

THE FUTURE IS ORGANIC (but it's more than organic)

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INTRODUCTION

Organic will be the conventional agriculture of the future, not because of wishful thinking or because it is the right thing to do, or because of some universal truth revealed from on high.

You don't need to be a utopian to see the agricultural landscape of the future dominated by organic practitioners - whether in the city or in the country - if you stop to ask yourself ...

• **why are we not organic now?**

How did we get to where we are now, and not just in farming but in the entire agri-food system? How did we evolve an agri-food system so centered on specialization, consolidation, and globalization? What drove us to an agri-food system that reportedly consumes 19% of the national energy budget - but only 7 of the 19% are used on the farm, with the remaining 12% incurred by post-farmgate transport, processing, packaging, distribution, and meal preparation (Pimentel, 2006)? Is this all the result of Adam Smith's invisible hand - an inevitable and inescapable result of the unfettered free market or other universal principle in action - or is there more to it?

This paper will present the argument that the future is organic because the design drivers that have shaped and molded the current agri-food system are changing, demanding a wholly new, and largely organic, approach to agriculture. Efforts to make the current model *less bad* - more sustainable - are counterproductive because they dilute and deflect the creative energy and commitment that are urgently needed to craft productive, ecologically sound systems driven by current solar energy (Pollan, 2008). Although time does not permit coverage, post-oil design drivers will also necessarily demand not just organics but novel agri-food systems emphasizing

- local/decentralized food production, and
- seasonal consumption expectations,
- from minimally processed foods.

Evidence will be presented to show that organic is not enough, however. Ecological soundness¹ will require a de-emphasis on annual cropping coupled with re-integration of livestock, both to mimic the principles that sustain Nature and to dramatically reduce dependence on fossil fuels.

¹As a concept, 'sustainability' rests on economic and social as well as ecological 'legs'. For the present talk, however, the focus will be on ecological soundness.

AGRICULTURE WAS NOT DESIGNED TO BE SUSTAINABLE

The design of contemporary agriculture did not evolve in a vacuum. McDonough and Braungart (2002) said that:

- **“Design is the first sign of intention”.**

So what was agriculture designed to do? Agriculture here in the colonies was designed primarily for one thing - to export vast quantities of undifferentiated, raw commodities back to the Mother Country. We do the same thing today, but the recipient is ADM, Cargill, Smithfield and Tyson. Arguably, agriculture performed other services as well - sustenance, good place to raise a family, and a way to make a living.

But those seeking to ensure food production in a post-oil future must first explicitly acknowledge that agriculture was never designed to be sustainable - not ecologically, not economically, and not socially sustainable, at least for primary producers. It would be a coincidence of miraculous proportions if agriculture would be sustainable, simply because it was designed to do things which are incompatible with sustainability. Thus, efforts to adjust, refine, or otherwise tweak contemporary agriculture to sustain productivity are starting from a flawed design.

Agriculture is intrinsically unsustainable for the same reason that it takes a toothbrush 500 years to break down in a landfill: because it wasn't designed *not* to take 500 years. Likewise, we have the 20,000 square kilometer - and growing - hypoxic zone at the mouth of the Mississippi (USGS, 2009) because N and P retention on corn farms was *not* a design driver. Export-oriented agriculture is completely incompatible with ecological soundness, because unlike Nature, nutrients flow linearly away from the farm and don't return - whether exported to Waterloo County or to Germany.

The issue is design. The question is whether the current flawed design can be refined to enable sustained food production in the post-oil era - or not. And if not, then what to replace it with? Although the time of onset of the post-oil era is unclear, the time is now for research, extension, and education to prepare the way for it.

HISTORIC DESIGN DRIVERS

The inter-related drivers which have created today's model in the organic as in the conventional agri-food system were: a) cheap energy and b) the pervasive externalization of costs, neither of which can persist for much longer.

Cheap Energy? Without further elaboration, I will take as a given:

- that Hubbert's Peak is not a bad joke,
- that there are no viable alternatives to oil (Kunstler, 2006; Homer-Dixon, 2009; and Rubin, 2009), and hence, it follows
- that academic curricula can no longer justify an agri-food system that burns up millions of years of accumulated solar energy to grow, process, transport, store, package, and sell a few hundred years of food.

