the 1990 CAAA, primarily against SO2 and NOx emissions from the electricity sector. (Center for Clean Air Policy)

I. C. ii. N Inputs and Eutrophication

Concentrations of NH4 nutrients in CAFO waste and N crop fertilizers alter the global nitrogen cycle, resulting in ecosystem disruption. Intensive livestock production adds to industrial crop agriculture's nitrogen fertilizer runoff by concentrating both the

size and location of CAFOs. According to the IAQAB report, "The USDA estimates that, in 1997, operations in 165 US counties resulted in 1.5 billion tons of nitrogen outputs from manure in excess of absorption capacity of adjacent lands."

When manure from intensive hog farms and cattle feedlots is stored in open pits spills, the excessive nutrient exposure joins with nitrogen runoff to create algal blooms and, in some cases, lake and ocean dead zones. Similarly, precipitation can carry vaporized NH3 from manure pits to cause eutrophication in lakes and oceans and ecosystem disruption elsewhere. (Donham)

Increased levels of animal consumption accompanying rising levels of affluence will create (and is creating) far more N-inputs than do grain-based diets. U.S. corn fields alone use up around 40% the country's nitrogen fertilizer. (Durning and Brough) A Norwegian study conducted by M.A. Bleken and L.R. Bakken locates the N-cost, "the ratio between fertilizer N-input (including animal manure) and the N in product, [as] around 3 for wheat, 14 for dairy products and 21 for meat."

I. C. iii. Livestock and Climate Change

Direct emissions from livestock include the greenhouse gases CO2, CH4, and N2O. A UN Food and Agricultural Organization (FAO) report released November 29, 2006 states that indirect and direct livestock-related activities, at a converted-CO2 equivalent of 18%, contribute more to global warming than transport. While the livestock sector produces only 9% of human-related CO2 (ruminant species are the greatest offenders), it produces 65% of all human-produced nitrous oxide (which has 296 times the Global Warming Potential (GWP) of CO2) and 37% of all human-produced methane

(23 times CO2's GWP). *Livestock's Long Shadow* notes that tropospheric methane has increased by 150% since the dawn of the industrial revolution, in large part due to livestock intensification and the resulting CH4 emissions from manure and fertilizer decomposition.

In addition to direct warming effects attributable to livestock, indirect contributors abound. They include: fossil fuel burned to transport animal products and to produce mineral fertilizers for feed production, land uses changes for grazing and feed production, and land degradation. (FAO/LEAD)

II. The Causes of Environmentally Hazardous Intensive Livestock Production

At the basic level, population growth and urbanization are responsible for the development of intensive crop and livestock agriculture. The specific manner of CAFO implementation, however, is driven by economic doctrine and facilitated by technological innovation and deregulated global trade. Government regulation of industry and cultural concerns about animal welfare can, in some countries, play a part in mitigating the relative concentration of intensive production; elsewhere, cultural arguments defending free markets and governmental noninterference, as well as lack of public awareness and access to information, contribute to greater intensification.

II. A. Urbanization and Technological Development

The global geographic shift from pastoral and smallholder rural agricultural communities to market-based urban centers removes urban dwells from the agricultural sector. With urbanization comes market sector diversification and increased affluence,

which leads to increased meat consumption, a good with a high elasticity of demand.

Intensification was made possible in large part by scientific and technological advances. In chemistry, the Haber-Bosch process and synthetic nitrogen fertilizers ushered in a new age of agriculture productivity. In biology, advances in immunology allowed for the otherwise unattainable stocking densities in CAFOs. Technologically, innovative developments in agricultural machinery have streamlined crop harvesting and livestock husbandry from birth to slaughter.

II. B. Economics

Although the simple existence of intensive agricultural and livestock practices stems from urbanization, population growth and the enabling power of scientific and technological innovation, much of intensive livestock's environmental harm is a result of modern economic theory. Large firms prioritizing globally provisioned supply and economies of scale are often concerned solely with profit maximization, and the 'externalities' of environmental safety and animal welfare result in lower production costs.

