Four Fallacies of Agricultural Sustainability, and Why They Matter: Part 1- We should tread more lightly on the agricultural land base

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Introduction

The view that additional steps should be taken to confirm that food is produced sustainably has become ubiquitous in Canada, as well as in other developed countries. Consistent with this, the downstream food industry has become much more interested in the upstream elements of its supply chain, especially the farm segments and the technologies/processes it employs, and has sought to derive metrics that measure and influence the sustainability of this food end product. This plays out across a range of parameters, including carbon footprint, water use, pesticides, fertilizers, antibiotics, hormones and growth promotants, animal welfare, labour standards, as well as others. In some cases, specific technologies or techniques related to the above have been targeted, such as genetically modified, specific pesticides, specific animal health products, certain livestock housing systems, etc.

This represents a plausible response to increased public awareness of natural resource scarcity and of food security. However, important aspects of this movement are simplistic, misguided, or simply wrongheaded, and following these through to their logical extent presents the prospect of pitfalls for the agri-food system. Perhaps more fundamentally, it begs the question as to how the agri-food system, and primary agriculture in particular, grew to become so unsustainable to begin with. In Canada many generations of farmers have seen themselves as stewards of the land, farm product production has greatly increased and intensified, and rather than starve or cause mass illness, we have produced significant surpluses for export at steady or improving quality standards.

Others, including some farmers, are deeply concerned about the future of the agri-food system, how natural resources, human resources, and technologies are used and what the potential consequences may be. There are examples that can be cited that lend support to these types of concerns.

This highlights a gap that has emerged in our understanding of how agri-food production systems develop and evolve, and how this relates to sustainability. As a means of advancing our understanding, four fallacies related to agri-food sustainability are identified and discussed in this series below. These are:

1. We should tread more lightly on the agricultural land base
2. Small farms are better
3. Farm technologies can be picked from a menu
4. New technology will solve all problems

This paper is the first in the series of four, which considers the first of these issues.

We should tread more lightly on agricultural land

Food demand is increasing, and the need for increased production of farm products is increasing. This is broadly recognized; the UN Food and Agriculture Organization has estimated that global food production will need to increase by 70-100% by 2050. The Royal Society observed in 2009 that increased demand of food can only be satisfied if: "there is also a substantial increase—by between 50 and 100%—over today's levels of production of all major food crops (Davies *et al*, 2009).

Fundamentally, there are two alternative approaches to meeting this demand (1) convert land into agricultural use which is currently in some other use, or (2) increase the output from the existing agricultural land base. The former approach increases production by extending agricultural land use by converting land from other uses (extensification); the latter increases production by more intensively using the existing land base (intensification). These two alternatives are not equivalent, particularly in terms of environmental sustainability, as discussed below.

First, consider the apparent advantages of the extensive approach. It allows for reduced input use- fertilizers, pesticides. It may be consistent with more holistic, historic or traditional farming methods, and with a particular perception of rural culture. In some ways, it could be viewed as a lower risk approach.

However, when it is acknowledged that land in other uses, including land in pristine condition, provides an existing stream of benefits such as wildlife habitat, wetland/groundwater recharge, carbon sequestration, etc. it becomes clear that by "treading more lightly" and thus increasing the footprint of agriculture, we are in fact not treading more lightly at all. The literature supporting this is voluminous.

For example, Burney *et al* (2010) found that agricultural intensification between 1961 and 2005 avoided the release of about 161 gigatons of carbon. They observed that "our results demonstrate the importance of land use change emissions over direct emissions of methane and nitrous oxide from agricultural systems, and suggest that the climatic impacts of historical agricultural intensification were preferable to those of a system with lower inputs that instead expanded cropland to meet global demand for food" (Burney et al, 2010). Recent work by Stephenson *et al* (2013) found that genetic improvements in major field crops between 1965 and 2004 saved between 18 and 27 million hectares of land conversion into agricultural use. Foley *et al* (2011) observed that "to meet the world's future food security and sustainability needs, food production must grow substantially while, at the same time, agriculture's environmental footprint must shrink dramatically"; clearly this implies more intensive use of agricultural land.

With regard to biodiversity effects, most of the evidence comes from developing countries where new land conversions to agricultural use are occurring on a significant scale. Phalan *et al* (2011) compared the densities of tree and bird species according to varying levels of agricultural intensity in India and Ghana. They found that more species were negatively impacted by

agriculture than benefitted from it, suggesting a benefit to more intensive use of the existing agricultural land base and leaving other lands undisturbed. Similar effects were observed by Guitierrez-Velez *et al* (2011) in oil palm production in Peru, and across a range of crops in tropical countries by Phalan *et al* (2013).