Why was cheap oil such a pivotal design driver? Hindsight reveals that cheap energy was foundational to the transitory, apparent economic competitiveness of *bigness*, a premise which in turn, facilitated the specialization, consolidation, and globalization which dominate our time.

You don't have a million head on feed in Feedlot Alley near Lethbridge, AB to feed Lethbridge (pop'n 85, 500). You have a million head on feed because you fully expect to ship beef and be economically competitive with beef producers across the continent. You have every reason to expect this because the energy cost of transport has been tiny relative to the economies of scale you've captured [and because you are not obliged to cover the cost of the massive pollution and risk to human health that evolves from high density confinement; see below].

The opportunity to ship and extract profit over geographically large areas advantages those willing and able to consolidate to mega-scale proportions for production and processing. Specialized businesses tailored to producing vast quantities of bulk, homogenous product necessarily exclude or co-opt smaller scale operators by driving down prices, narrowing the profit margin, and forcing farmers to 'get big or get out'. Thus, the cheap energy that enables bigness is very much the driver for the specialization/consolidation/globalization trajectory that has so marked our recent past.

Costs Externalized? The historical willingness of society to allow or even encourage externalization of costs to the environment and to society as a whole also encouraged bigness, as in Feedlot Alley. When the price paid at the store does not reflect the true costs of production or processing, consumers are given a false perception of how cheap and easy it is to produce food, fly to Tahiti, or air condition our homes. And it is not necessarily a straightforward process to relate adverse externalized costs back to the original source.

What is an externalized cost? I'll illustrate with a final exam question in my Crop Ecology course.

"You are an Illinois corn farmer, sitting at your kitchen table, staring in disbelief at a letter to you from the Governor of Louisiana. It is a bill for \$253,476.15 as your share of the cost of cleaning up the 20,000 square kilometer - and growing - hypoxic zone at the mouth of the Mississippi. USGS studies have conclusively demonstrated the dominant role of N and P runoff from corn land in the Mississippi watershed in causing this problem. Your assignment

is to frame a polite response, indicating the various strategies you have implemented to retain nutrients on-farm and avoid paying the bill”

The magnitude of costs externalized by contemporary agriculture is staggering. Pretty et al. (2000) conservatively estimated that UK agriculture externalized £208/ha of arable and pasture land, equivalent to 89% of net farm income. Using the approach of Tegtmeier and Duffy (2004), MacRae et al. (2009) reported an annual, externalized cost of \$145 million from Ontario agriculture.

The wave of legislation and market-driven challenges to once common agricultural practices, as promulgated by Michael Pollan, Marion Nestle, and others through such media as *King Corn* and *Food Inc.*, reflects growing societal alarm with costs externalized by agriculture. As the proverbial chickens come home to roost, whether in the form of hypoxic zones (USGS, 2009) or pathogens, antibiotic-resistant bacteria, and other drug residues evolving from CAFOs (Orlando et al. 2004; Fremaux et al. 2008; Khan et al., 2008; Martinez 2009; Mulvey et al. 2009; Schmidt, 2009) or birth defects from biocide use (Winchester et al., 2009), society is awakening to the full meaning of ‘externalized costs’.

Consider that:

- **if every farmer had had to absorb all of the costs** routinely externalized on farms today, many common practices would be unimaginable because they would be prohibitively expensive, and
- **if farmers were paid** for all the downstream benefits society receives from ecologically sound management, such as clean air and water, robust and functional biodiversity, and food free of pharmaceuticals, antibiotic resistant bacteria, and human pathogens, many practices common on organic farms would be ubiquitous on conventional farms as well.

The point to get from the above is that neither of these interrelated design drivers will pertain in the future - the near future. Furthermore, the faltering of these historically all-powerful design drivers frees us of the need to labor within the debilitating and dehumanizing constraints of today’s model. When the price of fuel is high, small-scale Ontario organic producers won’t be fighting an uphill battle to compete economically with industrial-scale organic exporters in California.