In addition to existing agricultural subsidies in the global north that incentivize overproduction, increased international market liberalization has altered CAFO input options, and the availability of cheap coarse grain has increased the global CAFO focus on monogastric animals like chicken and hogs. By sourcing feed at the lowest prices the international market has to offer, CAFOs may be exploiting developing countries' lower environmental standards. Land conversion in Brazilian grasslands has doubled the hectares producing Soya—both for domestic livestock and to export—in the past decade

to 21 million ha in 2005, and is expected to grow by 40 million ha or more. The consequences for biodiversity, soil, water and climate are mostly unmeasured. (Naylor *et al*)

In the U.S. domestic context, producers have economic incentives to locate CAFO facilities where land and labor prices are cheapest, often in states using lenient regulatory standards as a means to entice industry presence. Following models of vertical integration and vertical and horizontal coordination, producers are also incentivized to cluster groups of CAFOs in close proximity to each other. (Carpentier *et al*) Significantly, the FAO asserts that "environmental problems created by industrial production systems derive not from their large scale, nor their production intensity, but rather from their geographical location and concentration."[*] (FAO/LEAD)

Producers also have incentives to increase stocking densities: higher densities produce lower monetary return per unit, but the output per unit floor area increases, reducing the fixed cost of production. In the case of intensive poultry farming, profit margins increase linearly up to stocking densities of 75 kg/m^2. (Hall)

II. C. Culture

Urbanization, technology and economic dicta may be the dominant factors determining livestock intensification, but cultural values[†] often shape intensive livestock's environmental and welfare effects. "Culture," a notoriously ambiguous term,

[*] Although this may be the case regarding purely environmental concerns, instensification of stocking densities raises public health problems by heightening the risk of transferring antibiotic-resistant diseases from animals to humans (a process known as zoonosis). The World Organization for Animal Health estimates that 75% of recent emerging diseases are zoonotic. (FAO/LEAD)

[†] Predicated, arguably, on the speciesist view of human dominion over the Earth inherited from the Judeo-Christian tradition.

impacts intensive livestock's environmental effects primarily as a result of two correlative concerns: the extent to which a polity is receptive to free markets and corporatism (negative correlation), and the amount of social capital and governmental and non-governmental oversight of corporate actors in a polity (positive correlation).

III. Economics in Society

The age of fossil fuel, nuclear and hydroelectric energy has freed humanity from the animal power used for the last ten millennia in agricultural work, but it may have come at a high price. By divorcing urbanized society from the array of animal by-products and excreta used throughout history to provide clothing, fertilizer, labor, (Hodges) industrial livestock production has adverse effects both on sustainability and on civic engagement.

First, CAFOs compound the environmental harm inflicted by disconnecting livestock systems from agricultural systems and by operating at wasteful but profitable economies of scale. Second, marketing strategies and the nature of modern capitalism alienate denizens of urban society from the realities of CAFO methodology, often keeping both environmental and welfare concerns out of the public forum.

III. A. Disconnecting Livestock and Agriculture

The development of anthropogenic nitrogen fixation in the late 19th century combined with innovations in machine technology, biomedical breakthroughs and the accelerated liberalization of international trade to separate animal husbandry from crop agriculture. As a result, transport expenditures add to livestock's existing fossil fuel GWP

(used in feed production and processing). Furthermore, as Naylor *et al* note, internationalized grain markets in a nexus of burgeoning world demand for livestock feed make it difficult to fully account for—or regulate—the extent of global environmental harm.

III. B. Industry and Public Opinion

Although international organization (IO) and treaty attention and national policy placing environmental controls on intensive livestock are necessary to control the exploding demand for meat products' environmental effects, public education and awareness programs aimed at reducing meat consumption would help to mitigate intensive livestock's environmental harm.

In much of the developed world, however, farragoes of advertising and industrial legal and lobbying muscle obfuscate public debate; much of the American public, for example, is too deeply rooted in the industrial system to acknowledge the very *need* for debate. As J.K. Galbraith realized in *The New Industrial State*,

> If we continue to believe that the goals of the industrial system—the expansion of output, the companion increase in consumption, technological advance, the public images that sustain it—are coordinate with life, then all of our lives will be in the service to these goals.

The industrial model stands in the way of an environmentally sound global livestock system.

III. C. i. The U.S., the E.U. and Animal Welfare: Lessons for the Environment

European national and regional consumer-driven progress towards higher animal welfare standards in the intensive livestock sector provide a potential template for

consumer-driven change toward an environmentally sustainable livestock sector. In addition to welfare benefits, lower stocking densities help to mitigate animal waste concentration's environmental harm.

