

LECTURE 2_11:

FEB. 11, 2014

AGRICULTURE

CANADIAN AGRICULTURE AND RELATED ENVIRONMENTAL IMPACTS & SUSTAINABLE FOOD SYSTEMS

Text Reference: Dearden and Mitchell (2012), Ch. 10, pp. 347-368.

T. Randall, Lakehead University, WA 2014

Recall from Last Lecture

- Agriculture: current agricultural systems
 - ▣ Green Revolution
 - ▣ Competition for agricultural land (with urbanization; with biofuel production)
 - ▣ Measures to protect agricultural land (in Quebec, BC, Ontario)
 - ▣ Genetically Modified / Transgenic Crops and related uncertainties with their use: 1) Pleiotropic effects; 2) Environmental effects; 3) Unintentional Spread;

Outline



From: Dearden and Mitchell (2012)

- Trends in Canadian Agriculture
- Environmental Challenges for Agriculture in Canada
 - {Land Degradation; Soil Erosion; Soil Compaction, Acidification & Salinization; Organic Matter & Nutrient Losses; Biocides; Biomagnification; }
- Sustainable Food Production & Organic Farming
 - {Integrated Pest Management; Integrated Plant Nutrient Systems; No-Till/Conservation Agriculture}

Trends in Canadian Agriculture

- 7% of Canada's total land area is agricultural land – relatively unchanged fraction in past 50 years;
- Decrease in number of family farms with corresponding increase in farm size (see Fig. 10.5)
- Only 3% of employment in Canada in farming (cf 80% earlier in our history)

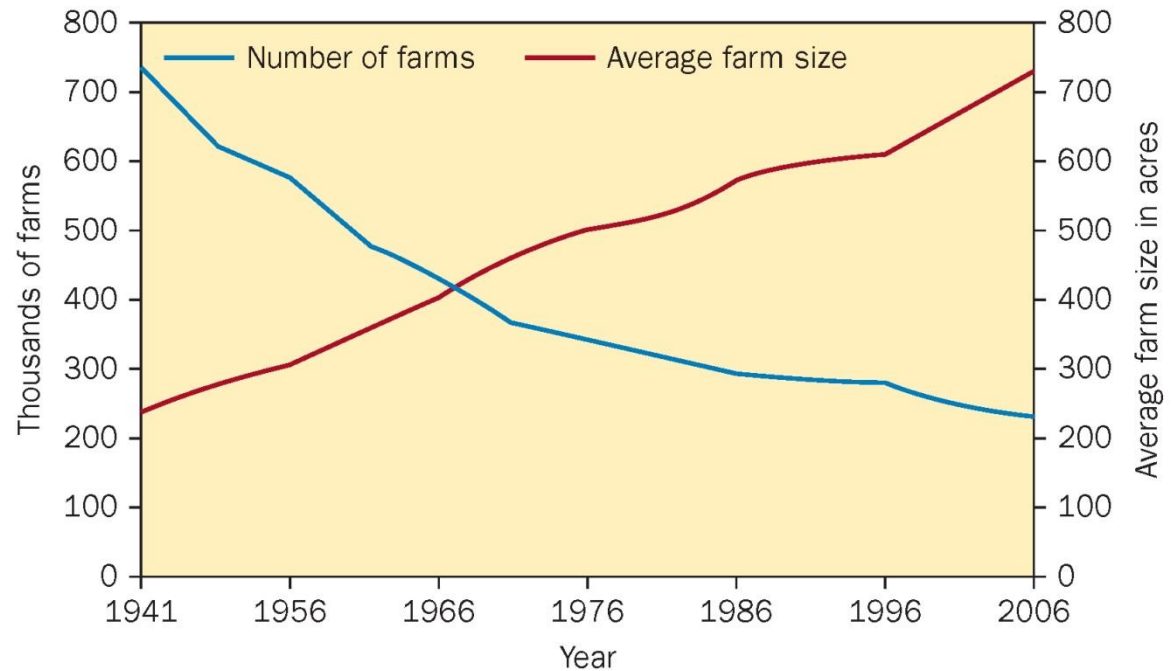


Figure 10.5 | Number and size of farms in Canada, 1941–2006. Source: Statistics Canada. Census of Agriculture, various years.