Anticipating the end of cheap oil gives us the freedom, and indeed the responsibility, to conceive, validate, and refine alternative designs driven by a new suite of predictable design drivers.

FUTURE DESIGN DRIVERS

So what will drive the design of agriculture in the future? Arguably, the overriding design driver,

from which everything else will follow², will be the displacement of systems dependent on stored fossil fuel with systems centering on **current solar fuel** (Pollan, 2008). In simplest terms, living on current rather than stored solar energy is an absolute prerequisite to inter-generational equity - enabling our children, and indeed all of the earth's children, to be sustained in the future.

Crafting agri-food systems to meet this goal will demand a massive reconsideration of what we will do, and how we'll do it. And the time to rethink such an overhaul is now.

THIS IS WHERE ORGANIC FITS IN

To support the claim that the future is organic, we must first clarify what is meant by the term organic, and then rationalize why organic is suited to meeting the demands of farming on current solar energy.

What is Organic?

As defined today, 'organic' is just a set of scale-neutral production practices - a set of rules for ecologically sound and humane food production and processing. Compliance with standards derives from annual audits by independent certifying bodies (CB), costing individual farmers and processors from hundreds to thousands of dollars a year. The CB, of which there are currently 6 in ON, are themselves certified by a Competent Authority - which in Canada is the CFIA (<http://www.inspection.gc.ca/english/fssa/orgbio/man/orgbiomane.shtml>) . The newly minted organic standards are far from perfect, and are by no means followed perfectly on all farms - yet. But unlike other common terms, such as regenerative, alternative, and sustainable, standards exist by which different people can look at the same farm and agree that it is or is not in compliance with the label 'organic'.

Keep in mind that there is nothing in organic standards that could not and should not be done on conventional farms. In a review paper, Stockdale and Watson (2009) noted that the higher biological activity, biodiversity, and biofertility of soils under organic management derive not from organics, per se, but from the higher amount and quality of organic matter added to the soil in organic systems. Anyone can rotate crops, compost manure, and treat livestock humanely. Anyone can tailor cultivation equipment to manage weeds. The same equipment is used, and in the absence of targeted breeding, many of the same crop varieties and livestock breeds are used.

What sets organic farmers apart, however, is that they actually *do* these things not just because they should, but because they must - for both functional and auditable reasons.

For example, complex crop rotations are not just for show. On an ecologically sound farm,

²Everything else will include the design of cities, for example. What is the upper limit of population for a city that feeds itself on current solar energy? A million? A hundred thousand?

crop rotation is a tool of production, indeed, the center pivot of production tools. Crop rotation serves to manage weeds, soil nutrients, soil and hence plant health, promote water infiltration and storage, discourage pest proliferation, and build soil. This is not arcane dogma but a pragmatic form of agriculture designed to capture the ecological benefits served by biodiversity in Nature.

In sum, organic standards codify ecologically sound production practices, with mandated practices affirmed through obligatory annual, third party audits.

Why Will Organic Become Mainstream? Organic will predominate in the future because:

- Rising energy costs will preclude continued reliance upon energy-dependent inputs. Synthetic N alone currently accounts for about 40% of the energy budget of grain crops, encouraging a shift toward biological N fixation, but also toward less extreme levels of labile N.
- The rising costs of ‘fixing symptoms’ created by ecologically dysfunctional production systems will demand less intrusive, more ecologically sound approaches. For example, the weeds promoted by simple crop rotations will be viewed as a symptom of an unsound system, rather than as a problem. The solution then is not just to kill the weeds which will just reappear next year, but to strategically design rotations and other practices to narrow the weed niche.
- Organic practices are designed to *internalize* costs of production, reducing or eliminating the off-farm impacts objectionable to society

To illustrate the concept of internalizing costs, stockless organic horticultural farmers surveyed by Clark and Maitland (2004) actually marketed hort crops from a given field just 4 years in 10. In effect, they sacrificed hort crop income to grow hay, grain, or other service crops to add or scavenge N, suppress weeds and pests, and improve the soil. Organic practices are designed to internalize costs which are routinely externalized by conventional farming. Organic farmers do not ask society to absorb the cost of antibiotic resistant bacteria entering the food chain (Martinez, 2009) or endocrine-disruptor impacts on stream organisms (Orlando et al., 2009) or birth defects deriving from biocide use (Winchester et al., 2009).