The European public has made its voice heard in national and E.U. law. A recent Eurobarometer poll indicates that 54% of consumers would be willing to pay a price premium for welfare-friendly sourced eggs, (Kyprianou**)** and fully 86% of the respondents to a 1997 UK survey on battery cage eggs showed concern for animal suffering. (Bennett) Correspondingly, the EU adopted a binding Protocol at the June 1997 Amsterdam Inter-Governmental Conference (EU Treaty 1997) that recognizes animal sentience and obliges members to 'pay full regard to the welfare requirements of animals' agriculture, transport and research. (Brooman and Legge) More recently, on October 12, 2006, the European Parliament adopted an Action plan on the Protection and Welfare of Animals 2006-2010, by 565 votes to 29.

It is no surprise, then, that EU countries are increasingly affected by national policies intended to comply with the European Nitrate Directive of 1991.

In contrast, U.S. animal law is dominated by livestock producers' interests and has moved to exempt food animals from its otherwise stringent anticruelty statutes. Crucially, the American Animal Welfare Act does not apply to animals raised for food; more than any other livestock animal, poultry is exempted from U.S. animal law, in part due to the lobbying power of the twenty companies producing eighty percent of U.S. poultry.[*]

[*] U.S. Senator Metzenbaum stated that "the poultry industry is dominated by a few giant corporations, all of whom produce the same product with the same problems. Twenty companies produce eighty percent of U.S. poultry. For [of these] companies produce forty percent." (Wolfson)

III. C. ii. EPA Non-compliance and U.S. Industry Emasculation of Government

Whereas the prominence of E.U. animal welfare concerns hints at the strength of European governmental regulation in response to public concern, the non-enforcement of the Clean Water Act (CWA) and Clean Air Act (CAA)[*] by the U.S. Environmental Protection Agency underscore the industry dominance of American society. The CWA requires livestock permits for large installations, but the U.S. has issued only 2,520 of the 13,000 permits required by 2001 EPA estimates, and CAFO compliance is rarely enforced. (Merkel) Although the CAA is meant to regulate air pollution, every CAFO to date has negotiated an administrate consent agreement with the EPA to circumvent CAA requirements. (Merkel)

IV. Policy Responses to Intensive Livestock Production

Intensive livestock's environmental harm is too diffuse and ecologically pervasive for any single multilateral treaty of global standing to govern all facets of its conduct. Rather, Domestic harm is regulated nationally under legal public nuisance provisions and legislative statute, while bilateral and multilateral treaties and IOs address regional or global concerns.

IV.A. Research from International Organizations

IOs, particularly FAO, UNEP,[†] the World Bank and the International Livestock Research Institute (ILRI), help shape the debate over intensive livestock and industrial

[*] As well as, Merkel asserts, the Comprehensive Environmental Response, Compensation and Liability Act (CERCL or Superfund) and the Emergency, Planning and Community Right-to-Know Act (EPCRA).

[†] A UNEP report from 2000 warned that we "are fertilizing the Earth on a global scale and in a largely uncontrolled experiment." (UNEP)

agriculture; a 2005 report from the World Bank's International Bank for Reconstruction and Development (IBRD), *Managing the Livestock Revolution* (Pehu and de Haan), acknowledges existing dangers and lays out public policy recommendations. The report acknowledges that "there is no "silver bullet" for solving these problems," and its recommendations include technology-driven waste mitigation, improved feeding technology to reduce nitrogen and phosphate emissions, soil and crop nutrient analysis to prevent leaching. Globally, the WB report calls for a comprehensive assessment of "the level of global externalities involved."

Indeed, the FAO/LEAD's 2006 release of *Livestock's Long Shadow* is a reasonably comprehensive assessment of global externalities, and it indicates a growing awareness that business as usual entails enormous risk. Although the FAO has been criticized for its promotion of commercial forest and crop exploitation and substantial chemical input use, recent developments indicate its ability to broker environmental agreements on fisheries, pest management, and biodiversity. (Chasek *et al*)

Pehu and de Haan also recommend the following global and national priorities for the near future:

Global

- increase efforts in public awareness
- connect livestock waste treatment to global carbon markets and other Global Environmental Facility (GEF) services
- expand research on waste management technologies

National

- coordinate action between financial, regulatory, and institutional instruments
- increase public awareness
- create national manure management plants in countries with current or expected problems[*] (such as Brazil, China, Thailand, Mexico, Philippines, Vietnam)
- implement regional zonal planning capacities
- strengthen market-based incentives, including a tradable quota system

[*] In this vein, the ECE executive body report on LRTAP acknowledges that "abatement of ammonia emissions from agricultural differs fundamentally from the abatement of any industrial emissions because of the intrinsic difficulties entailed in regulating biological as opposed to engineering processes. (Chapter V, section 4, EB.AIR/1999/2)

- develop associative forms of waste management[*] (cooperative biodigestion systems, watershed-focused manure plants, and others)
- prevent monopolies by developing legislation to protect smallholders

The study acknowledges, however, that "fewer policy options exist for controlling the impact of diffuse, non-point source pollution from agricultural production. Non point discharges are difficult to monitor because they occur over wide areas and vary from day to day depending on weather conditions and the frequency and timing of application of potential pollutants."

