Science for Peace

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A Tribute to Shirley Farlinger

by Janis Alton & Vicki Obedkoff

Shirley's death on December 18, 2012 was somewhat a surprise, because time and again she had successfully rebounded from cancer's grip. Her sparkle, humour and good sense were woven into the work of Science for Peace, among many other organizations. Shirley's peace activism, like her life, was filled with passion. It was no less than seeking to build a culture of peace! For example, along with her many friends such as those in Canadian Voice of Women for Peace, she lobbied steadily for the abolition of war and its system. With VOW, she travelled often to the UN, mostly to its headquarters in New York but also to Vienna and Geneva. She took these opportunities to push for various disarmament issues and, it seemed to her travel mates, to effortlessly produce fulsome reports of many of these international encounters.

In the midst of this, Shirley took time out (1993) to learn more and enrolled in the fledgeling European Peace University based in a beautiful castle in a colourful town not far from Vienna. Here she thrived on the teachings of itinerant scholars from far and wide, including the "Father of Peace Research" Johann Galtung.

Perhaps equally, she wore a feminist hat which on several occasions expressed itself through her witty plays on the long overdue victories of Canadian women being rightfully declared persons, and the more recent right of women, globally, to be included in decision-making related to all aspects of peace building - from prevention to post conflict reconstruction. These plays stand as examples of resources Shirley's creative self contributed to the cause. One of the latest was a package of greeting cards with satirical, illustrated messages meant to wake us up about environmental threats. She was the change she wanted to see – zealous, optimistic, studious, creative and unfailingly supportive to companions in this mammoth struggle for a peaceful world. How we will miss her! ***-Janis Alton***

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I miss Shirley, that lovely spirit, a wonderfully witty, warm friend. Her father was a stretcher-bearer in the First World War, and the horror he witnessed strongly influenced Shirley to become one of Canada's most passionate peace activists. Learning from her first- born son Brian, an AIDS activist, Shirley dedicated the last thirty years of life to world peace, the environment, and women's equality. To improve her writing and advocacy skills she returned to university, graduating with a journalism degree in 1980. In 1988, Shirley ran in the federal election against the Minister of National Defence, Perrin Beatty, in order to highlight peace issues.

Throughout her entire life, Shirley remained a faithful and active member of the United Church of Canada. In 1984 the UCC set aside half a million dollars for a Peacemaking Fund dedicated to making peace education and advocacy a high priority for the following five years. This money seeded 150 grassroots projects across the country. Shirley served on the Working Group on Peace and Justice of the church which shaped this peacemaking fund and project. Then she wrote the story of the

Peacemaking Fund, "A Million for Peace", published in 1995. *"The sight of two boxes marked "Archives- Peacemaking Fund" at United Church House was the first catalyst for writing this book. I believe they were filled with stories that were about to be buried alive. I just couldn't let that happen."*

She captures how those funds were used as part of a continuing social movement, from nuclear weapons-free zones campaigns to church coalitions around uranium mining, to folksinger/activist Bob Bossin and the Raging Grannies with their cheeky and popular cultural work for peace. Shirley's story is found in the United Church Archive's *Making Room for Women* oral history project.

And to the very end of her life she was a board member of the International Institute of Concern for Public Health, founded by Dr. Rosalie Bertell, Grey Nun. Shirley's deft editing touch is present in the "Lives Lived" piece written by Dr. Mary Lou Harley, and published in the Globe and Mail on August 6, 2012 in memory of Rosalie.

Shirley, May Lou and myself began a book about Rosalie, and the torch has been passed to Mary Lou. The first chapter, "Why Care", starts with a quote from Rosalie:

We are part of a great chain of people who care about the Earth, about the life that gives it fruitfulness and about a world where rights would be respected, children cherished and peace prevail. We have to be part of something larger than ourselves, because our dreams are often bigger than our lifetimes.

Shirley's dreams are rippling beyond her lifetime, through our collective future.

Mary Lou loved Shirley's wicked sense of humour. They would go out to a restaurant and Shirley would pull out yellow post-it notes saying "No Nukes" from her purse, and stick them on the mirrors in the women's washroom. In 2012 Shirley and I attended the Darlington hearings where I presented the UCC's policy – maybe she left post-it notes there as well!

Her lightness and playfulness helped her deal with heavy problems. Shirley's poem 'Guantanamo' was read at the celebration of her life at Trinity-St. Paul's United Church. Shirley led us in "Prayers of the People" on Sunday mornings, even in the last months before she died. During the Nov. 20, 2011 service, the day her play "1325 Keys to Peace" was read, Shirley's spirit shone in our ecumenical prayer:

We pray with the church in Burkina Faso, Chad, Mali, Mauritania and Niger:

> **We share a common earth. We stand among each other.**
> **We share our planet,**
> **we share birth, death, hunger and love.**
> **We are the people of pain and fear,**
> **we are the people of anger and joy,**
> **we are the people of compassion and grace.**
> **In all of us is a longing for a life that will yet come,**
> **for a world that is free and just,**
> **a dream of hope for all people.** - *adapted from Wendy Robins*

Even in her dying days, she was sending out the last of her 150 published letters to the editor of The Toronto Star. That must be a record. I still open my Star and turn to the letters, expecting to see one from Shirley. ***- Vicki Obedkoff***

The following page exemplifies the work that Shirley did – it is a reply from Mordechai Vanunu in 1996 (please note that it has been redacted by the Israeli government).

Dear shirley Farlinger Jan: 19th-96

thank you for your letter. I am very glad to know that you have heard about my case. and you want to do for my release. the point is that Mr' peres who is now the prime minister I had wrote an appeal to court against his apointment as prime minister. because I claimed he is the man behind all the Israel [redacted] programs From the begining 1950s' until this days. and he also the man who was prime minister when the Israel security services kidnapped me [redacted]

So peres is not the man who will release me.

[redacted] he lies and cheated the goverment of Israel by bringing wars and terors actions on Israel to [redacted]. he used the Jewish Holocaust to justify the [redacted] Israel.

peres never want peace with the Arabs. he need enemies and wars. For making Israel a state that is in dangers. to receive sympaty and support From all the world. and make the Arabs the hostiels. and the very bad - the Evil. but now after my revelations 9 years ago all the world demanding From Israel to do peace. and peres must do peace despite all his cheating and puting many obstecles in the way. the Future is peace and [redacted] and also my release, Freedom. Now. about you I would like to know more about you. you can write. and you can send packages. [redacted] C. Ds. [redacted]

yours Sincerly

Vanunu Mordechai J.C.

President's Corner: Constraints on Freedom of Scholarship and Science

by Metta Spencer

Most Science for Peace members are "knowledge workers" in the new "knowledge economy." Increasingly, people in rich countries earn our living by producing and trading symbols—notably words, equations, maps, and musical notes—instead of physical goods. This surely is an improvement over my grandfather's career; he spent 60 years walking back and forth across a field behind a horse and plow (later on a tractor) producing food and fiber. The knowledge economy also is improving the environment by decreasing our need for finite material resources. Let's celebrate.

Yet there are many unresolved (barely even recognized) questions about the organization of our own work. We are finally becoming aware of these issues because of the growing political crisis involving Canadian researchers. (See, for example, http://www.theglobeandmail.com/news/politics/tories-accused-of-trying-to-bury-climate-research/article10357515/) Some of us are planning protest actions to defend the many institutions and jobs that the Canadian government has been eliminating.

Yet a deeper analysis is also required. It's time now for privileged knowledge workers to review these issues ourselves in a sustained, serious investigation. Is our work "alienated labor"? We produce ideas and knowledge and then, like factory workers, no longer "own" our products or control their use. Perhaps, like the nuclear scientists at the Manhattan project, we should stop, think, and become more responsible for our own work.

How problematic are the current institutions of knowledge production? Admittedly, symbols are very different from material products and cannot be "alienated" in the sense that Marx meant the word. For one thing, information is not subject to the first law of thermodynamics—the conservation of energy. If I make a widget and you take it from me, I no longer have it. But ideas are different; if I write a poem or solve a mathematical problem, I can have it and so can you—and everyone else who learns it.

Knowledge is not scarce; we can share it with everyone—but for various reasons (some of them valid) we do not always do so. When and how to disseminate our knowledge responsibly is sometimes arguable—and frequently restricted legally, e.g. by intellectual property rights, national security concerns, or publishers' routines for choosing and publicizing manuscripts.

Many Science for Peace members are supported by public funds to generate knowledge, so it is fair for the public to ascertain which of our projects are good investments to benefit society. It is politically fair to demand that scholars and scientists really be "worth our salt." Unfortunately, however, no *objective* gauge is (or probably ever will be) available to ascertain this, for the verdict depends not only on calculable costs and benefits but also on personal values. Nevertheless, all of us probably ask ourselves during "dark nights of the soul" whether we are really serving humankind optimally.

Who should make such judgments? Normally, and preferably, researchers validate their results mutually by submitting to "peer review," whereby only accredited members of their profession judge the importance and quality of their projects. Lately, however, without publicly declaring that it was doing so, the current government of Canada seems to have decided that many scientific studies either are not worth the price or even are antithetical to the success of our economy. Even universities are being re-structured so as to foster research with commercial applicability.

This is not merely a Canadian phenomenon. Friends in other countries have been telling me that exactly the same constraints are being placed on their own scholars and scientists. However, I do not know of any comparative study that has been made, so I cannot guess whether it is happening only in a few countries or whether it is a world-wide trend. Nor can I say what historic changes are driving the trend, or which interventions have successfully reversed it.

But fortunately, Science for Peace comprises scholars with sufficient qualifications and research skills to investigate the situation ourselves and reach a credible assessment. Besides writing protest letters about science policy to Ottawa, we should investigate the situation in a systematic way. I suggest that we do so.

The studies that seem most seriously in jeopardy at present are conducted by scientists in government-run institutions. Some of our members are already devoting their attention primarily to those cases, and every day the newspapers report the shutdown of yet another research institution. Several scholars throughout Canada are compiling lists, and the Canadian Association of University Teachers is launching a two-year campaign to oppose the "muzzling of scientists."