As reviewed by MacRae et al. (2004), EU nations subsidize ecologically sound management exactly for this reason - to pay farmers for the extra costs incurred in order to internalize costs of production. Farmers are paid for societal services beyond the market-driven premium paid by individuals. Thus, ecologically sound management will be advantaged when input costs become prohibitive, and when society rejects the costs externalized by contemporary farming.

What About Organic Yields? One argument often heard for rejecting organic approaches to food production is the perception that high yields depend integrally on resource-intensive inputs. We have become so entrained to the notion that fertilizers and biocides are essential to high crop yields that many reject even the notion of high organic yields.

When studied systematically, however, organic yields can be quite comparable to conventional

yields, particularly after the 3-5 year transition interval. In MD, USDA researchers (Cavigelli et al. 2008) reported 6-year yields in corn, soy, and wheat under conventional (no-till and chisel plow) and organic management (2, 3, and 4(+)-year rotations). Organic corn yield in the longest rotation was 24% lower than from conventional yield, an effect which was attributed largely to insufficient N and weed control issues (73 and 23% of yield reduction, respectively). Organic soy yield was 16% lower than conventional, but wheat yield did not differ between systems. After the transition interval, Pimentel et al. (2005) found no difference in corn yield or in soy yield between conventional and organic systems in a 21-year trial conducted in PA. Similarly, over a 9 year interval in Iowa, Delate et al. (2008) showed no significant difference in yield for corn, for soy, or for wheat yields when grown in conventional versus organic systems.

Clearly, organic management is able to provide on-farm N and pest control comparable to what is purchased off-farm in conventional systems. However, it must be noted that the longer rotations typical of organic management mean corn may be grown once in 5 or 7 years, compared to in alternate years in a typical corn-soy rotation. Thus, total corn production in 10 years time will be much less in an organic system.

Can Organic Feed the World? Is this the right question to ask, given

- the dependence of conventional farming on inputs derived from diminishing and increasingly costly supplies of fossil fuels,
- the depletion of nonrenewable reserves, such as P (Cordell et al. 2009), and
- the adverse priming effect of synthetic N on breakdown of soil organic matter (Mulvaney et al. 2009) and on nitrous oxide emissions (various, in Clark, 2009)?

In other words, are current conventional yields an appropriate standard against which to compare organic yields, given that such yields will not be remotely sustainable in the post-oil era?

Furthermore, organic and low-input yields reportedly already surpass conventional yields in the Third World (Badgley et al. 2007). According to the UNEP-UNCTAD (2008), the issue in the third world is not 'how to feed people', but rather, 'how to end poverty and hunger'. Organic farming is viewed there as an enabling or empowering vehicle for social change and development, not just a way of producing food. How you frame the question predetermines the range of possible answers. The answers to 'how to end poverty and hunger' are quite different from 'how to feed the world'.

WHAT ABOUT SUSTAINABILITY?

It is argued by some that organic is conceptually narrowing; too limited to justify an academic curriculum, and that a broader focus on sustainability is enough. The problems with sustainability are several:

- In the much-cited Brundtland Report, "sustainable development is development that meets the

needs of the present without compromising the ability of future generations to meet their own needs” - which means exactly *what?* Except in the broadest sense, how do these words inform and give direction to curriculum to actually *prepare* people for a post-oil future?