The IBRD study recommends regulatory instruments (limiting plant density and expansion, and restricting the manure amounts and uses), financial instruments (establishing tradable quotas), and communication instruments (promoting voluntary environmental agreements and the sharing of technical information.

IV. B. Multilateral Environmental Agreements

Some environmental repercussions of intensive livestock are dealt with by a range of Multilateral Environmental Agreements (MEAs): the Convention on Biological Diversity,[†] the Convention on Long Range Transboundary Air Pollutants (LRTAP), the Framework Convention on Climate Change, and others.

Particularly relevant is LRTAP's most recent regional protocol, which is also the first protocol to address Ammonia: the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication, and Ground Level Ozone. The protocol entered into force in May 2005 and now has 31, mostly European, signatories; the United States has signed and accepted the protocol, and Canada has only signed. Annex IX to the protocol contains a provision

[*] The IBRD study places waste storage cost at between US$1 and US5.50 per 1,000 gallons of storage space.

[†] For example, the Spanish action plan of the Convention on Biological Diversity (CBD) highlights intensive livestock's dangers to soil and water pollution.

to establish an advisory code controlling ammonia emissions from the livestock sector; the results of a protocol-sponsored ammonia workshop held December 4-6 2006 in Edinburgh[*] indicate that research is still under way. The European EMEP (the Cooperative Programme for monitoring and Evaluation of LRTAP) has been tasked to assess issues related to atmospheric nitrogen deposition.

IV. C. National Regulation

Intensive livestock also requires local and regulation. At the national level, regulations include zoning requirements to decentralize CAFO systems and restrictions on livestock numbers and waste methods; for the most part, enforcement has been poor, and in many countries only piecemeal regulation by county exists. To date, financial mechanisms have focused on subsidizing pollution mitigation and reductions in numbers. (Pehu and de Haan)

V. The Future of Intensive Livestock Production

The centrality of food security to all states' national interest cannot be dismissed, but the exigencies of providing ample nutrition and animal protein to the world's growing population need to be balanced against increased awareness of—and action on—the world livestock system's expanding hazards. For instance, increased international attention should focus on the environmental and health consequences wrought by the coming intensification of livestock systems in the less-regulated developing world.

Livestock's Long Shadow reveals that intensive livestock's global environmental dangers are severely underappreciated. In light of the FAO/LEAD study, the IBRD's

[*] Available at http://www.ammonia-ws.ceh.ac.uk/documents.html

policy recommendations may be insufficient to stave off grave long-term environmental harm. The *Managing the Livestock Revolution* recommendations represent a realistic—if quite lenient to industry—first batch of regulatory, financial and communication instruments.

However, the fact that "diffuse, non-point source pollution from agricultural production" are difficult to deal with via policy mechanisms is an insufficient reason to do nothing. It is important to recognize that the Multilateral Environmental Agreement (MEA) mechanism may be ill-suited to deal with the full scope of intensive livestock's concerns. Neither Gothenburg nor the IBRD report address how expanding agriculture in the developing world is in lock-step with growing intensive livestock demand; intensive livestock must logically hold responsibility, at least in part, for the climate ramifications of such deforestation and land-use change.

The IBRD's recommendations should be supplemented with strong financial "polluter pays" mechanisms to adjust for non-point air and water pollution, and federal states should enact federal regulations that disincentivize constituent states from becoming industry pollution havens. On a larger scale, restructuring agricultural subsidies in developed countries to assist sustainable agriculture would help enormously.

Wherever possible, livestock should be reintegrated into agricultural systems, and the WTO Committee on Trade and the Environment (CTE)—or another body with more substantial effective power—should establish environmental trade exceptions for geographically reconnecting agricultural feed grain and livestock production. As the IBRD notes, study and application of sustainable systems like E.J. Shirima's study of "dual purpose goats from crop and livestock production under small-scale peasant

systems" in Tanzania should not be undercut by intensive systems reliant upon low-cost or subsidies feed imports.