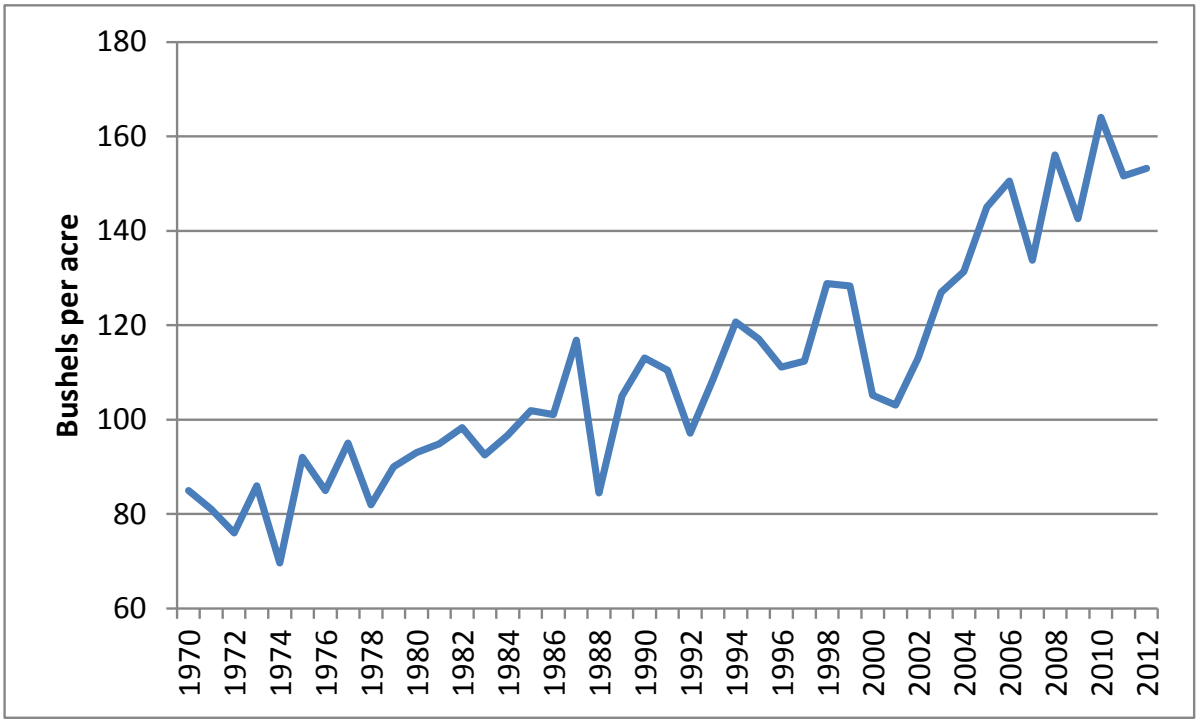
Intensification has been a key driver of economic development in Canada. This relates to the development and use of yield increasing and labour-saving technologies that allow for increased production but with limited expansion in land, labour, and water use. As noted by Evans (1998), since the 1960's the bulk of increases in agricultural production have occurred through yield increases rather than through expansion in the area farmed. Intensification in both crops and livestock ultimately relates to agricultural land and water use, since the efficiency in animal growth relates to feed efficiency, which in turn consumes feed crops, land, and water from alternative uses.

The extent of increase in agricultural productivity improvement needs to be appreciated; Figures 1 to 4 provide selected Canadian examples to illustrate the broader point. Figure 1 shows that Ontario corn yields literally doubled between 1970 and 2013, from barely 80 bushels/acre to about 160 bushels/acre. Figure 2 plots Alberta wheat yields; these have increased by more than 50% since the mid-1970's, from around 30 bushels per acre to almost 50 bushels/acre recently. Figure 3 measures improvement in Canadian swine growth efficiency. In 1980 it took around 185 days (and the associated feed, labour, other inputs) for a pig to reach 100 kg. Today it only takes about 155 days to reach 100 kg. Figure 4 shows that milk production per cow has also increased markedly over time- from about 6,600 kg/cow in the mid-1980's, to almost 9,800 kg in 2012. In order to produce the same volume of corn, wheat, pork and milk as occurs today absent these yield improvements would require a markedly larger amount of land, water, and human effort.