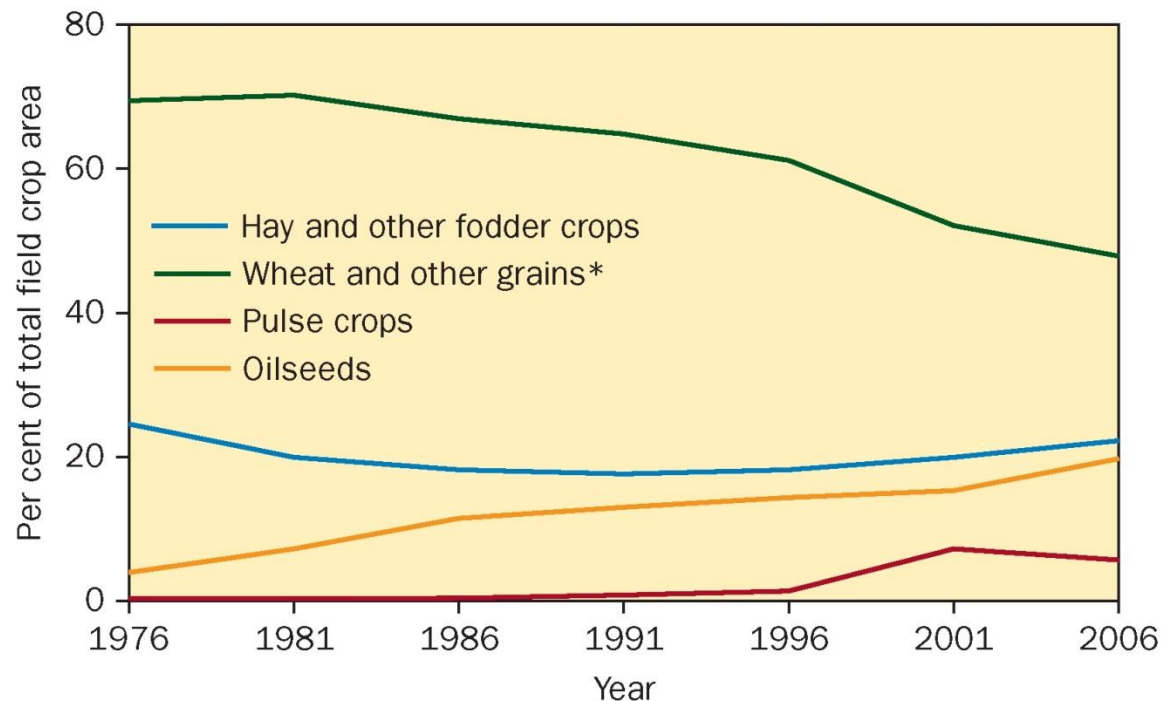
Note: It is interesting that although Canada officially uses metric units, Agriculture and Agri-Food Canada continues to use imperial units (acres) even in recent publications such as this graph. In a sense, this can be seen as symbolic of the inertia in Canada's agricultural sector.

From: Dearden and Mitchell (2012)

Trends in Canadian Agriculture



- **Wheat** is still the dominant crop in Canada
- The **agricultural and agri-food sector** is a \$86-billion industry, exporting more than \$28 billion in products annually;



* Other grains include oats, barley, mixed grains, corn for grain, rye, and buckwheat.

From: Dearden and Mitchell (2012)

Figure 10.6 | Crop area allocation, 1976–2006. Source: Statistics

Canada's 5 largest agricultural production sectors

Five Largest Agricultural Production Sectors.^[23]

Sector	per cent cash receipt	Primary market
grains and oilseeds (wheat, durum, oats, barley, rye, flax seed, canola, soybeans, rice, and corn)	34%	domestic and export
red meats – livestock (beef cattle, hogs, veal, and lamb)	24%	domestic and export
dairy	12%	domestic
horticulture	9%	domestic
poultry and eggs	8%	domestic

Canadian Federation of Agriculture (2007).