However, the constraints on scholarship are far more common than these newsworthy cases, and we require a study of the institutions and vested interests that facilitate or impede various kinds of research. I intend to engage in this investigation for several months this summer, interviewing scholars who have some first-hand acquaintance with muzzling, or who are studying relevant institutional developments. Some studies are already going on. For example, I went to a debate recently over the pros and cons of commercializing research in the universities. If we can bring some of these researchers together, their findings can be shared in a conference in a year or so. The proceedings may be helpful to CAUT and other activist campaigns. However, because many constraints on research are ubiquitous and traditional, anyone organizing such a project must specify a narrow range of phenomena to explore. I suppose we must exclude certain types of knowledge, such as *tacit* knowledge, *artistic* creations (e.g. in music, fiction, and drama), computer and other *digital* research, and *journalism*. "Tacit" knowledge consists of capacities that cannot be taught through language. For example, some of us (not I) can ride a bike, but we cannot teach others by telling them how. If such tacit knowledge can be taught at all it is only through personal contact—demonstrations rather than written manuals. People working in the performing arts and in such fields as dentistry generate tacit knowledge that our study cannot cover. (Anyway, I don't know whether it is ever suppressed.)

Second, I would hesitate to include the suppression of Internet knowledge. It is an immensely important and urgent topic—probably the most fateful one of all, if you listen to Ron Diebert (please watch his TED lecture)— but there may be no Science for Peace members who could do the work. The mysterious realm of hacking, building firewalls, and negotiating international governance of the Internet is probably beyond the scope of this project.

Third, I would exclude the constraints against artistic production, though the arts certainly are censored at times, as we all know from the cases of Salman Rushdie and Boris Pasternak. However, there are already organizations that defend those knowledge workers better than we could: PEN, for example, and in the UK the Index on Censorship, which was created by Soviet dissidents as a way of publishing their *samizdat* writings. It still provides opportunities for censored writing to be published. Fourth, journalists also sometimes have their findings suppressed (and in Russia they are even murdered), but I do not propose that we include them in our study of scholarship and science. They have excellent champions in such organizations as the Committee to Protect Journalists, and the various Civil Liberties Unions. In California there is "Project Censored," which identifies the 25 most censored news stories of each year, and even publishes them.

I hope that some Science for Peace friends will join me in interviewing scientists or colleagues from their own disciplines about their research experiences and fears, including times when they may have self-censored in order to avoid problems. Those interviews can inform our agenda for a conference to be held in a year or so.

In 1991 a Science for Peace Committee produced the "Toronto Resolution," which consisted of twelve considerations that should be addressed by all codes of ethics for scientists. This meeting occurred at the end of a Royal Society conference on "Constraints on Freedom of Scholarship and Science." Several members of Science for Peace's ethics committee have reassembled, intending to revisit the question today. Our focus will not be on revising ethical principles for *individual* researchers but on the ethical issues involved in research *institutions*. We hope that a new discussion can be generated concerning the constraints on scholarly and scientific knowledge.

This analysis may look beyond the simpler forms of censorship and consider certain basic vectors that shape the quality of intellectual products. Let me mention a few such determinants.

One vector is the *intellectual environment*. The excellence of research depends initially on the importance of the question that is being addressed by the study. Brilliant questions are rare, so studies of trivial questions are common—but worth little.

My teacher, Karl Popper, used to say that a genius was a person with a great nose for interesting problems. But geniuses apparently flock together—you find them in certain times and places more than others. Intellectual stimulation requires contact with others who are different from oneself. Dense city life is more stimulating than country life, as Richard Florida has pointed out, and some city universities are more stimulating than others. An aspiring researcher will go to the most interesting work environment possible, but the social setting is only one of the factors that enhance the likelihood that she will produce wonderful knowledge, and it is not a vector that astute policymaking can rectify.

Another vector is *support*—both moral and financial. Academics submit proposals for funds—or more often they tailor their research proposals to fit the kinds of projects for which funding has already been allocated. Thus the government or major corporations influence the nature of research by making grants available for specific types of investigation. This is especially obvious when a huge project is designed that will employ thousands of scholars—a Manhattan project, a trip to the moon, or the Large Hadron Collider. Probably no amateur will ever win a Nobel Prize again by fiddling with test tubes in her garage. Of course, though we recognize this limitation we do not call it censorship, nor do we consider the garage science project "constrained" — though in a way, it is.

We do call it constraint, however, when a research laboratory is shut down by authorities who evidently dislike the findings that are emerging there. This is more likely the fate of a government-owned lab than a university facility because government employees are contractually constrained from attacking their government's policies while it employs them. (Military officers are likewise muzzled until they retire.) Public universities, on the other hand, generally uphold the principles of academic freedom. (However, in some countries private institutions such as religious universities do not have to promise academic freedom to their professors.) When addressing the *funding vector,* an astute analysis of the decision-making procedures of research institutions may greatly release the constraints on research.

Finally, the researcher needs to *disseminate* her findings. Submitting the manuscript can be an adventure in itself, for there's a critic lurking behind every tree. This is the stage where the suppression of knowledge normally becomes apparent. Nice people who aver a deep commitment to freedom of expression and intellectual debate often try to silence views that they disapprove. Not only governments, but also publishers, corporate interests, competing scholars, and nationalistic or faith groups sometimes try to prevent the dissemination of ideas that they dislike. Many academics can tell grim stories about the suppression of their work on grounds other than its quality. (I myself have two books remaining unpublished because they would have offended certain people.)

Peer reviewing (especially by anonymous reviewers) is our preferred means of preventing the suppression of research, and it may be the optimum procedure, but nothing is perfect. As an editor of a magazine I must admit that on occasion our editorial board rejects a submission that is cogent and well-written, just because we dislike its conclusions. That's simply human and we'll never eliminate all such instances of subjective bias.

However, maybe we can spot certain systematic distortions. Conceivably our universities and research centres can be improved by procedural innovations that liberate scholarly production. If you are interested in participating in this project, let's talk about it.

Board & Executive Nominations / AGM 2013

by The Science for Peace Nominations & Elections Committee 2013:

Janis Alton, David Burman & Timothy Donais

Nominations for positions on the Board of Science for Peace are now open until May 15th. Nominees are requested to submit two nominations from Science for Peace members (including a self-nomination) and a biography (100-250 words). Members will be polled for their approval of the Nominees between May 15th and May 31st. Results of this poll will be presented to the AGM for their consideration before the official voting for Board Members takes place at that same meeting. Terms on the Board of Science for Peace are two years.

Nominations are also open until May 15th for the position of Secretary and two positions of Member-at-Large of the Science for Peace Executive Committee. These Executive Committee positions require the ability to meet at least once per month in person or via Skype to lead the organization. Nominees are requested to submit two nominations from Science for Peace members (including a self-nomination) and a biography (100-250 words). Members will be polled for their ranking / approval of the Nominees between May 15th and May 31st. Results of this poll will be presented to the AGM for their consideration before the official voting for Executive Committee Members (which takes place at the Board Meeting which is held immediately after the AGM). Terms on the Executive Committee of Science for Peace are two years.

The Science for Peace Annual General Meeting 2013 will be held on June 1st at 2pm – 4pm in the North Dining Room of Hart House (7 Hart House Circle, Toronto, ON, M5S 3H3). All members who have paid their dues until that date are eligible to vote for Board members at the meeting. A Board Meeting is held immediately after the AGM to elect Executive Committee members.

If you have given Science for Peace your email address for correspondence, a link to the poll for Board and Executive members will be sent to you via email. If you have told Science for Peace that you want to correspond via regular mail, you will receive your ballot by post. To find out if you are on our email or mailing list, to find out about your membership status, for more information on the Nominations and Elections procedure, Board and Executive duties or to submit a nomination, please contact the Nominations and Elections Committee at: sfp@physics.utoronto.ca or 416-978-3606.

The Environmental Impacts of Intensive Livestock Operations in Canada

by Paul York

Introduction

Greater worldwide demand for animal products within the last fifty years, due to increased affluence, urbanization and population growth has been facilitated by industrial animal agriculture methods (Steinfeld*et al*, 2006; Pimentel, 2004; Myers and Kent, 2003). This method, characterized by large scale, intensification, focus on economic profit, and increased use of off-farm inputs, is generically termed 'Intensive Livestock Operations' (ILOs)(Abdalla, 2002). ILOs are part of a vast network of industrial techniques and practices involving unsustainable resource consumption for the production of livestock using monoculture feed cropsthat can collectively be termed "the industrial grain-oilseed-livestock complex" (Weis, 2010a). ILOs consume vast quantities of limited resources such as water and fossil fuels, contribute to biodiversity loss, deforestationand soil erosion, and generate significant greenhouse gas emissions (GHGs) and other air pollutants detrimental to human health and natural ecosystems. The overall environmental impact of ILOs, which this paper provides a sketch, could be referred to as their "ecological hoofprint"(Weis, 2007: 45).

The meatification of diets

ILOs can be understood within an historical context. Meat, eggs, milk, and seafood consumption are the fastest growing segment of global food consumption patterns (Halweil and Nierenberg, 2008; Pimentel and Pimentel, 2003). On a per capita basis, Canadians and residents of other industrialized countries consume these animal products above global averages (Bruinsma, 2003).[1] The rate of meat consumption has increased since the 1960s: in 2006, global livestock farmers produced four times as much chicken, pork, beef and other meat as in 1961, resulting in a twofold increase in meat consumption per capita (Halweil and Nierenberg, 2008).

This centrality of animal products in human diets in industrial countries is a recent phenomenon in human history; for most of agricultural history, animal foods were on the periphery. The rapid escalation of consumption of animal products in recent decades, due to industrialization,could be referred to as the deliberate 'meatification' of diets (Weis, 2012a), precipitated byseveral related factors: industrial capitalism, increased incomes, population growth, and urbanization.[2]

The meatification of China, industrializing Asian countries, and developing nations

In recent years many developing and industrializingcountries have embraced industrial methods to meet the growing demand for animal products. The most prominent example of this pattern is China. With an annual production of about 50 million metric tonnes, China is now the world's single largest pork producing nation, with roughly 50 per cent of global industrial pig production (Schneider, 2011). Economic growth, population growth, and rapid urbanization since the late 1970s are drivers of the "meatification" of China, with the result that China is the largest animal product producer in the world (Liu and Deblitz, 2007). Many other developing and industrializing countries have followed suit, following the pattern of the importation of ILO technologies and management practices, consistent with globalization.[3]

Food security issues have been framed in terms of volatile grain and oilseed markets in Asian markets, and the call for increases in food production to meet growing human populations, but this solution does not take into account the biophysical contradictions of the industrial grain-oilseed-livestock complex, and how they are worsening worldwide inequality by taxing the limited resources and environmental burden of industrializing economies (Weis, 2012b).