This trend is true more broadly. Ausubel *et al* document dramatic increases in crop yields and land "saved" from conversion to agricultural use from North America, Europe, Asia. Robert Thompson (2010) notes that

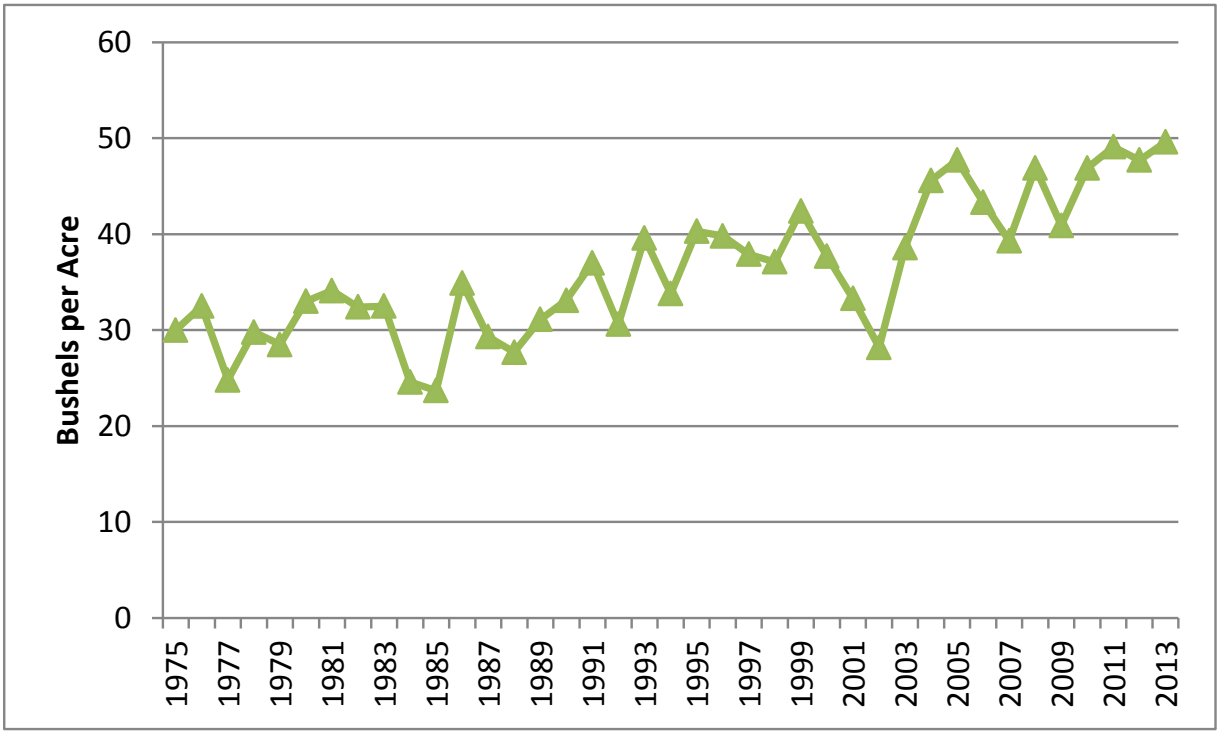
"*A century ago, cereal grain yields in Western Europe and the United States were little higher than those observed in sub-Saharan Africa today. The large increases in productivity since then have reduced the unit cost of production and kept the price of food lower, benefitting farmers through higher household incomes and low-income consumers who spend the largest fraction of their incomes on food. Moreover, this has made famine a rarity in the world and has allowed millions of hectares of trees to remain standing in the world's forests instead of being cut to make way for an expanded area under cultivation."*