Trends in Canadian Agriculture



Crop Dusting
theperiledsea.ning.com

Ottawa Citizen
syndicom.com



http://www.deere.com/common/media/images/product/tillage/r4d021995_2600_tillage_942x458.jpg

- Unfortunately, many innovations & technologies in use on Canadian farms have **negative implications for ecosystem health**;

From: Dearden and Mitchell (2012)

Environmental Challenges for Canadian Agriculture

- **Land degradation** includes a number of processes that reduce the capability of agricultural lands to produce food:
 - Soil Erosion
 - Soil Compaction
 - Soil Acidification
 - Organic Matter and Nutrient Losses

Land Degradation (1)

- **Soil erosion** is a natural process whereby soil is removed by gravity and water & wind processes
- **Soil compaction** is the compression of soil as a result of frequent heavy machinery use on wet soils or the overstocking of cattle on the land



.... “that erosion has a double impact on the planet - washing away vital nutrients from the soil but also, surprisingly, helping lock carbon into the soil and preventing it from reaching the earth's atmosphere”.

Soil erosion – the forgotten player in the global change debate

Lancaster University News Archive
news.lancs.ac.uk

30 April 2010

Land Degradation (2)

- **Salinization** is the deposition of salts in irrigated soils, making soil unfit for most crops; caused by a rising water table due to inadequate drainage of irrigated soils
- **Summer fallow** is a practice common on the Prairies in which land is ploughed and kept bare to minimize moisture losses through evapotranspiration but which leads to increased salinization
- Soil degradation, including erosion and **nutrient depletion**, is undermining the long-term capacity of many agricultural systems worldwide