ILOs in the U.S. and Canada

The U.S. and Canada are generally recognized as major centres for industrialized agricultureand industrialized livestock production. As of 2007, the U.S. and Canada together produced 14 per cent of the world agro-exports by value, and accounted for 15 per cent of the world's agricultural GDP (FAO, 2007a; Tables C.1., C.2). Livestock production in the U.S. and Canada is centered upon three species – cattle, chicken and pigs – which account for virtually all animal flesh, as well as derivatives like eggs and dairy products (FAO, 2007a; Table B.2; FAOSTAT, 2009). Most of the livestock (including nearly all the chickens and pigs) are raised in homogenized, warehouse conditions on a massive scale. These arrangements are euphemistically termed 'concentrated animal feeding operations' or CAFOs (Weis, 2007: 19).

In industrialized nations, ILOs are based on

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[1] For example, the per capita consumption of meat in industrialized countries went up 61.6 kg per person per year in 1964-66 to 88.2 kg in 1997-99, and is estimated to increase to 100.1 kg by 2030. In developing countries, it was 10.2 kg in 1964-66, 25.5 kg in 1997-99, and is estimated to be 36.7 kg by 2030. There has been a steady increase in meat and milk consumption in industrialized countries and a rapid increase in developing countries since the 1960s. See J. Bruinsma ed. *World agriculture: towards 2015/2030. An FAO perspective*. Rome, Food and Agriculture Organization of the United Nations/London, Earthscan, 2003, referenced in World Heath Organization. "Global and regional food consumption patterns and trends: Availability and change in consumption of animal products" available online at http://www.who.int/nutrition/topics/3_foodconsumption/en/index4.html

[2] "Annual meat production is projected to increase from 218 million tonnes in 1997-1999 to 376 million tonnes by 2030. There is a strong positive relationship between the level of income and the consumption of animal protein, with the consumption of meat, milk and eggs increasing at the expense of staple foods. Because of the recent steep decline in prices, developing countries are embarking on higher meat consumption at much lower levels of gross domestic product than the industrialized countries did some 20--30 years ago."World Health Organization.*Diet, nutrition, and the prevention of chronic diseases.* WHO Technical Report Series, no 916, p. 20. Available online at http://www.who.int/dietphysicalactivity/publications/trs916/en/gsfao_global.pdf

[3] The industrialization of livestock in developing nations has been aggressively pursued as part of agenda of increased economic growth in those regions, as illustrated by C. Devendra and P. Gardiner in *Global Agenda for Livestock Resarch* (1995) International Livestock Research Institute, Nairobi, Kenya.

a model of economic efficiency, with animals kept in small, confined spaces to maximize their growth, feed conversion and speedy transport to market (Weis, 2007: 19). These production methods disrupt the traditional 'short cycle' system between crop and livestock production where smaller numbers of animals are produced on larger areas of land, enabling the recycling of wastes as fertilizer in manageable quantities (FAO, 2005). The use of external inputs, in the form of industrial agro-chemicals, has undermined the importance of localized ecological knowledge in agriculture (Weis, 2010a).

Transnational corporations have driven technological advances in processing, packaging, refrigeration, transportation and food safety, thus overriding previous limits to centralization imposed by perishability and increasing fossil fuel consumption at every stage in the process (Weis, 2010). As P. S. Hooda*et al* have noted, the post-war "move from mixed arable–livestock farming towards greater specialization, together with the general intensification of food production have had adverse effects on the environment" (Hooda*et al*,

2000). These effects can be described in terms of inefficiency ratios in the use of finite resources.

<u>Inefficiency ratios</u>

A major defining characteristic of ILOs, in terms of their use of finite resources for food production, as compared to food production plant-based diets, is their gross inefficiency, exceeding the biophysical limits of the planet (Weis, 2010a).An inherent component of the intensive animal agriculture model is the production of monoculture grain crops for livestock feed, which replaces the grass and forage traditionally provided in pre-industrial models. These concentrated diets enable rapid growth, reducing the time required for animals to reach market weights in a shorter time than traditional animal agriculture. The 'management' model of ILOs includes selective breeding and genetic engineering to increase total product value relative to body size, higher rates of reproduction, and "more efficient lean growth to market live weight and earlier sexual maturity" (Dickerson, 1970).

Despite providing short-term economic gains, grain-based feeding systemsare hugely inefficient, with only ten percent of the plant matter consumed by livestock being converted into edible animal protein (Godfray*et al.*, 2010). As a result, land requirements for livestock production are, on average, ten times greater than those for plant production, with fossil energy requirements about eleven times greater (Leitzmann, 2003; Pimentel and Pimentel, 2003).

Globally, industrially reared livestock use up about one third of the world's arable land and its grain harvests (FAO, 2007). In Canada and industrialized nations the percentage is much higher: seventy per cent of all agricultural land used goes toward livestock production, most of it indirectly through feed crop production (Steinfeld*et al*, 2006:

Environment and land	Total land for grazing	3,433 million ha or 26 per cent of terrestrial surface	
	Grazing land considered degraded	20 to 70 percent	
	Total land for feed crop cultivation	471 million ha or 33 per cent of arable land	
Environment: air and climate	Livestock's contribution to climate change in CO_2 equivalent	18 percent	Includes pasture degradation and land use change
	Livestock's share in carbon dioxide emissions	9 percent	Not considering respiration
	Livestock's share methane emissions	37 percent	
	Livestock's share in nitrous oxide emissions	65 percent	Including feed crops

Table 1: Global Facts About Livestock: land, air, climate (Steinfeld*et al*, 2006: 271).

xii) (See Table 1). Overall, feed crop production is the single largest environmentally destructive component of ILOs.

Inefficient feed conversion ratios touch on three major allocations of finite resources – energy (in the form of fossil fuels), water and land – often termed "inputs." For example, roughly three quarters of all freshwater use is for industrial agriculture and in industrialized nations over half of that amount is used for feed crops (Steinfeld*et al.*, 2006). Far more energy, water and land are used to produce one unit of industrially produced animal-based food for human consumption than is used to produce one unit of industrially produced plant-based food (see Table 3).

<u>The paradigm of production</u>

The livestock sector impacts a wide range of natural resources through unsustainable consumption and production patterns. The industrial animal agriculture system, highly prized for its ability to produce an immense quantity of inexpensive food to consumers, is based on economies of scale, where unsustainable 'technological fixes', such as the use of industrial fertilizers,are central to the paradigm of production, and externalized costs such as environmental destruction are easily undervalued and masked behind an aura of plenty (Weis, 2010a).

<u>Natural resource depletion is a human rights issue</u>

The depletion and/or degradation of these resources is not only an environmental and wildlife conservation concern, but also a human rights issue of the first order, given rapidly mushrooming global human populations relative to finite resource depletion (Gleick, 1999). The United Nations has declared that access to water is a human right (United Nations, 2010). Given that ILOs are the single largest industrial user of this vital resource, it could reasonably be argued that they represent a threat to human rights.The same argument applies to global warming: it is now generally recognized as the human rights issue, given the growing number of eco-refugees, displaced by global-warming related events (Myers, 2002).

The moral imperative of resource conservation, in consideration of basic needs of current and future generations, is neglected in favour of the capitalist imperative of short-term economic gains at any cost.Increased meat and milk production and consumption are frequently framed as beneficial for human health and prosperity by ILO industries and governments, but this framing does not take into account the real human costs of environmental externalities. These costs are hidden behind an aura of prosperity (Weis, 2010a). David Loy refers to "the religion of the market," to describe the worldview promoted by economists who subscribe to a"gospel of sustained economic expansion"without regard for the environmental destruction it causes (Loy, 1997). This worldview does not accept the idea of biophysical limitations, preferring instead to advance technological solutions for environmental problems, for the sake of advancing economic imperatives such as the meatification of society or the expansion of the Alberta oil sands, in violation of the 'precautionary principle.'

<u>Plant-based versus animal-based diets</u>

Pimentel and Pimentel (2003) conclude that "the meat-based food system requires more energy, land and water resources than the lactoovovegetarian diet." It is reasonable to suppose that even more energy, land and water would be saved by an entirely plant-based diet. Given that human beings are able to sustain healthy lives without consuming animal-based foods,[4] it could be argued that industrial animal agriculture is one of

[4]There are numerous medical studies that argue that vegan diets are healthier than diets based on animal products or that animal products are unhealthy and can cause cancer and other preventable diseases. These include T. Colin Campbell; Thomas M. Campbell.(2006) *The China Study.*BenBella Books Inc.; GanmaaDavaasambuu. "The possible role of female sex hormones in milk from pregnant cows in the development of breast, ovarian and corpus uteri cancers" (2005) *Medical Hypotheses.*Vol 65, Issue 6, pp 1028-1037; and Neal Barnard *et al*. "A Worksite Vegan Nutrition Program IsWell-Accepted and Improves Health-Related Quality of Life and Work Productivity" (2010) *Annals of Nutrition & Metabolism.* Issue 56. pp 245-252.[5] The distinction between luxury and necessary activities that cause greenhouse gas emissions, made by James Garvey in *The Ethics of Climate Change* (2008) can be extended to luxury and necessary natural resource use, to argue that consumption of animal products is unnecessary and wasteful, environmentally.

the most unnecessary and unsustainable types of consumption of finite resources in present-day industrial society. This argument rests on the distinction between luxury and necessary uses of natural resources[5] and the designation of the consumption of animal products – especially those produced by ILOs – as a major source of luxury emissions.