Ultimately, since intensive livestock production is directly responsible for an increasing amount of the world's industrial crop agriculture, any measure to address the environmental sustainability of intensive livestock must incorporate large-scale sustainable agricultural practices. Such practices include, but are not limited to: crop rotation, cover crops, no-till and low-till farming, responsible soil management, crop diversity, frugal nutrient management, integrated pest management, and rotational grazing. (Horrigan *et al*)

The report also underemphasizes the potentially harmful effects of livestock intensification in predominantly agricultural societies. Although increasing global urbanization requires considerable livestock intensification, excessively rapid transitions can lead—as was the case in Indonesia's poultry industry—to business failure and resulting food supply and malnutrition problems. In countries like Vietnam, where approximately 70% of the citizenry still rely upon agriculture for employment, intensification needs to be balanced with the realities of the natural and socio-economic environments. (Trach)

Both intensive and extensive livestock innovations can mitigate the industrial system's harm. Non-cereal diets for geese and ducks, like sugar cane or African oil palm, (Preston, 1992) would diminish market demand for grain. IO research, think tanks and academic institution—for example, the Cornell University Nutrient Management Planning System (*cu*NMPS)—can help to protect air and water quality while maintaining profitability.

Although the IBRD study prioritizes public awareness programs, it is wrong to dismiss NGO and grassroots efforts to promote ecolabeling or certification programs and minimal meat consumption; such efforts mitigate the inevitable future harm caused by increased global meat demand. Although such consumer choice is still relatively rare, modern protein alternatives and ethical considerations of human and animal welfare and of the future health of the planetary ecosystem guarantee that such voices will only grow stronger.

It is imperative that governments do not allow industry representatives to carry the terms of the debate:[*] national governments should legislate public access to CAFO hazard and welfare information to allow consumer choice freer reign in directing demand.

[*] A study conducted in North Carolina indicates that hog industry coercion can dissuade effective study of adverse health and environmental effects of manure 'lagoons' on the rural poor. (Wing) Such cases indicate the need for greater regulatory presence.

REFERENCES

Barrett, Julia R. "Livestock Farming: Eating Up the Environment?" *Environmental Health Perspectives* 109, no. 7 (2001).

Bennett, R. "Measuring Public Support for Animal Welfare Legislation: A Case Study of Cage Egg Production." *Animal Welfare* 7 (1998): 1-10.

Bleken, M.A. and L.R. Bakken. "The Nitrogen Cost of Food Production: Norwegian Society." *AMBIO - A Journal of the Human Environment* 26, no. 3 (1997): 134-142.

Brooman, S., and D. Legge. "Animal Welfare *vs.* Free Trade – Free Trade Wins: An Examination of the Animal Welfare Implications of R v Ministry of Agriculture, Fisheries and Food *ex p* Compassion in World Farming (1998)." *Animal Welfare* 9 (2000): 81-85.

Brusnma, J., ed. *World Agriculture: Towards 2015/2030, an FAO Perspective*. FAO. Rome and London, Earthscan, 2003.

Carpentier, Chantal Line, Deepananda Herath, and Alfons Weersink. "Environmental and Other Factors Influencing Location Decisions of Livestock Operations." Winrock International, 2000.

Chapin, Amy. **"**Airborne Bacteria in CAFOs**:** Transfer of Resistance from Animals to Humans." *Environmental Health Perspectives* 113, no. 2 (2005).

Chasek, Pamela S., David L. Downie, and Janet Welsh Brown. *Global Environmental Politics, 4th Ed.* Boulder, CO: Westview Press, 2006.

Cole, D.J.A. and G.C. Brander. *Ecosystems of the World 21: Bioindustrial Ecosystems.* New York: Elsevier, 1986.

"Comparison of the EU and US Approaches Towards Acidification, Eutrophication and Ground Level Ozone." *Assessment of the Effectiveness of European Air Quality Policies and Measures*, case study 1. A project for DG Environment carried out by Milieu Ltd, the Danish National Environmental Research Institute, and the Center for Clean Air Policy. 4 October 2004.

Delgado, Christopher, Mark Rosegrant, Henning Steinfeld, Simeon, Ehui, and Claude Courbois. "Livestock to 2020: the Next Food Revolution." International Food Policy Research Institute. Food, Agriculture, and the Environment Discussion Paper 28, 1999.