Nitrogen inputs required to maintain grain yields in the Prairies

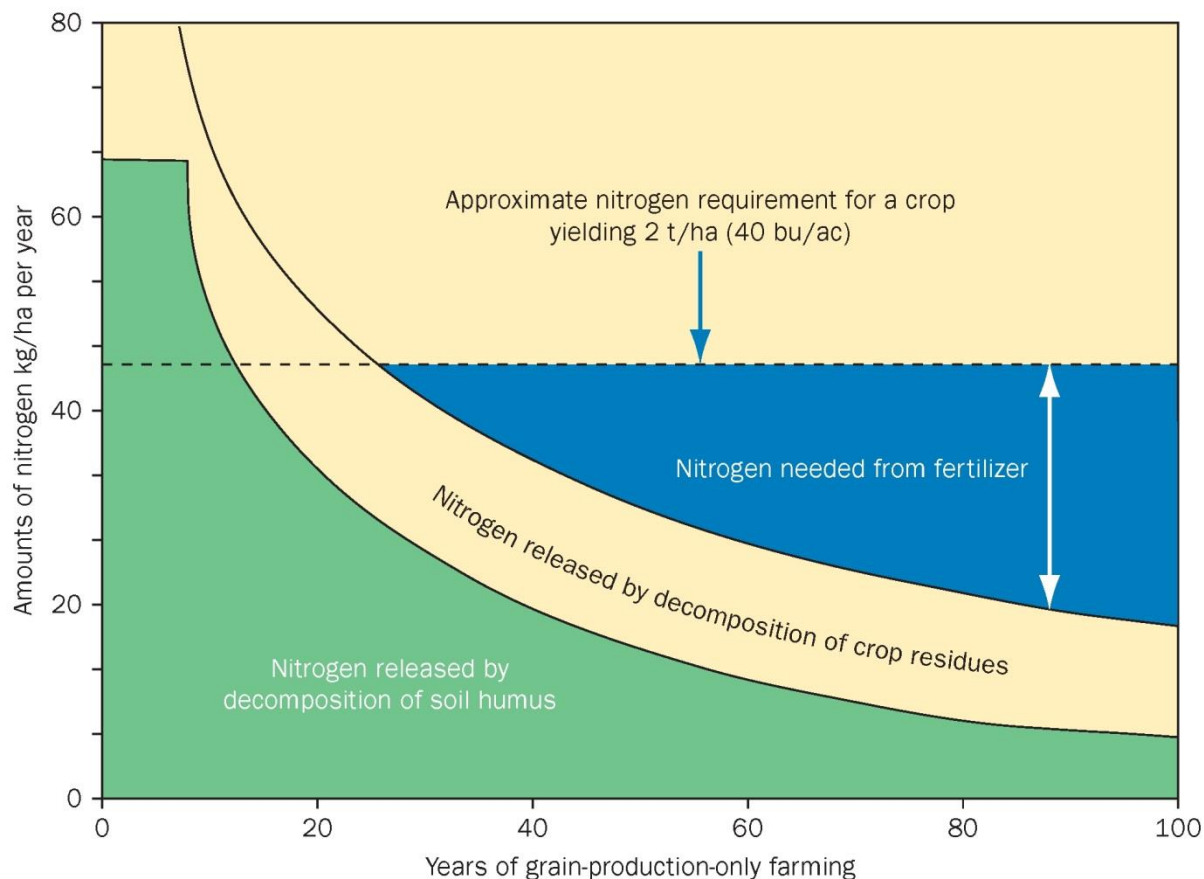


Figure 10.7 | Diagrammatic illustration of approximate sources of nitrogen needed to maintain grain yields of about two tonnes per hectare (40 bushels per acre) of barley under a system of continuous grain production in the prairie region.

Note that this diagram illustrates plant requirements, not supply—i.e., the amount of fertilizer nitrogen applied would normally be greater than the plant requirements because of losses due to denitrification and/or leaching. Source: Bentley and Leskiw (1985).

Biocides

- **Biocides** are chemicals that kill many different kinds of living things (include: pesticides, herbicides, insecticides)
- Controversial use since the publication of *Silent Spring* (1962):

Positive outcomes

- Boost in **global food yields**; preventing more serious starvation issues;
- **Saved countless lives** through control of infectious diseases (e.g., attack on malaria-carrying mosquitos)

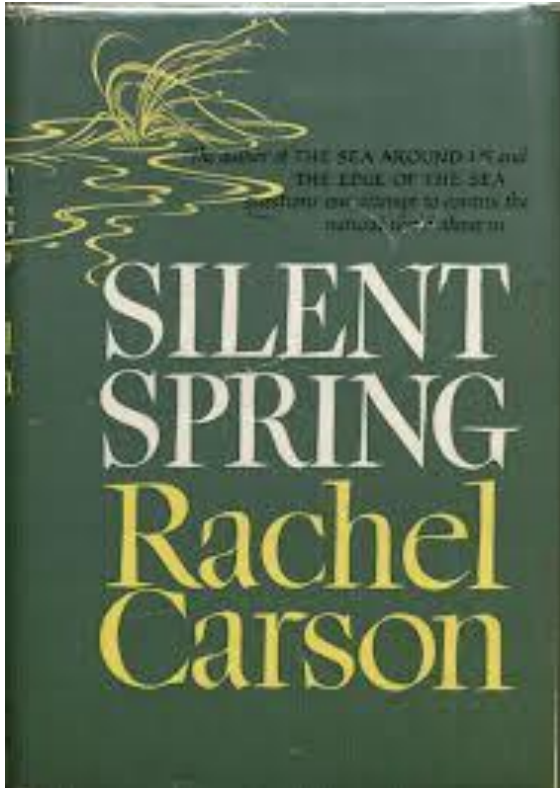
Negative consequences

- Possible **environmental problems & health impacts**; (e.g., resistance, mobility, persistence, bio-concentration)



"We spray our elms and the following springs are silent of robin song, not because we sprayed the robins directly but because the poison traveled, step by step, through the now familiar elm leaf-earthworm-cycle."

Rachel Carson Silent Spring (1962)



'Silent Spring' Is Now Noisy Summer

Pesticides Industry Up in Arms Over a New Book

By JOHN M. LEE

The \$300,000,000 pesticides industry has been highly irritated by a quiet woman author whose previous works on science have been praised for the beauty and precision of the writing.

The author is Rachel Carson, whose "The Sea Around Us" and "The Edge of the Sea" were best sellers in 1951 and 1955. Miss Carson, trained as a marine biologist, wrote gracefully of sea and shore life.

In her latest work, however, Miss Carson is not so gentle,



Rachel Carson Stirs Conflict—Producers Are Crying 'Foul'

fending the use of their products. Meetings have been held in Washington and New York. Statements are being drafted and counter-attacks plotted.

A drowsy midsummer has suddenly been enlivened by the greatest uproar in the pesticides industry since the cranberry scare of 1959.