Environmental impacts caused by ILOs

The environmental impactsof ILOs can be broken down into several key areas: greenhouse gas emissions, water stress, water pollution, air pollution, land use change, land degradation, energy consumption, deforestation, habitat destruction and loss of biodiversity. This paper will provide a quick survey each of these areas.

Greenhouse gas emissions

Environmental externalities extend far beyond their borders, and in the case of greenhouse gas emissions have significant global implications. ILOs play a significant part in Canada's per capita greenhouse gas footprint, which at 23.14 tonnes CO_2equivalent in 2005 is among the highest per capita GHG emissions rates in the world (Environment Canada, 2007). This fact is made even more reprehensible by the fact that Canada has had a prominent role impeding multilateral action on climate change (Weis, 2010a).[6]

According to an important study by the Food and Agriculture Organization (FAO) of the United Nations, *Livestock's Long Shadow* (2006),18 per cent of all anthropogenic greenhouse gas emissions associated with ILOs are attributable to livestock production, globally.[7]Environment Canada estimates GHGs from agriculture at 8 per cent of the national total, or 460 kt/CO_2 equivalent (Environment Canada, 2010); however, this figure does not appear to include some of the variables included in the FAO study.[8] Another possible reason for the discrepancy is due to the percentage related to energy-related emissions (55 per cent) and transportation (28 per cent) (Environment Canada, 2010), which are far higher than the global averages referred to by the FAO 2006 report – perhaps due to the Alberta oil sands and Canada's large geographic footprint, or perhaps due to the use of different standards of measurement. Another possible factor is that the single largest source of emissions related ILOs is caused by deforestation, which occurs to a greater extent in the global south than in the global north (Steinfeld*et al*, 2006: 91).

Environment Canada notes that significant increases in GHG emissions from the agricultural sector since 1990 are due to "the expansion of the beef cattle and swine populations, and increases in the application of synthetic nitrogen fertilizers in the Prairies. Beef, swine and poultry populations in Canada are 23%, 19% and 31% higher, respectively, than in 1990. The significant growth in animal populations largely accounts for the 19% increase in emissions, from 29 to 34 Mt CO_2eq in emissions associated with animal production over the 1990-2009 period" (Environment Canada, 2010).

[5] The distinction between luxury and necessary activities that cause greenhouse gas emissions, made by James Garvey in *The Ethics of Climate Change* (2008) can be extended to luxury and necessary natural resource use, to argue that consumption of animal products is unnecessary and wasteful, environmentally.

[6]Germanwatch and Climate Action Network Europe ranked Canada fourth from the bottom 57th out 60 nations (or "very poor"), and last out of the 10 largest CO_2 emitters, on the Climate Change Performance Index, Dec 2010, available online at http://www.germanwatch.org/ccpi.htm Canada's total emissions are 2% of the global total, but the population of Canada is 0.5% of the total world population, with the result that Canada has among the highest *per capita* GHG emissions in the world. The increase in GHGs in Canada is 25% between 1990 and 2005, outpacing population growth in that period (17%), which means that per capita GHGs have gone up as well, reaching 23 tonnes CO2 equivalent per person in 2005 (Environment Canada, 2007).

[7]Eighteen per cent (see Table 1) is based on an estimate that 7,516 million metric tonnes per year of CO_2 equivalents (Steinfeld*et al*, 2006: 113). It is worth noting that a subsequent report, published in response to the FAO report, measures global GHG emissions from ILOs at much higher rate: Goodland Anhang say that ILOs emit 32,564 million metric tons or 51 per cent of the global total and that the discrepancy is due to alleged overlooked and undercounted data (Goodland and Anhang, 2009:11).

[8] Environment Canada refers only to enteric fermentation [in ruminants], manure management, and agricultural soils (Environment Canada, 2010: 104), and does not specifically mention housing and machinery, processing, transportation, or waste disposal.

GHGs can be broken down in three greenhouse gases: methane (CH_4),[9] nitrous oxide (N_2O)[10] and carbon dioxide (CO_2). The first two gases are measured as CO_2 equivalents, based on the

measurement that methane is 21 times more effective at trapping heat than CO_2, and nitrous oxide is 296 times more effective that CO_2. Because the higher heat-trapping properties of CH_4 and N_2O are greater than that of CO_2, they pose a significant threat insofar as they are able to precipitate what is commonly referred to as the "tipping point" of

runaway climate change.[11] In other words, the deliberate "meatification" of society is in large part responsible for the accelerating a process that represents a significant threat to human civilization, biodiversity, and the life systems of Earth, insofar as it is responsible for the conditions accelerating catastrophic climate change.

Total global anthropogenic CO_2 emissions related to ILOs are 24 to 31 billion tonnes, most of which is due to deforestation (Steinfeld*et al*, 2006: 113). Total N_2O emissions are 3.4 billion tonnes, the greatest part of which relates to manure emissions. Total CH_4 emissions are 5.9 billion tonnes, the greatest part of which issues from enteric fermentation from the digestion of ruminants. The total of the three gases is 33 to 40 billion tonnes per annum; 4.6 to 7.1 billion toonesof that is directly from livestock related activities, and rest is due to

Life cycle stage	Process creating emissions	Type of emissions
Production of feed crops	Production of nitrogenous and other fertilizers, agricultural machinery, pesticides	N_2O emissions from grazing land, fertilizer production, CO_2 from fertilizer production
Housing, maintenance, machinery	Heating, lighting, etc.	CO_2
Digestion (ruminants)	Enteric fermentation	CH_4
Waste products	Manure and urine	CH_4 and N_2O
Slaughtering, processing, waste treatment	Machinery, cooking, cooling, chilling, lighting, leather and wool production, rendering and incineration	CO_2 and refrigerant emissions
Transport, storage, packaging	Transport, chilling, lighting, packaging materials	CO_2 and refrigerant emissions
Domestic consumption	Refrigeration and cooking	CO_2 and refrigerant emissions
Waste disposal	Transport, composting, anaerobic digestion and incineration	CO_2, CH_4 and N_2O

Table 2. Livestock life cycle and associated emissions (Garnett, 2007).

[9]Methane. "Once emitted, methane remains in the atmosphere for approximately 9–15 years. Methane is about 21 times more effective in trapping heat in the atmosphere than carbon dioxide over a 100- year period . . . The IPCC has estimated that slightly more than half of the current CH_4 flux to the atmosphere is anthropogenic . . . Total global anthropogenic CH_4 is estimated to be 320 million tonnes CH_4/yr, i.e. 240 million tonnes of carbon per year (van Aardenne*et al*, 2001). This total is comparable to the total from natural sources (Olivier *et al*, 2002)" (Steinfeld*et al*, 2006: 82).

[10] "Nitrous oxide . . . is present in the atmosphere in extremely small amounts. However, it is 296 times more effective than carbon dioxide in trapping heat [its Global Warming Potential or GWP] or and has a very long atmospheric lifetime (114 years)" (Steinfeild*et al*, 2006: 82). "Nitrogen inputs to agricultural systems contribute to emissions of the greenhouse gas nitrous oxide. Rice paddy agriculture and livestock production [the latter being dominant in Canada] are the most important anthropogenic sources of the greenhouse gas methane (Tilman*et al*, 2002: 673).

[11]The "tipping point" is defined as the critical point at which accentuated positive feedbacks, such as the albido effect at the Earth's poles or the loss of carbon sinks through deforestation, could lead to runaway climate change. The worst case scenario, discussed by James Hansen, is the Venus Syndrome, so-called because in this model positive feedbacks would lead to temperature increases of hundreds degrees Celsius, similar to the atmosphere of Venus, effectively eradicating life on Earth's surface (Hansen, 2009).

feed crop production and land use change (Steinfeld*et al*, 2006: 113).

ILOs emit greenhouse gases in several ways (see Table 2). For the sake of brevity, just feed crops, animal digestion, manure, and transportation will be examined.

Feed crop production emissions

Greenhouse gases emitted during the entire feed crop production life-cycle represent the single largest source of GHGs associated with ILOs. Much of this comes from the release of nitrous oxide from fertilizers (see Table 1). Historically, there has been a steady increase in the use of feed crops for animal agriculture (Steinfeld*et al*, 2006:38-9). The estimates of GHG emissions,as given in the 2006FAO report, as CO_2 equivalents in tonnes per year globally (Steinfeld*et al*, 2006: 86-93), are as follows:

- Fossil fuel use in manufacturing fertilizers: 41 milliontonnes
- Livestock-related land change, including the loss of carbon sinks through deforestation: 2.4 billiontonnes
- Emission release from cultivated soils: 28 milliontonnes
- On-farm fossil fuel use: 90 milliontonnes
- Livestock-induced desertification of pastures:100 milliontonnes

The greatest of these, globally, is land use change from deforestation, the most prominent example of which is the burning of tropical rainforests to make way for cattle ranching (Steinfeld*et al*, 2006: 91). In Canada the majority of feed crop production emissions are from other major areas noted above.

Emissions from feed crop production: fertilizers, fossil fuel use, carbon release from soil

Fertilizers include synthetic nitrogen fertilizers and manure. Both producethe greenhouse gas nitrous oxide (N_2O), which has almost 300 times the heat-trapping effect (Global Warming Potential) of carbon dioxide, making both synthetic and organic fertilizers used in feed crop productionsignificant drivers of global warming. About half (55 per cent) of Canada's total use of chemical nitrogen fertilizer (897,000 tonnes/year)[12] is used for feed related to livestock, and most of it is produced using natural gas (Steinfeld*et al*, 2006: 87), adding to CO_2 emissions. Globally, "fossil fuel use in manufacturing fertilizer may emit 41 million tonnes of CO_2 per year" (Steinfeld*et al*, 2006: 86).About half of total maize production is used for feed crops and GMO maize is a crop that requires larges amounts of fertilizer (Steinfeld*et al*, 2006: 87). Canada accounts for 2,237,000 tonnes out of the estimated 41 million tonnesof the synthetic nitrogen fertilizer used globally every year (Steinfeld*et al*, 2006: 88). Increases in nitrous oxide emissions have also largely been driven by increased manure production from increased animal populations (Paton, 2003).

In terms of on-farm fossil fuel use, the majority is spent on feed crop production. This will be addressed later in the section on energy.Desertification of pastures will also be addressed later, in the section on land use.