Donham, K.J. **"**The concentration of swine production. Effects on swine health, productivity, human health, and the environment." *Food Animal Practice* 16, no. 3 (2000): 559-597**.**

Durning, Alan B. and Holly B. Brough. *Taking Stock: Animal Farming and the Environment*. Worldwatch Paper 103, 1991.

Executive Body for the Convention on Long-Range Transboundary Air Pollution. Economic Commission for Europe. Seventeeth Session, Gothenburg (Sweden). 29 November-3 December 1999.

"FAO: Globalized Livestock Markets Pose Potential Risk to Human Health (Brief Article)." *Europe Agri* (2005): 407.

Galbraith, John Kenneth. *The New Industrial State*. Boston: Houghton Mifflin Company, 1967.

Global Environment Outlook 2000, United Nations Environment Program.

Gold, Mark. "The Global Benefits of Eating Less Meat: a Report for Compassion in World Farming Trust." Compassion in World Farming Trust, 2004.

Hall, A. L. "The Effect of Stocking Density on the Welfare and Behavior of Broiler Chickens reared Commercially." *Animal Welfare* 10 (2001): 23-40.

Hodges, John. "Animals and Values in Society." *Livestock Research for Rural Development* 11, no. 3 (1999).

Horrigan, Leo, Robert S. Lawrence, and Polly Walker. "How Sustainable Agriculture can Address the Environmental and Human Health Harms of Industrial Agriculture." *Environmental Health Perspectives* 110, no. 5 (2002).

"In the Name of Progress: How soya is destroying the Amazon rainforest;" available from http://www.greenpeace.org.uk/forests.

Kyprianou, Markos. EC Member, Health and Consumer Protection, "Speech to the Animal Welfare Intergroup of the European Parliament." 8 June 2005.

"Livestock a Major Threat to the Environment: Remedies Urgently Needed;" available from http://www.fao.org/newsroom/en/news/2006/1000448/index.html.

"Livestock impacts on the environment" Agriculture 21; available from http://www.fao.org/ag/magazine/0612sp1.html.

Merkel, Michele M. “EPA and State Failures to Regulate CAFOs under Federal Environmental Laws,” Outline of Remarks Prepared for the National Commission on Industrial Farm Animal Production Meeting, September 11, 2006.

Naylor, Rosamond, Henning Steinfeld, Walter Falcon, James Galloway, Vaclav Smil, Eric Bradford, Jackie Alder, and Harold Mooney. “Losing the Links Between Livestock and Land” *Science* 310 (2005): 1621-1622.

Pehu, Eija and Cornelis de Haan. “Managing the Livestock Revolution: Policy and Technology to Address the Negative Impacts of a Fast-Growing Sector.” The World Bank, 2005.

Preston, T.R. and Leng, R.A. “The Greenhouse effect and its implications for world agriculture. The need for environmentally friendly development.” *Livestock Research for Rural Development* 1, no. 1 (1989).

Preston, Thomas R. “Alternative non-cereal diets for poultry,” *Livestock Research for Rural Development* 4, no. 3 (1992).

Summary of Critical Air Quality Issues in the Transboundary Region. Report from the International Air Quality Advisory Board to the International Joint Commission.” January 2004.

Shirima, E.J.M. “Benefits from dual purpose goats for crop and livestock production under small-scale peasant systems in Kondoa eroded areas, Tanzania.” *Livestock Research for Rural Development* 17, no. 12 (2005).

Speir, Jerry, Marie-Ann Bowden, David Ervi, Jim McElfish, and Rosario Pérez Espejo. “Comparative Standards for Intensive Livestock Operations in Canada, Mexico, and the US.” Prepared for the Commission for Environmental Cooperation. 4 February 2002.

Taylor, David A. “From Pigsties to Hog Heaven?” *Environmental Health Perspectives* 109, no. 7 (2001): 328-331.

Trach, Nguyen Xuan. “Possible consequences of inappropriate intensification of animal production in Vietnam and approaches to avoid.” *Livestock Research for Rural Development* 15, no. 1 (2004).

Wing, Steve. “Social Responsibility and Research Ethics in Community-Driven Studies of Industrialized Hog Production.” *Environmental Health Perspectives* 110, no. 5 (2002): 437-444.

Wolfson, David J. “Beyond the Law: Agribusiness and the Systemic Abuse of Animals Raised for Food or Food Production.” *Animal Law* 2, no. 123 (1996).