Miss Carson's new book is entitled "Silent Spring." The title is derived from an idealized situation in which Miss Carson envisions an imaginary town where chemical pollution has silenced "the voices of spring."

Aspects of the biocide issue:

□ **Resistance**

- a constant need to develop new biocide products to keep one step ahead of biological adaptation

□ **Non-selective**

- Many biocides are popular because they are broad-spectrum poisons; there is no need to identify the specific pest, because a broad-spectrum poison will kill most insects

□ **Mobility**

- The effects of the chemical application are often felt over a much wider area

The US Department of Agriculture estimates that less than 2% of applied insecticides reach their targeted destination.



Much enters the hydrologic cycle.



usatoday30.usatoday.com

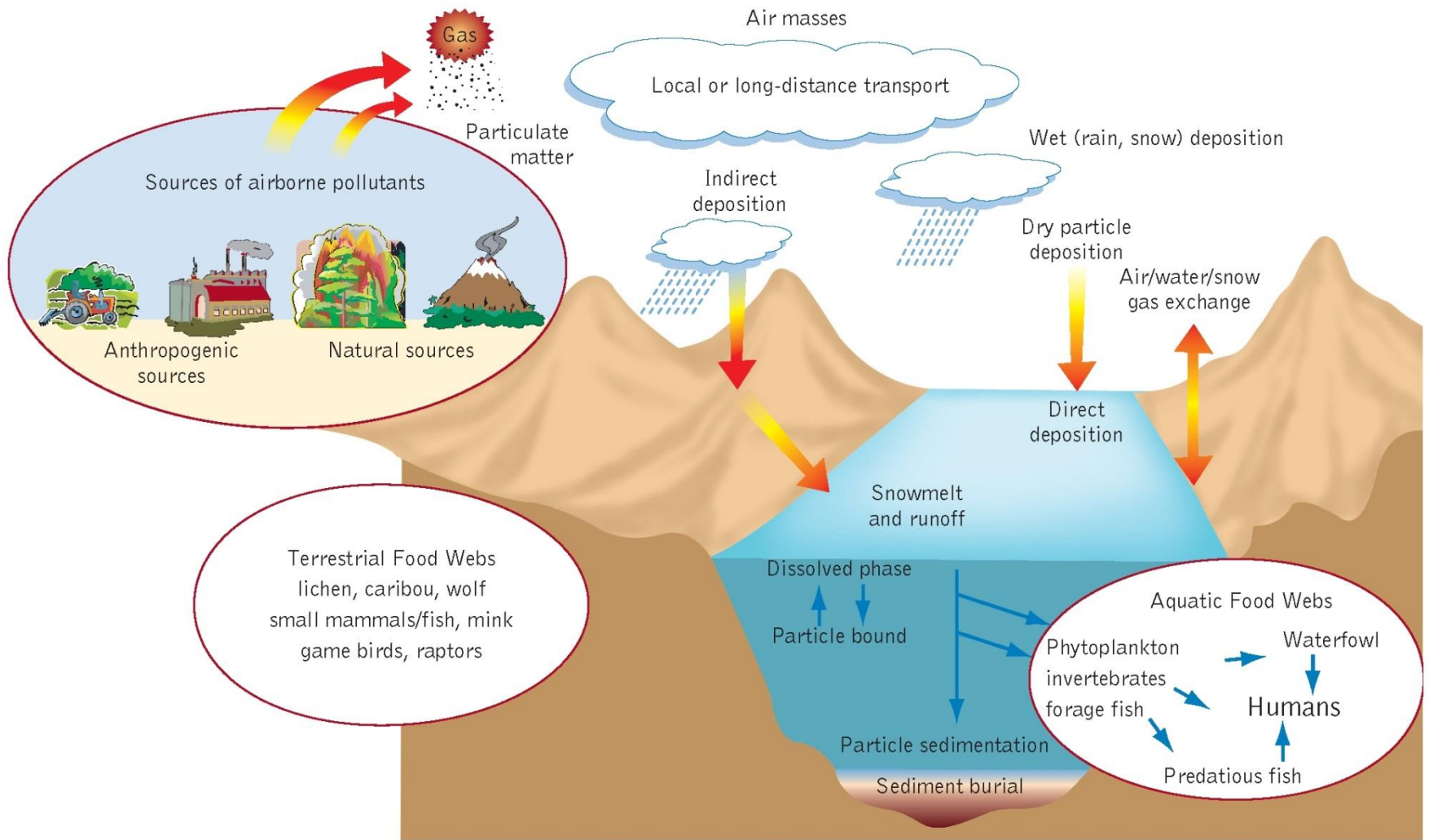


Figure 10.9 | Pesticide transportation in the environment. Source: Adapted from Indian and Northern Affairs Canada (1997b). Reproduced with the permission of the Minister of Public Works and Government Services, 2004.