Carbon release from the soil through feed crop production represents the largest potential source of emissions (1,100 to 1,600 billion tonnes*in toto*) but currently it is a relatively small fraction of that (28 million tonnes per year). Historically, the cumulative amount is far greater: 18 to 28 billion tonnes. The current rate of loss, as well as emissions from desertification,may increase as a result of climate change (Steinfeld*et al*, 2006: 93). This represents a serious concern, given the enormous potential for soil carbon loss that exists. Currently, carbon release from soil is caused by practices such as tilling and soil liming (Steinfeld*et al*, 2006: 92).

Emissions from animal digestion

Because methane (CH_4) has many more times heat-trapping qualities than carbon dioxide (21 times to be precise), the industrial production of methane is a significant driver of global warming. Globally, ILOs account for 37 per cent of methane

[12] Of this amount the vast majority, 894,000 tonnes, is used for feed production and 3,000 tonnes is used for pasture and fodder (Steinfeld*et al*, 2006: 155).

production (Table 1). The digestive process of bovine ruminants, called enteric fermentation, is the major source of ILO-related methane. It is also released from the breakdown of animal manure, both solid and liquid. Additionally, animal respiration is a cause of CO_2 (Steinfeld*et al*, 2006). These are major sources of on-farm emissions.

Emissions from manure

Globally, farm animals excrete approximately 135 million tonnes per year (Steinfeld et al, 2006: 110). This results in 0.3 million tonnes N_2O annually in North America; two thirds of that is due to beef cattle (Ibid). There is a high ration of nitrogen loss from manure applied to fields, adding to a process known as 'ammonia volatilization,' which refers to the return of ammonia (NH_3) to the atmosphere."Ammonia volatilization takes place when soils are moist and warm and the source of urea [ammonia in its organic form], is on or near the soil surface."[13]

Another related type of loss of nitrogen is manure-induced soil emission, which is the largest livestock related source of N_2O (Steinfeld et al, 2006: 109).

Transportation emissions

The industrial transformation of agriculture is related to the increasing distance and durability of food (Friedmann, 1993) and centralized production and processing systems. Food has to travel further, a fact popularly referred to as 'food miles'. Much of the growing popular awareness about food miles has focused on the resulting carbon emissions (e.g. *The Hundred Mile Diet*), which has made this concept a very visible marker for how the food system is linked to climate change. Canada is a major exporter of both feed crops and industrially produced meat, adding to emissions.[14] It should also be noted that Canada's larger geographic footprint increases transportation emissions, as compared to other industrialized regions, such as the EU or Japan.

Water

Water makes up at least 50 per cent of most living organisms and plays an essential role in the functioning of ecosystems, yet only 2.5 per cent of all water resources are fresh water, and 70 per cent of those are locked up in glaciers, permanent snow at the poles and the atmosphere (Steinfeld*et al*, 2006). Globally, water shortage and scarcity is a looming concern, exacerbated by the unequal distribution of water and the demands placed on the world's freshwater used for agricultural purposes (Tilman*et al*, 2002).

Water issues related to ILOs fall into two basic categories: water stress and water pollution, corresponding to environmental inputs and outputs.

Water stress

Industrial agriculture is responsible for almost three-quarters of total freshwater use worldwide, and also the single largest consumer of water in Canada (Weis, 2010a; Steinfeld*et al*, 2006; Briscoe, 2002). Agriculture practices and processes consume water in a variety of ways, with feed crop production accounting for the bulk of water use. Feed crop production requires irrigation watering systems, which is a growing concern since in many areas of the world, especially where water is being taken from aquifers in excess of its recharge rate (Weis, 2012a; Steinfeld*et al*, 2006; Tilman, 2002). Increasing global meat consumption and intensive production systems' dependence on grain harvests aggravates water shortages (Myers and Kent, 2003). Many countries will soon fail to have enough water to maintain per capita food production from irrigated land (Tilman, 2002).

It is estimatedthat 100 times more water is required to produce 1 kg of animal protein than to produce 1 kg of grain protein (Pimentel and Pimentel, 2003) (Table 3). Beef production, which has the most inefficient feed conversion ratio of any animal, requires about 13 kg of grain and 30 kg of hay for 1 kg of fresh beef (Pimentel and Pimentel,

[13] Scott C. Killpack and Daryl Buchholz. 'Nitrogen in the Environment: Ammonia Volatilization.' Department of Agronomy, University of Missouri. Available online at http://extension.missouri.edu/p/WQ25

[14]For example, CO_2 emissions for bovine meat exports from Canada to the U.S. and Mexico was 20,000 tonnes CO_2 and Canadian exports of pig meat to Japan and the U.S. was 1,400 tonnes CO_2 (Steinfeld*et al*, 2006: 372).

2003). To produce a 100 kg of hay and 4 kg of grain requires water inputs of 100,000 L and 5,400 L respectively. On a rangeland production system,

more than 200,000 L of water are needed to produce

1 kg of beef (Pimentel and Pimentel, 2003), and beef produced in a feedlot system (grain-fed beef production) requires 100,000 L of water for every kilogram of beef (Pimentel, 1997).

Chicken production, though less water-intensive than beef production, still demands a higher input of water per kilogram of food protein produced than plant protein. One kilogram of broiler meat requires about 2.3 kg of grain feed which would use about 3,500 L of water in its production (Pimentel and Pimentel, 2003). A pound of poultry requires 9,463 L of water, or the same volume of water as the average Canadian consumes domestically each month (Environment Canada, 2007). The use of water for "watering livestock is such a common use in Alberta that [in Alberta] submitting an application for a water licence actually provides a 'guide' for calculating the quantities of water needed for raising beef, hogs, chickens, and turkeys" (Nowlan, 2005: 32).

Resources are further taxed by other aspects of livestock production such as "service water" and "flushing" needs on industrial operations. Water needs for carrying manure down a gutter on a standard pig operation is about seven times higher than the animals' drinking needs (Steinfeld*et al*, 2006). Additionally, freshwater consumed in milk production and tanning can be counted as part of the total water consumption: "water is a major input at each processing step, except for final packaging and storage" (Steinfeld*et al*, 2006:130).

Meat processing plants also have very high demands for treated freshwater, competing directly with domestic use in years of drought. For example, 5 to 10 gallons of water are used to process one, five pound, average–sized chicken (McMahon, 2007). It is not unusual for a typical poultry processor to generate one to 1.5 million gallons of wastewater daily.[15] This water waste is representative of the inefficiency ratios and disregard for biophysical limits, discussed earlier.

Crop/Food Produced	Water requirement (kg of water per kg of food)
Potato	500 to 1500
Wheat	900 to 2000
Alfalfa	900 to 2000
Sorgham	1100 to 1800
Corn/Maize	1000 to 1800
Rice	1900 to 5000
Soybeans	1100 to 2000
Chicken	3500 to 5700
Beef	15000 to 70000

Table 3. Approximate crop water requirements to produce food harvested (Gleick, 2011).

Water as a human rights issue

As with greenhouse has emissions, water shortages represent a human rights issue of the first magnitude:it is predicted that "by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions" (FAO, 2006b)The United Nations recognizes the right to clean water as a human right, and the IPCC is concerned about the possibility of extreme water conflicts, in response to water stress (Nordas and Gleditsch, 2007). For these reasons, it is reasonable to state that ILOs, as the single largest industrial source of water stress, represent an extreme threat to the well-being of humanity.

[15]For example, "at a [poultry] processing plant located in Batesville, AR . . . the system treats all plant effluent of about 1.5 million gallons per day." See Wayne Labs (2010) "Wise Water Usage, Treatment, and Reclamation." *Food Engineering Magazine*. BNP Food and Media Beverage Group. Available online at http://www.foodengineeringmag.com/articles/wise-water-usage-treatment-and-reclamation

Water pollution

Water used in agricultural production is returned to the environment, with some of it re-usable and some polluted, thereby contributing to water depletion (Steinfeld*et al*, 2006). Industrial farming, feedlots and factories pose a serious threat to the integrity of many freshwater systems. Water pollution occurs via a number of pathways. Surface water pollution from livestock waste can be caused by direct runoff the farm site, after field application of manure (slurry)[16] or by contaminated water from barns or open feedlots (Steinfield*et al*, 2006). Water contamination also occurs from direct deposit of fecal material into waterways, pesticide and fertilizer application to feed crops and livestock processing (slaughterhouses, meat-processing plants, dairies and tanneries) (Steinfeld*et al*, 2006). Groundwater contamination can be caused by leaching,following excessive manure or fertilizer application to land, and leaking earthen manure storages, or direct runoff into poorly sealed well heads (Steinfield*et al*, 2006).

One of the largest burdens on water health is runoff from fertilizer nutrients and animal waste from ILOs (Weis, 2012a). This occurs when "large amounts of nitrogen and phosphorus enter the environment through runoff, percolation into groundwater, and volatilization of ammonia (Mallin and Cahoon, 2003, 369).

Pre-industrial versus industrial waste treatment

Traditionally, animal wastes were collected in straw bedding to compost before being applied onto fields. Many potentially pathogenic micro-organisms were killed during composting, because of the elevated temperatures, and the manure was used as a rich source of nutrients and humus usually without pathogen contamination risks (Shepherd Jr. *et al*, 2010). This system is a fundamental aspect of organic and mixed farming production systems where small amounts of waste are recycled as fertilizer on the land (FAO, 2005).

In contrast to traditional methods, ILOs concentrate large numbers of animals in a small geographic area, producing high volumes of manure, which then must be managed. The wastes are typically spread or sprayed onto fields, and pumped into waste lagoons (Mallin and Cahoon, 2003). ILOs typically contain highly concentrated amounts of feces, laden with drug residues, heavy metals, pathogens, and heavy nutrient loads (i.e. nitrogen, phosphorus, potassium) (Steinfeld*et al*, 2006). Water pollution problems can be exacerbated by periodic lagoon ruptures, or major leaks to storage systems (Mallin and Cahoon, 2003).