Figure 1 Ontario Corn Yields



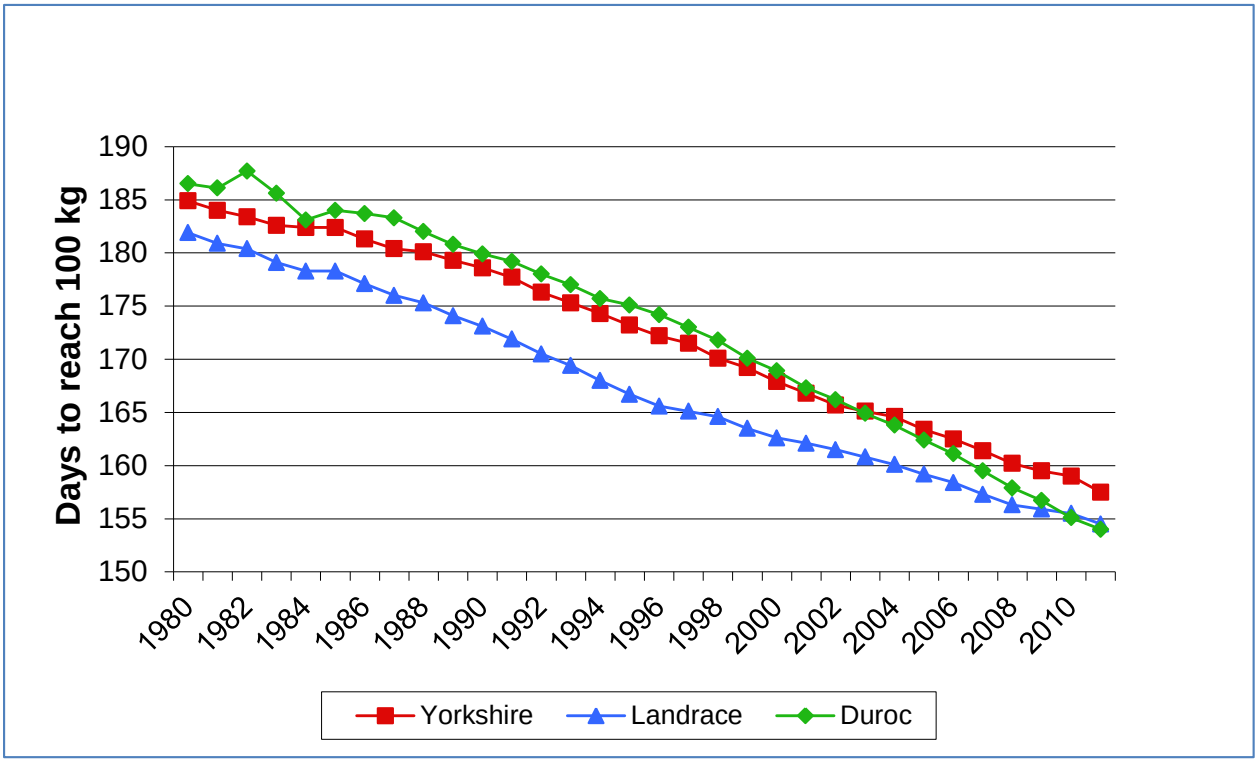
Source: Statistics Canada

Figure 2 Alberta Wheat Yield



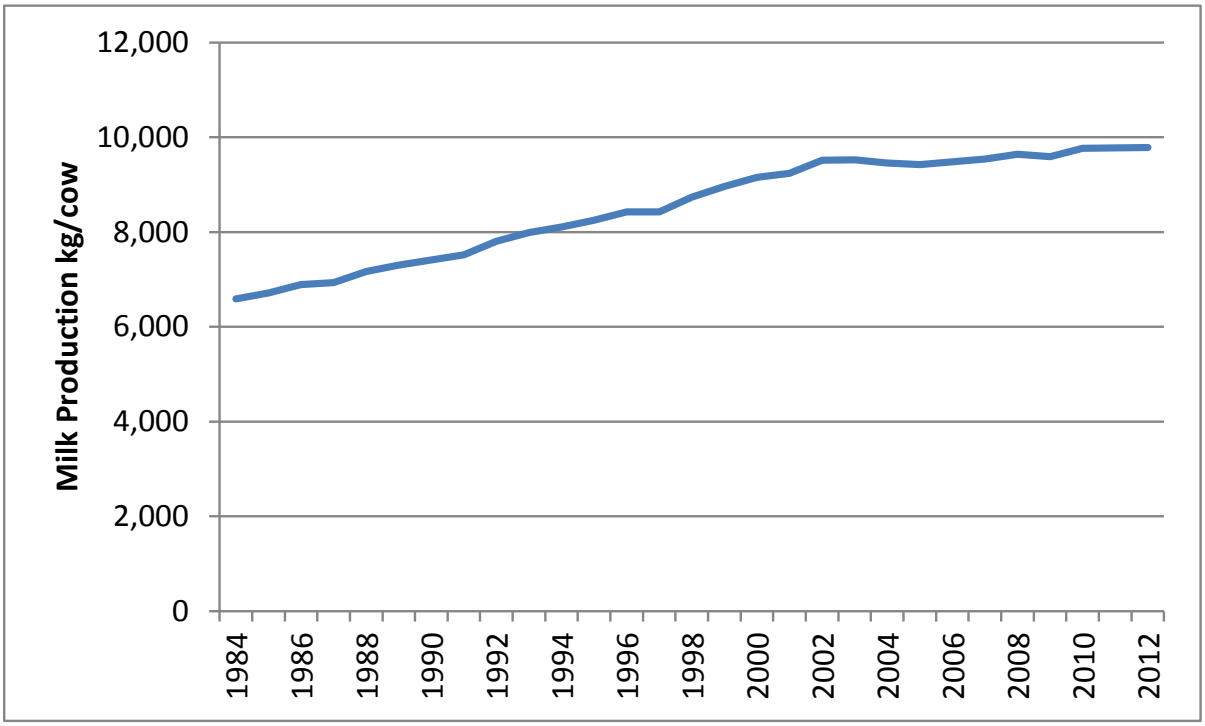
Source: Statistics Canada; All Wheat

Figure 3 Age at 100 kg, Major Swine Breeds on Genetic Testing



Source: Canadian Centre for Swine Improvement

Figure 4 Canadian Average Milk Production per Cow, Dairy Herds on Official Milk Recording Programs



Source: Canadian Dairy Information Centre

Intensifying agricultural land use as a means to expand output creates (or retains) an environmental benefit, in terms of land not converted into agricultural use. Agrarian landscapes are not "natural", as farmland in use today was historically converted from some prior, pristine state into agricultural use. Intensification of existing agricultural land use reduces the extent to which new land must be converted into agricultural use to increase production; this is critical in reducing carbon and water footprint, and in protecting alternative land uses such as wildlife habitat.

Thus, there are major environmental and economic benefits of intensifying existing agricultural land use in terms of maintaining other land uses, some of which are associated with more pristine conditions. It is also relevant that land use intensification has produced economic benefits for farmers, especially for those with a fixed land base from which to operate. Indeed, this has been an important element of economic sustainability for farmers as farm prices received have broadly decreased on an inflation-adjusted basis, over an extended period of time. Farm products marketing rules that prescribe more extensive land use practices can have precisely the opposite effect in terms of reducing economic benefits to farmers that consequently produce less product from a given land resource base. In such cases, appropriate farm product price adjustments must be made in order for the farmer to be kept whole.

It should also be acknowledged that in a free enterprise, market-based agricultural system many farmers have chosen to undertake more extensive methods of farming, such as organic, voluntarily. This may occur due to personal conviction, attitudes towards particular technologies or farming methods, or in the expectation that the price premium resulting from their marketing efforts based on their farming practices will more than bridge the yield gap. Among other things this offers variety in the marketplace, and in choosing to avoid more intensive farming methods, some of the potential risks associated with misuse or mismanagement of more intensive farming methods may be avoided (more on this below).