- Chuck Francis of Nebraska says that sustainability is ‘too good a word’, having been co-opted and used by anybody and everybody, to mean whatever they want it to mean. Without an accepted definition, it is a word without meaning. On what basis can one decide if growing corn for ethanol or adopting conservation tillage or precision agriculture is, in fact, genuinely sustainable? Or even less bad? Sustainability, arguably, is a ‘feel good’ word. However, because it means whatever you want it to mean, it does not lend itself to constructive engagement when such action requires a population of people to accept fundamental change. Academically, it lets us look like we are ‘doing something’ constructive, when in fact, we are just spinning our wheels.
- From a comparative perspective, pretty well every school has courses or programs dealing in some way with sustainability, often from a social perspective. Guelph’s unique advantage, as an agricultural school, is it’s capacity to create, examine, and validate the biophysical soundness of agri-food systems. Defaulting to a program on sustainability would obscure this unique advantage in functional expertise, and ultimately, in Guelph’s relevance to future agriculture.
- Bill McDonough, award-winning architect and designer (<http://www.mcdonough.com/>) views sustainability as a flat, stagnant, and uninspiring call to action, using the analogy of:

Q - “So, how’s your marriage?”; A - “Well, it’s sustainable”.

McDonough says that we need to vision, dream, and aspire to more than just incremental modifications that let the current system be ‘less bad’. He states:

“What if humans designed products and systems that celebrate an abundance of human creativity, culture, and productivity....so intelligent and safe (that) our species leaves an ecological footprint to delight in, not lament?”

What indeed? As applied to date, research and education on agricultural sustainability have tended to focus on making the existing system less bad. For example, the harms of biocides are increasingly recognized, encouraging efforts to reduce their use through scouting to monitor pest levels and establish thresholds for applying biocides. This is supposed to enhance sustainability.

But recall that agriculture was never designed to be sustainable. To illustrate the flaw in this logic, note that McDonough and Braungart (2002) have no use for recycled paper, which they call ‘slow motion waste’. Paper was never designed to be recycled, such that efforts to do so consume large amounts of water, chlorine and other chemicals, leave large amounts of toxic

Who are these guys? Seem farfetched? Implausibly futuristic? Then recognize that their company is hired by the likes of John Deere, Ford Motor Company, Nike, and Wal-Mart to design buildings, complexes, and systems. Their focus is on design, and their way-out-of-the-box methods work.

sludge, and never recover the original fiber quality - a cradle to grave approach. So their book, Cradle to Cradle, is made of plastic made to look like paper. It is designed so that when the lifespan of the book is finished, the ink can be lifted off into the ink pot, the plastic goes back to the plastic pot, and a new book can be recycled without waste. No waste. Not *less* waste. *No* waste.

Is making an inherently flawed system less bad - analogous to tweaking the process of recycling paper - the best that Guelph, the top agricultural school in the country, can come up with - or do we welcome the opportunity to dedicate ourselves to exploring entirely novel approaches?

In other words, and with thanks to an anonymous author, when you find that you are riding a dead horse, do you buy a stronger whip, appoint a committee to study the horse, or announce a new funding program for dead horse performance? Or do you just get a new horse?

ORGANIC IS NOT ENOUGH FOR POST-OIL AGRICULTURE

So what would ecologically sound, post-oil agriculture look like? Organic? For sure. Of necessity. But organic according to contemporary North American organic standards is not enough. Humans have a long history of farming themselves to extinction, and long before GMOs or biocides or synthetic fertilizer were invented. So the issue of resolving the problem of ecologically unsound farming is more than replacing these inputs with rotations and composting.

Organic standards do indeed help us to avoid many of the needless harms we've imposed upon ourselves in recent decades. But as much as it pains me to say it, as practiced today, some (most) organic farms are still ecologically unsound.

Why? Several issues can be mentioned, not least the one-way nutrient movement embodied by export-oriented agriculture, but in the interests of time, we'll consider just one. I would suggest that the over-reliance on large-seeded annuals in agriculture is the root cause of the unsustainability of agriculture, historically and today.

What's Wrong with Large-seeded Annuals?!

If we accept:

- that Nature is the only true and certain model of ecological soundness
- that the type of vegetation adapted to much of North America is perennial - trees and grasses
- that agriculture is an inherently unnatural system, and
- that to approach ecological soundness, agriculture must emulate the principles that sustain Nature; and further,

then I put it to you that ecologically sound agriculture - including organic agriculture - will

necessarily rely less on *annuals* and more on *perennials*³- with a central role for grass-fed livestock⁴. And let me re-affirm that this does not mean less vegetables, as these account for barely 2%⁵ of arable land in ON. The problem is the predominance of large-seeded annual grains, which currently occupy over half of the arable land in ON, grown largely although not solely for livestock feed to enable the confinement industry.