Biochemical oxygen demand

One assessment of nutrient concentration causing water pollution is called "biochemical oxygen demand" (BOD_5); it is the measure of organic and inorganic substances subject to aerobic microbial metabolism, referring to the amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water, such as that polluted by sewage. BOD_5 is used to measure of the degree of water pollution (Pew Commission, 2008). For example, cattle slurry has a biological oxygen demand (BOD_5) of 10,000 to 20,000 mg/liter (Steinfeld, 2007), and whey, a dairy product, has a typical BOD_5 level[17] ranging between 30,000 and 60,000 mg/L. Clean water, by comparison, has a BOD_5 level of 5. As shown in Table 4 the BOD_5 levels typical of animal/bird slurries and wastewater have a deadly impact if discharged into a waterway.

[16] Slurry can be defined as an animal farm product made up of feces, urine, uneaten food, and wash water from the barns. It is stored in earthen lagoons, occasionally in tanks, until field conditions are suitable for application to agricultural land. Therefore, large storage volumes are typical of intensive livestock operations. Farm slurry is widely used as a fertilizer and that can lead to the spread of pathogens (viral, bacterial, protozoan, parasitic worms) that may contaminate crops grown on those soils. There is also the potential that these pathogens may be carried in field run-off into sources of water used for recreation or drinking water for livestock, wildlife and humans (Bicudo and Goyal, 2003).

[17] The BOD_5 is a measure of the dissolved oxygen required to stabilize the organic matter in wastewater in five days. A manageable level of these nutrients should be in the range of 5-30 mg BOD_5/litre. This number is based on the level human sewage must be reduced to before it can be discharged into surface water.

Source	BOD_5 (mg/litre)
Milk	140,000
Silage effluents	30,000 – 80,000
Pig slurry	20,000 – 30,000
Cattle slurry	10,000 – 20,000
Liquid effluents draining from slurry stores	1,000 – 12,000
Dilute dairy parlour and yard washing (dirty water)	1,000 – 5,000
Untreated domestic sewage	300
Treated domestic sewage	20 – 60
Clean river water	5

Table 4. Ranges of BOD_5concentration for various wastes (Steinfeld, 2007)

Manure contains nitrogen, phosphorous, potassium, drug residues, heavy metals and pathogens, which contaminate water. Water can also become contaminated through storage facility failures, manure runoff from farms and grazing areas, and direct deposit of mature into bodies of water (Gerber, 2006). One cow excretes as much phosphorus as 18 to 20 humans.

When organic waste contaminates water, it increase algae's demand for oxygen, need by other species.Discharge of these very concentrated organic wastes containing nitrogen, phosphorus and other nutrients into a waterway causes nutrient-driven eutrophication, or severe oxygen depletion in the water. Algae blooms, death of fish and other aquatic aerobic organisms result when excreta or wastewaters from livestock production get into streams, rivers and lakes through discharge, runoff or overflow of storage lagoons. In many parts of Canada, major blooms of blue-green algae (cyanobacteria) are associated with eutrophication. The deteriorating state of Lake Winnipeg has been attributed in large part to the excessive phosphorous emissions from Manitoba's pork industry (Friesen, 2011).

The Charest Report (1991) noted that livestock manure is, "one of the principle, non-point sources of nutrient pollution in Canada, and one that has yet to be adequately addressed from an environmental perspective."[18]

Groundwater forms an important source of municipal, industrial, agricultural and residential water supply in rural Canada, but it is a finite resource now endangered by industrial agriculture: in Canada 43% of the agricultural sector relies on groundwater (Nowlan, 2005: 5). In addition to excessive nutrient loading from manure and fertilizer application to crops, which may percolate into groundwater stores, there is concern regarding contamination from earthen lagoon structures used for sewage storage. (MacMillan and Llewellyn, 200). Among many members of rural communities on the Prairies, earthen manure storage structures have attracted widespread concern regarding their potential for groundwater contamination.[19]

Meat Processing

Wastewater produced from livestock processing is laden with fats, proteins and carbohydrates from meat, fat, blood, skin and feathers.The water is also polluted with grit and other inorganic matter. In addition to meat processing gelatin production, rendering plants and dairy processing can produce large amounts of wastewater (Burton and Turner, 2003). Modern processing plants are required to remove the majority of all soluble and particulate organic material, phosphates and ammonium in their wastewater prior to any discharge from the plant. In Canada this discharge is usually released into

[18] The Charest Report on the state of the environment, from 1991, is still relevant in 2012, and is frequently cited for its accuracy: "It is one of the few reports in Canada that was subject to independent external review by scientists across the country . . . The Charest Report (1991) also addresses impacts of animal agriculture. [It notes that] 'Livestock manure constitutes one of the principal, non-point sources of nutrient pollution in Canada, and one that has yet to be adequately addressed from an environmental perspective.'" William Paton (2007) "The Sustainability of the Hog Production Industry in Manitoba."*Canadian Society of Environmental Biologists Newsletter.*vol 64, Issue 2, p. 11, available online at http://cseb-scbe.org/files/Newsletters/CSEB_Vol64-2.pdf

[19] For example, an report published in July 2000 by Alberta Agriculture, Food and Rural Development focused on seepage from five central Alberta earthen manure storage lagoons (MacMillan and Llewellyn, 2000). The report identified two of the five lagoons examined had severe to moderate seepage and contaminant movement in the underlying groundwater.

surface waters and has to be in compliance with local, provincial and federal environmental regulations. Often these large processing plants are enticed to a region with significant municipal, provincial and federal contributions to capital costs and design.(Ibid).

Air pollution

Air pollution can be generated by buildings, manure handling and storage systems and during land application in the form of odours and gases (in particular ammonia) generated from anaerobic manure decomposition (Paton, 2003). Microbial agents (viruses, bacteria, fungal spores) and products (endo- and other toxins) have been confirmed in the air associated with ILOs (Ibid). These agents and products can also be of concern for the livestock, workers and downwind community. Dust can also be a concern arising from feed systems and the animals. Two related aspects of air pollution discussed below are odour and ammonia.

Odour from ILOs is generally recognized as a public health issue. Most problems arise with intensive pig and poultry units, and when animal manures are stored for lengthy periods: anaerobic (oxygen deprived) storage of manure, common practice in intensive livestock production, results in the production of malodorous compounds, which are intensified under severe winter conditions when biological activity is minimized. Odours may also arise from land spreading of wastes: odours from wastes are carried on dust and other particles as well as in gases and vapours (Paton, 2003). Some of the gases released from manure storage in the absence of oxygen are toxic to humans and animals (Paton, 2003).

Ammonia volatilization, the release of ammonia from animal manure into the atmosphere,can have a negative impact on plant and animal biodiversity (Phoenix *et al*, 2006).“Agriculture accounts for more than 50% of the ammonia released into the air”, according to a Government of Canada report, *The Health of Our Air* (Agriculture and Agri-Food Canada, 1992). The report adds that “much of this ammonia comes from livestock production.” In one study about 60-80 per cent of nitrogen (an element in ammonia, NH_3) was lost from pig manure in lagoons exposed to air (Marks, 2001: 18). The effects of NH_3 can be local or long range: ammonia can be carried long distances by wind before being deposited, sometimes up to 300 miles (Ibid). Once deposited, it can disrupt sensitive ecosystems.

Land Use and Land Degradation

There are two uses of land associated with ILOs: land occupied by animal agriculture directly (i.e. CAFOs and feedlots), which can lead to overgrazing, compaction and soil erosion, and land used for growing feed crops. Of the two, land use problems associated with feed crop production are more significant because they affect such large areas.

Land use costs related to industrial feed crop production

Industrial crop agriculture has several negative environmental impacts: the results of pesticide and fertilizer use, water consumption exacerbated by reduced soil moisture retention and ‘thirstier’ seed types, soil mining, deforestation, increased tillage by heavy machinery, and impact on biodiversity. Land used for feed crop production has a significant environmental impact in Canada. This is because industrially-reared livestock consume more than a third of the world’s grain harvest, and a much greater share of all oilseeds, with the ratios of cycling feed through livestock the highest in industrialized countries. In the U.S. and Canada, roughly 80 per cent of the total volume of agricultural production comes from the industrial grain-oilseed-livestock complex (Weis, 2010b:13). Together, the U.S. and Canada produce roughly one-fifth of the world’s total grain production and one-third of the world’s oilseed production (mainly soy in the U.S. and canola in Canada) (Weis, 2012a).

Soil pollution can be caused by applying high rates of nutrients to the land, which can lead to imbalanced plant nutrition and poor plant growth and development. Several studies have reported that anaerobic livestock slurries can be toxic to seeds and reduce or inhibit germination. Pig slurry in Manitoba, Alberta and some U.S. states can be extremely high in sodium chloride and therefore potentially damaging to sustainable crop production (Paton, 2003). It has been suggested that by giving the animals high amounts of sodium chloride in their feed, they take up more water into the tissues and gain fresh weight faster. This salt would add to the soil degradation concerns raised by the 1984 Senate Standing Committee on Agriculture:

> *"Another serious result of current agricultural practices is the increase in cultivated land affected by salts …. The presence of high salt concentrations at or near the soil surface are now increasing at a rate that can only be described as alarming . . . On lands affected by salinization in the Prairies, crop yields have been reduced by 10 to 75%, even though farmers have increased their use of fertilizer . . . The presence of high salt concentrations at or near the soil surface renders the soil infertile. In some areas the telltale white patches on the surface are now increasing at a rate that can only be described as alarming."* [20]

The Standing Senate Committee, reporting in 1984, estimated that the cost to Canadian farmers is more than $1 billion per year in farm income, as a result of salinization. They added: "we are clearly in danger of squandering the very soil resource on which our agricultural industry depends." More recent reports have confirmed the same. [21]With the increased intensification of industrial agriculture since 1984, the problem has worsened, but rather than responding to the causes of soil degradation by finding ways to restore organic content and enhance soil formation, the response of transnational corporations running ILOs has been the use of industrial fertilizers to replace lost nitrogen, phosphorous, and potassium. This approach entails a host of environmental costs (McKinney, 2002; Warshall, 2002), or in economic jargon, 'externalities.'