The important point, however, is that in aggregate, by treading more lightly on the existing agricultural land base out of environmental interest, we unintentionally create the opposite effect. Policies that support or encourage more extensive land use exacerbate the issue by requiring more land to be used in expanding the supply. This extends to private product standards in which food marketers assign "sustainable" attributes to practices that result in more extensive land use (such as non-Genetically Modified, antibiotic-free, etc.) which should be understood as a confusion in terms- extensification is the least sustainable because it implies land conversion.

However, it must also be recognized that as more intensive production proceeds, it will (and must) be accompanied by more intensive management as we utilize greater levels of technology and inputs on an acre of land. The agricultural technologies that facilitate intensification can fail or create unintended consequences, and greater effort to prevent this is warranted. Examples currently in use include the refuge protocol used with Bt corn production, and crop fertility

management using 4-R principles. This is consistent with ever-greater public expectations in environmental protection in general, and sustainable production of food in particular.

Moreover, greater intensification does entail certain increased risks (spills, leaching, etc.) and technologies can fail (for example, through pest resistance). Thus, instead of contradicting sustainability by prescribing farm production practices that logically lead to extensification, the agri-food system would be better served if downstream customers encouraged intensification, but in so-doing encouraged adoption of appropriate management and metrics to mitigate the risks of intensification and demonstrate the safety and sustainability of technologies employed.

This appears counter to current trends, in which some food marketers are unwittingly encouraging extensification, a contradiction to their sustainable messaging.

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