Most of global nutrition today comes from barely a dozen crops, with **large-seeded annuals** like corn, rice, and wheat accounting for the lion's share. So what?

- Annuals introduce **periodicity into nutrient sinkness**, leaving gaps early and late in the year that coincide with times when precipitation exceeds evapotranspiration and the net direction of water movement is downwards. Perennials more effectively cover off these leaky intervals with active nutrient sinkness earlier and later in the year
- Annuals require **bare soil**. Nature has evolved strategies, such as the soil seedbank, seed rain, and laterally encroaching vegetation to keep the ground covered. Keeping soil bare, apart from the sown crop, means perpetual war with Nature, whether through tillage or herbicides. A perennial grass sward, however, behaves a lot like Nature, keeping the ground covered year-around, and with an economically valuable crop.
- Annuals are almost always sown in **monocrops**, impoverishing the plant **biodiversity** so vital to many of the functions that sustain natural ecosystems, including controlling pestiferous populations. Perennial grass swards, in contrast, quickly become biodiverse even if sown to just a few species, and are thus better able to sustain ecosystem functions.
- Annually re-setting a field back to the pioneer stage loses the accumulating advantages of **succession**, which include building soil organic matter and nutrients, with follow-on benefits in water conservation, risk management, and disease/pest control. Again, perennials intrinsically capture these advantages, which is why withholding land from cultivation under a perennial grass sward actually builds and regenerates soil damaged by annual cropping
- Modern agriculture **linearizes** nutrient flow, extracting nutrients to deficit in one place and concentrating them to excess in another, generating both scarcity and excess. Real sustainability demands nutrient return - popularized as Howard's 'Law of Return'. Exporting an acre of land as meat, milk, or eggs means a fraction of the implied nutrient export of grain or vegetable crops.

The large-seeded annual growth habit is adaptive primarily in Mediterranean climates which are characterized by protracted summer drought. Allowing annuals to become so prominent in North America, where a perennial growth habit is adaptive, necessarily exposes ecological disjuncts or incompatibilities.

³ plants that live 3 or more years, including most fruits and nut-bearing trees,

⁴ horses, cattle, sheep, and goats evolved to consume grass and some woody species; pigs can consume diets largely or wholly made of grass, while grass can be part of a diet for chickens and turkeys

⁵ And fruit, which occupy 1% of arable land in ON, are biennial or perennial already

I put it to you, then, that whether fruit and nut trees or grass swards, perennials will have to account for a much larger share of the agricultural landscape if our goal is ecologically sound agriculture.

And be very clear that this reasoning pertains whether it is barley or soybean, conventionally or organically grown, and arguably, independent of tillage practices. Contrary to conventional wisdom, conservation-tillage practices are demonstrably effective in sequestering carbon and improving soil organic matter only in some agro-climatic regions (Gregorich et al., 2005). Using conservation-till practices in order to prolong annual cropping is at best a weak proxy for the robust benefits - both to the farm and to the global issue of GHG abatement (Clark, 2009) - of withholding land from cultivation under a perennial sward.

Designing for the post-oil future means tailoring agricultural crops, practices, and expectations to the soil, climatic, and managerial constraints of each region. And for much of North America, that means a whole lot less annual - and especially grain - cropping. In other words, tailor the agriculture to fit the environment, rather than trying to shoehorn-in annual crops to an environment suited to perennials.

But What about All That Grass? Perhaps we can agree that ecological soundness depends on emulating the principles that sustain Nature, the only true and certain model of sustainability, and for much of North America, the native vegetation is perennial - not annual. But humans don't do well on grass or bark. This is where livestock come in, as a bridge to convert perennial grass swards - which are essential for ecological sustainability - into human-usable products. Livestock provide the economic justification for 'doing the right thing' by the planet - and for human sustenance.