Overgrazing, compaction and soil erosion

Canadian ILOs use intensification and confinement systems as the norm. Compared to nations in the global south Canada has less land use change. According to the authors of *Livestock's Long Shadow,* Canada experiences "intensive forage production," which is due in part to the fact that "climatic, economic and institutional conditions" favour intensification because land is scarce (Steinfeild*et al*, 2006: 38)[22]

Where Canada does experience land degradation, it is in the form of soil compaction and erosion, results from overgrazing in dry land, which is different than livestock-induced deforestation in the humid and sub-humid tropics" (Steinfeld*et al*, 2006: iii).About 73 per cent of the world's dry rangelands and pastures have been degraded as a result of compaction and erosion from cattle, over time -- including the Canadian prairies.[23]

Compaction and erosion is caused by "concentrated 'hoof action' by livestock – in areas such as stream banks, trails, watering points, salting and feeding sites [and] mechanically disrupts dry and exposed soils, followed by "discharge of eroded material into waterways, and eventually

[20] The Senate Standing Committee on Agriculture, Fisheries and Forestry, in Canada, received a great deal of publicity across the country when they released a report on soil conservation entitled "Soil At Risk: Canada's Eroding Future" in 1984.

[21] Allen Hall notes that "in 1986, the Science Council of Canada came to a similar conclusion and estimated that on-farm costs of soil degradation amounted to $1.3 billion (Science Council of Canada, 1986). They argued for immediate action. In a more recent government report, soil erosion, soil degradation and declining organic matter were estimated to cost Ontario farmers hundreds of millions of dollars worth of production annually (Ontario Roundtable on the Environment and Economy, 1991: 6)" (Hall, 1998).

[22] "Such conditions are typically found in the EU, North America, Japan and the Republic of Korea . . . Intensive forage production in some cases supplies processing industries, such as alfalfa dehydration and hay compaction. These industries (mostly in Canada and the United States) are highly export-oriented" (Steinfeld*et al*, 2006: 38).

[23] Globally "the livestock sector is by far the single largest anthropogenic user of land. The total area occupied by grazing is equivalent to 26 percent of the ice-free terrestrial surface of the planet. In addition, the total area dedicated to feed crop production amounts to 33 percent of total arable land. In all, livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet . . . About 20 percent of the world's pastures and rangelands, with 73 percent of rangelands in dry areas, have been degraded to some extent, mostly through overgrazing, compaction and erosion created by livestock action. The dry lands in particular are affected by these trends . . ." (Steinfeld*et al*, 2006: xxi).

desertification" (Steinfeld*et al*, 2006). It is possible that if more cattle were grass-fed on existing grasslands, to supply the growing niche market for grass-fed beef,[24] that this would result in even greater overgrazing of already degraded grasslands.

Energy

Industrial animal agriculture is more energy intensive than traditional farming systems requiring disproportionately large inputs of fossil fuels, industrial fertilizers, and other synthetic chemicals (Pew Commission, 2008). As noted previously this can understood in terms of inefficiency ratios, as it requires far less energy to produce animals for consumption than plant-based foods.

Traditionally, livestock production was based on locally available feed resources such as crop wastes and browse that had no value as food except as livestock feed. However, livestock production has intensified and grown increasingly dependent on feed concentrates that are traded domestically and internationally. In 2002, a total of 670 million tonnes of cereals were fed to livestock, this was almost one third of global cereal production. Another 350 million tonnes of protein-rich processing by-products are used as feeds (Paton, 2003).

The bulk of fossil energy expended in livestock production is on feed crop production (Pimentel and Pimentel, 2003) and associated tasks, including the production of feeds (land preparation, fertilizers, pesticides, harvesting, drying etc.), their bulk transport (rail, road ,air and sea), storage and processing (milling, mixing extrusion, pelleting, etc.) and their distribution to individual facilities. Once on the farm, and depending on climate, season of the year and facilities, more fossil fuel is needed to move stored feed to the animals; for control of the environmental temperature (cooling, heating or ventilation); and for the animal waste collection and treatment (separation solids, land applications etc.). Transport of products (meat animals to abattoirs; milk to processing plants; eggs to storage), processing (slaughtering, pasteurization, manufacture of dairy products), storage and refrigerated transport also require fossil fuels (Sainz,2003).

Livestock animals are inefficient converters of grain to animal protein. On average, for every kilogram of high-quality animal protein, livestock are fed about six kilograms of plant protein. In energy terms, more than eight times the amount of fossil fuel energy is used in livestock production for the same amount of plant protein produced (Pimentel and Pimentel, 2003). Stated in other terms, the average fossil energy input required to produce 1 kcal of animal protein is 25kcal of fossil energy compared to 2.2 kcal of fossil energy needed to produce 1 kcal of plant protein (Pimentel and Pimentel, 2003).Monogastric species that can most efficiently make use of concentrate foods (pigs, poultry), have an advantage over beef cattle, sheep and goats, but are still resource heavy compared to vegetarian diets (Pimentel, 2004; Pimentel and Pimentel, 2003).[25]

Deforestation, habitat destruction and loss of biodiversity

Biodiversity loss in Canada, as a result of ILOs, includes the destruction of local indigenous habitats to make space for crops, the toxic effect of pesticides and fertilizers and manure on marine habitats and soils, monocultures displacing native flora and the fauna that depend on them, and the production of greenhouse gas emissions, altering

[24] As a result of endorsements from several environmental NGOs and environmental writers, such as George Monbiot and Michael Pollan, the idea of grassfed beef has gained popularity in recent years. In response, transnational corporations, including JBS, Cargill, McDonalds and Wal-Mart, have decided to research and invest in this growing niche market. See Global Conference on Sustainable Beef, available online at http://www.sustainablelivestock.org/

[25] In terms of fossil energy expended according to specific animal proteins, broiler chicken production is the most efficient, with an input of 4kcal of fossil energy for each kcal of broiler protein produced. The broiler system is primarily dependent on grain. Turkey, also a grain fed system is next with a ratio of 10:1. Milk production based on two-thirds grain and one third forage is 14:1. Pork production also has a ratio of 14:1 and egg production has a 39:1 ratio. Beef production depending most on forage but also using significant quantities of grain has a ratio of about 40:1 ((Pimentel, 2004; Pimentel and Pimentel, 2003).

temperatures faster than the ability of many plants and animals to adapt. This has resulted in overall loss of animal and plant biodiversity, loss of soil biodiversity, and loss of crop and farm animal genetic diversity.[26]

The United Nations *Millennium Ecosystem Assessment* describes agriculture as the "largest threat to biodiversity and ecosystem function of any single human activity" (MEA, 2005: 777). This report also highlighted how the destruction of natural ecosystems for agriculture accelerated dramatically in the second half of the 20th century, with more land converted to cropland in only three decades (1950-80) than occurred during a century and a half of widespread colonial transformations (1700-1850) (MEA, 2005). The U.N.'s MEA report is corroborated by the Canadian government's report *Canadian Biodiversity: Ecosystem Status and Trends 2010,* which attributes Canada's biodiversity loss, in part, to industrial agriculture: "native grasslands have been reduced to a fraction of their original extent . . . Grassland losses exceed those of other major biomes in North America . . . Over the long term, changes in natural disturbance regimes due to . . . confined cattle grazing have had negative impacts on grasslands. Other stressors include . . . intensification of agriculture." (Government of Canada, 2010).[27]

Biodiversity loss can be observed from the scale of monoculture (i.e. single crop) fields down to the scale of plant and animal genetics. (Weis, 2012a).Biodiversity loss drivers such include "land use changes, physical modifications of rivers or water withdrawn from rivers" and "climate change, invasive alien species, overexploitation and pollution" (MEA Report, 2005b). All these factors are associated with the intensification of industrial agriculture. The following provides a description of these drivers in greater detail.

Loss of semi-natural land cover

Feedcrop production, representing more than half of total industrial crop production in Canada, is responsible for deforestation in some areas, though not nearly to the same extent as in the global south, where rainforests are cleared to make way for pastureland. In Canada, deforestation and habitat destruction takes the form of destruction of wetlands and forested areas (hedgerows and semi-natural land cover) adjacent to farmlands, to make way for farmland expansion. Historically this has occurred in Canada due to the intensification of agriculture:**from roughly 1980 onward there was a resulting loss of semi-natural land cover, and the ability of "agricultural landscapes to support wildlife in Canada" declined (Government of Canada, 2010). It is estimated that "agricultural landscapes [now] cover 7% of Canada's land area and provide important habitat for over 550 species of terrestrial vertebrates, including about half of the species assessed as at risk nationally (Government of Canada, 2010)."**

Impact on soil biodiversity

Pesticide and fertilizer use for mono-crops requires ever-greater uses of fertilizers to compensate for loss soil productivity, resulting in increased runoff and soil erosion due to dead soil. It is also the result of reduced recycling of organic material on farms as a result of the decline in soil biodiversity, fallowing, and scavenging by small livestock populations (Weis, 2012a).

Impact on plant biodiversity

[26]Globally, the expansive footprint of industrial monocultures in landscapes, magnified by factory-farmed livestock, reduces the space for natural ecosystems and other species. The shrinking of ecosystems and the extirpation, endangerment, and extinction of species that directly impair human economies is sometimes referred to as 'ecosystem services' to highlight the underappreciated ways that human economies depend upon natural processes, and translates to measurable economic costs when these are degraded. Ecosystem services can be understood through a range of biophysical processes and scales, such as: the role that forests play in the carbon cycle; the role that watershed health plays in freshwater supplies; the role that bees and other pollinators play in agriculture and plant life; or the role that micro-organisms play in soil formation. However, this is a monetary valuation; from a more biocentric, less anthropocentric perspective, the value of biodiversity is inestimable: it has an intrinsic value that cannot be measured.