To illustrate the concept of livestock as a bridge, I once saw a pile of termite nests near a dwelling deep in the rainforest of Nicaragua. The home had screenless window openings, and was in an area infested by night-flying mosquitoes carrying not just malaria but dengue fever. Each night, one of the termite nests - which look like a large rugby ball - was placed upwind of the house, set on fire, and allowed to smolder and smoke for hours to discourage downwind mosquitoes. The resident hen, chicks in tow, capitalized on the free lunch by scratching continuously at the termite nest, teaching the chicks to gobble up the termites as they tumbled out of their smouldering home. In effect, the chicken filled a missing link in the transformative chain of nutrition that started with a wholly inedible product - decaying wood - passed through the termites and chickens, and culminated in eggs and ultimately meat for the farm family.

But does this reasoning mean replacing all those annual vegetables we like and need with even more meat, milk, and eggs than we already eat? No. The grass ley system formalized by Stapledon and Davies (1948) facilitates the production of needed annuals by rotating annuals for direct human use with perennials to be grazed or conserved for livestock. In this system, an interval of 1 to several years under perennial sod is rotated with an interval of 1 to several years of annual crops, to produce what we need while at the same time, meeting the needs of Nature.

Is there enough land to support grassland ley farming in ON? Because over half of all arable land in Ontario grows grain for livestock, a return to traditional mixed farming simply means switching to a more grass-based ration for whatever livestock can be justified on the post-oil landscape.

Some have argued that we should stop growing livestock entirely, or at a minimum, eat less meat. While eating less meat is hard to argue with, I would argue that livestock - because of the forages they consume - are in fact a critical foundation to ecological sustainability. But I refer not to livestock in confinement, but rather, to livestock as service providers.

The exclusion of livestock from many farms, including many organic farms, challenges ecological rationality - exceeds the forgiveness limits of Nature. Yet many contemporary organic farms are nonetheless pursuing unsustainability by choosing to be stockless. Organic standards have been interpreted to permit the same commodification and polarization of crop and livestock farming which have proven to be so problematic on conventional farms. Yet mixed crop:livestock agriculture was the norm not even 100 years ago. As argued by no less an authority than Sir Albert Howard (1943), one of the founders of what has become organic farming:

“Mother Earth never attempts to farm without live stock; she always raises mixed crops; great pains are taken to preserve the soil and prevent erosion; the mixed vegetable and animal wastes are converted into humus; there is no waste; the processes of growth and the processes of decay balance one another; ample provision is made to maintain large reserves of fertility....”,

Livestock perform many services for us. Livestock are more than a source of meat, milk, and eggs. We need to take a step back and see the bigger picture, employing livestock to reconcile the divergent demands of ecological soundness with the needs of human nutrition.

GUELPH'S UNIQUE ROLE.

Gomiero et al. (2008) noted that universities have done little, in research or in education, to build the population of skilled organic farmers needed for the future. Based on sustained trends, MacRae et al. (2009) estimated that the number of organic farmers in ON will need to increase more than 10-fold over the next 15 years, just to keep up with projected demand for organic food. As the premier agricultural school in Ontario, and arguably, in Canada, Guelph has a unique responsibility to contribute to redesigning the agri-food system. Guelph's pioneering B.Sc.(Agr) Organic Agriculture major is explicitly designed to to prepare people - philosophically and functionally - for fundamental changes to how we will live and farm in the soon-to-be post-oil future.

CONCLUSIONS

1. The future, which is coming faster than most of us appreciate, will be organic.
2. Agriculture, as much of modern society, evolves in response to forces or drivers. Arguably, the dominant drivers in our recent past were cheap oil and the willingness of society to tolerate costs externalized by seemingly efficient mega-scale production and processing.
3. Drivers change, and the system they drive necessarily also changes. Post-oil realities will advantage small-scale, organic, locally-sourced, seasonal, and minimally processed food, just as cheap oil selected for bigness, resource-based production, globalization, and processing/packaging/refrigeration.
4. For much of North America, agriculture - including organic agriculture - is not ecologically sustainable, in part due to the absence of perennial forages, and hence, livestock to convert the forage into human-consumable food.
5. The sooner that academics and government policymakers acknowledge the implications of post-oil for the structure and function of agriculture - and education in agriculture - the easier it will be to design and educate for the future.

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