[27] Furthermore, **"between 1986 and 2006 the capacity of agricultural landscapes to provide habitat for wildlife declined significantly across Canada. The main causes are the conversion of natural areas to cropland and more intensive use of agricultural land. The proportion of agricultural land classified as cropland increased from 46 to 53% over this period." (Government of Canada, 2010: 4).**

In Canada, four major monocrops (barley, maize, wheat and soybeans) have replaced indigenous biodiverse flora over millions of hectares. This has a direct effect on animal biodiversity, insofar as certain animal species are dependent on specific plants for sustenance and shelter: the Prairies ecozone has lost most of its tallgrass prairie, in turn affecting animal species that depend on them (see Table 5). There has also been an introduction of invasive species, with the introduction of monocultures, displacing and affecting indigenous species. As a result, "the remaining grasslands in Canada are under stress. Natural disturbance regimes that historically maintained grasslands have been altered; in particular, the suppression of fire and replacement of free-ranging bison with confined cattle have modified the structure and composition of native grasslands. Also, many of the richest soils have been cultivated, leaving remaining grasslands on less productive soils" (Government of Canada, 2010: 14). Additionally, the negative effect on native plant biodiversity has been exacerbated by overgrazing and intensification of agriculture in recent decades (Government of Canada, 2010: 14).

Mixed Grass	Historic (ha)	Current (ha)	Decline (%)	Current Protected (%)
Alberta	8,700,000	3,400,00	61.0	<.01
Manitoba	600,000	300	99.9	<.01
Saskatchewan	2,500,00	2,500,00	81.3	<.01

Table 5. Estimated historic and current declines of the mixed grass prairies in Canada (Sampson, 1994).

Impact on marine biodiversity

Industrial agriculture impacts waterways in two major ways. First, wetlands and streams are often destroyed and diverted. Despite conservation efforts over the past several decades, wetland loss and degradation continue, largely as a result of intensification of agriculture: "between 1985 and 2001, 6 per cent of wetland basins were lost, representing 5 per cent of the total estimated wetland area. In addition, estimates of wetland area suffering a loss of function due to factors such as partial drainage were about 6% annually."(Government of Canada, 2010:16). Secondly, waterways receive runoff from farmland and are often poisoned by excessive nutrients and pesticides and animal manure. The runoff causes algae blooms that adversely affect native species: **"inputs of nutrients to both freshwater and marine systems [from] agriculture-dominated landscapes, have led to algal blooms that . . . may be harmful" to indigenous flora and fauna**(Government of Canada, 2010).

Global warming and biodiversity loss

The aforementioned impacts are local to Canada, but global biodiversity is adversely affected by Canadian ILOs through their contribution to global warming through greenhouse gas emissions. The threat to global biodiversity as a result of global warming is well documented by the IPCC, which notes that many of Earth's approximate 8.7 million species face extinction as pre-industrial temperatures significantly alter habitats (IPCC, 2007). Additionally, there are impacts on Canada due to global warming, include the loss of biodiversity in the Arctic and the infestation of western Canada's boreal forests by an invader species, the pine beetle. The Government of Canada notes that temperatures have risen in Canada over the past 50 years, with an average increase of 1.4°C and that "ecosystems and species are affected by all of these changes, often in complex and unexpected ways that interact with other stressors, such as habitat fragmentation." (Government of Canada, 2010: 4). It is further estimated that these impacts will increase exponentially as global warming continues.

Crop and farm animal genetic diversity

The standardization of plant and animal life enhances vulnerability to the impact of weeds, insects, fungus and diseases. Dozens of different genetic strains of crops replaced by one genetically modified crop makes crops more vulnerable to disease, which is in large part why more pesticides are used, furthering toxic runoffs and toxification of soils and killing soil biodiversity. This in turn requires greater amounts of water.

Although farm animals are selectively bred, and therefore not indigenous to Canada, the increasing loss of genetic biodiversity among farm animals, as a result of the transition from traditional to industrial methods, has been a source of concern for some farmers. Industrial animal agriculture has tended to narrow the genetic base for farmed animals. According to the FAO, "of the more than 7,600 breeds in FAO's Global Databank for Farm Animal Genetic Resources, 190 have become extinct in the past 15 years and a further 1,500 are considered 'at risk' of extinction" (FAO, 2007c).

Conclusion

There are strong indications that the biophysical basis for the industrial livestock system is beginning to fracture, due principally to the intersecting and intensifying factors of climate change, land degradation, water depletion, and increasing demands on finite fossil fuel reserves, all caused, in large part, by industrialized crop and livestock production methods (Weis, 2010a). Yet even as the physical limits of the Earth's natural resources are unsustainably stretched beyond the tolerance limits of the Earth (a phenomenon known as "ecological overshoot"[28]), ILOs continue to grow in size and number. For example, the average cattle farm in Canada had an inventory of 144 in 2006, a rough doubling in three decades (StatsCan, 2007a, Table 2.12). This trend is part of the larger pattern of the 'meatification' of diets, or the progressive shift of livestock products to the centre of societal food consumption patterns (Weis, 2007). As a result, the average Canadian now consumes 3 times more poultry, 2.5 times more beef, and 5 times more cheese than global averages (FAO, 2007b). Ultimately, this is both perilous and unsustainable.

With the global human population now (officially) at seven billion (United Nations, 2011) and rising,[29] and with meat consumption increasing in developing nations, and especially China (Liu and Deblitz, 2007), more sustainable agriculture practices, coupled with a reduction in the consumption of animal protein is required. This is why many notable voices, including IPCC Chair RajendraPachauri, are calling for a reduction in meat consumption, to mitigate greenhouse gas emission and the ensuing environmental crises exacerbated by ILOs.[30]

The alternate position, preferred by the transnational corporations that own and operate ILOs, as well as several scientists employed by or associated with the meat and dairy production industry, is that ILOs be made more "sustainable" through technological innovations.This, however, has not proven a viable option in the past, thus calling into question the viability of technological fixes for environmental problems caused by ILOs in the present. A lack of sufficient knowledge of all the interconnected variables in natural systems, and how they interact with one another, means that over-reliance on technology to solve environmental problems will frequently meet with disaster, as the effects of the technologies used cannot be adequately anticipated (Vanderburg, 2005). The tendency towards technological fixes, which is widely endorsed by the scientific community, has its historical origins in what has been termed the "faith in progress through technology," which seeks mastery over nature for the edification of often

[28] According to Wackernagel*et al* (2002), "Sustainability requires living within the regenerative capacity of the biosphere. In an attempt to measure the extent to which humanity satisfies this requirement, we use existing data to translate human demand on the environment into the area required for the production of food and other goods, together with the absorption of wastes. Our accounts indicate that human demand may well have exceeded the biosphere's regenerative capacity since the 1980s. According to this preliminary and exploratory assessment, humanity's load corresponded to 70% of the capacity of the global biosphere in 1961, and grew to 120% in 1999."

[29]The U.N. projection is that human populations will "surpass 9 billion people by 2050 and exceed 10 billion in 2100." See United Nations, Department of Economic and Social Affairs, Population Division (2011): 'World Population Prospects: The 2010 Revision.' United Nations, New York. Available online at http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Highlights.pdf

[30] Richard Black. 'Shun meat, says UN climate chief' *BBC News*, Sept. 7, 2008. Available online at http://news.bbc.co.uk/2/hi/7600005.stm

unnecessary human desires, rather than recognizing and respecting the limits of nature, and attempting to conform to them by adopting an "ethic of limitations," in consideration of the needs of future generations (Schmidt, 2008).[31] As a result, the biophysical instability of industrializing agriculture has been met with increasingly unsustainable solutions by the transnational corporations, exacerbating and complicating the initial problems (Weis, 2010).

A key historical example of the failure of technological fixes is the replacement of depleted soil nutrients with synthetic fertilizers (Weis, 2010). This had the unexpected side effect of further soil depletion, eventual soil erosion, loss of soil biodiversity, increased water usage and greenhouse gas emissions. Another example is ethanol biofuel, produced from maize, originally promoted as "sustainable" but now understood to be too fossil fuel and land intensive to merit that claim (Pimentel and Patzek, 2005; Patzek and Pimentel, 2006). [32] A more practically viable solution is to reduce the environmental "hoofprint" of industrial societies, by moving towards more plant-based diets.

As peak oil, climate change and water depletion take their toll, it will become a matter of practical necessity to find alternatives to the ILO model. As the biophysical limits of the land are exceeded, reduction of meat consumption will become a practical reality for most people (no longer a choice), although it is highly probable that animal products will continue to be consumed, but they will be locally produced, with a trend towards dairy and eggs and away from meat, and "food will become more expensive and take up much more of our income or tradable surplus" (Jermyn, 2009).[33] This is already leading to the emergence of alternative food networks, that take biophysical limits into consideration, such as the permaculture movement, the growth of community-supported agriculture, the slow food movement, and environmental and ethical plant-based diets.

Leaving aside the questions of animal cruelty and human health concerns, which are significant in themselves, the monumental waste of both renewable and non-renewable finite resources by ILOs, which comes at the expense of future generations, as well as their role as a significant driver of global warming, which poses a grave threat to humanity and all life on Earth, provides sufficient rational argument for the abolition of ILOs.

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[31] Furthermore, within the technological paradigm, environmental concerns from the public are regarded as problems to be managed through public relations exercises, which has had the effect of replacing the use of ethics with a managerial model to address issue that have significant moral implications (Schmidt, 2008).

[32] One of the 'technological fixes' that Canada has endorsed and subsidized, to supposedly mitigate greenhouse gas emissions, is the use of the biofuel ethanol, produced from the fermentation of maize, and also increasingly soybeans. This converts the sun's energy, captured in plant biomass, to liquid fuel. While ethanol burns more cleanly than oil, its production has an extremely environmental cost, due to the extensive fuel energy inputs that go into growing and converting most industrial crops into biofuels (e.g. farm machinery, fertilizer production and transport, agro-chemicals, irrigation systems, fermenting/ distilling, etc.), with the result that it takes almost as much (rare best case) or more (typically) fossil energy to make biofuels than is contained in the fuel itself (Pimentel and Patzek, 2005; Patzek and Pimentel, 2006). Additionally, biofuels pose a threat to international food security insofar as it uses crops for fuel, rather than for food (Bodiger, 2007).

[33] Jermyn predicts that "the future is not vegan" because people who consume animal products will eventually come to rely on local non-industrial animal agriculture (Jermyn, 2009). A related argument for relying on animal products in a Canadian context has traditionally been that Canada's northern climate requires this, due to short growing seasons; according to the Ontario Corn Producers Association, "warmer temperatures will mean longer Canadian growing seasons" (OCPA). If so, this may increase growing opportunities for 'locavore' vegan and vegetarian diets in Canada.

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