From: Dearden and Mitchell (2012)

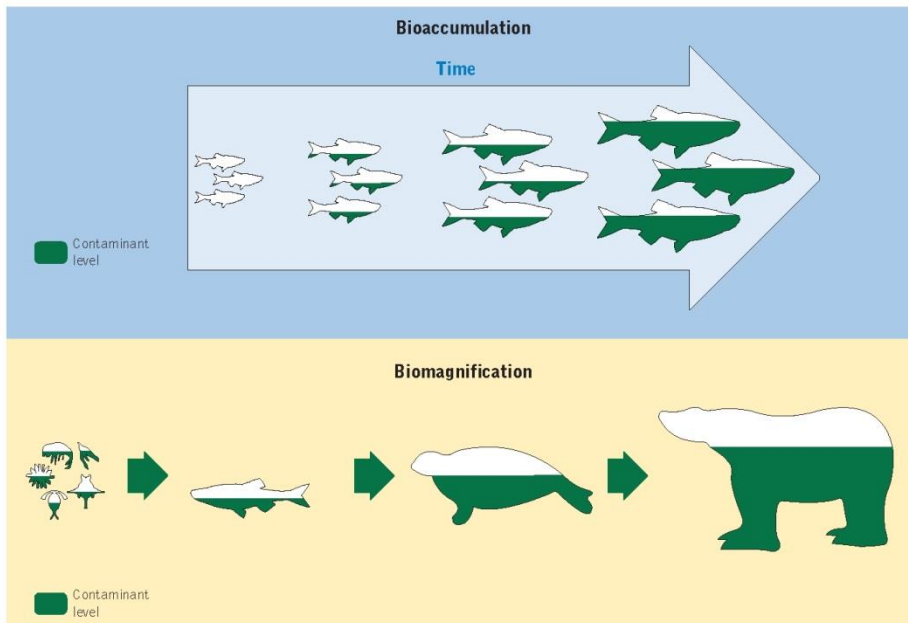
Impacts of biocide use

□ Persistence

- Biocides contaminate through time, as many of them are very persistent, such as DDT
- Became widely used in the 1940s; peaked in 1970; use banned in US (in 1972); use of DDT products ended circa 1985;

□ Biomagnification

- High concentrations of persistent organic pollutants (POPs) have been detected in top predators of the Arctic food chain



Concentrations increase 5x to 10x with each step in the food chain.

From: Dearden and Mitchell (2012)

Sustainable Food Production Systems

Three Components of:

1. Integrated Pest Management
2. Integrated Plant Nutrient Systems
3. No-Till/Conservation Agriculture



Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management

Integrated Pest Management

- Its is to avoid or reduce yield losses caused by diseases, weeds, insects, mites, nematodes, and other pests while minimizing the negative impacts of pest control;
- The presence and density of pests and their predators and the degree of pest damage are monitored, and no action is taken as long as the level of pest population is expected to remain within specified limits;
- IPM considers the crop and pest as part of a wider agro-ecosystem

Integrated Plant Nutrient Systems

- Imbalances in nutrient availability can lead to depletion of nutrients, with corresponding reductions in crop yields
- The goal of IPNSs is to maximize nutrient use efficiency by recycling all plant nutrient sources within the farm and by using nitrogen fixation by legumes
- Soil productivity is enhanced through the use of local and external nutrient sources, including manufactured fertilizers

No-Till/Conservation Agriculture

- Refers to **zero, minimum, or low tillage** to protect and stimulate the biological function of the soil while maintaining and improving crop yields;
- Includes direct sowing or drilling of seeds instead of ploughing, maintenance of permanent cover of plant material on the soil ("**cover crops**"), and **crop rotation**;

Advantages:

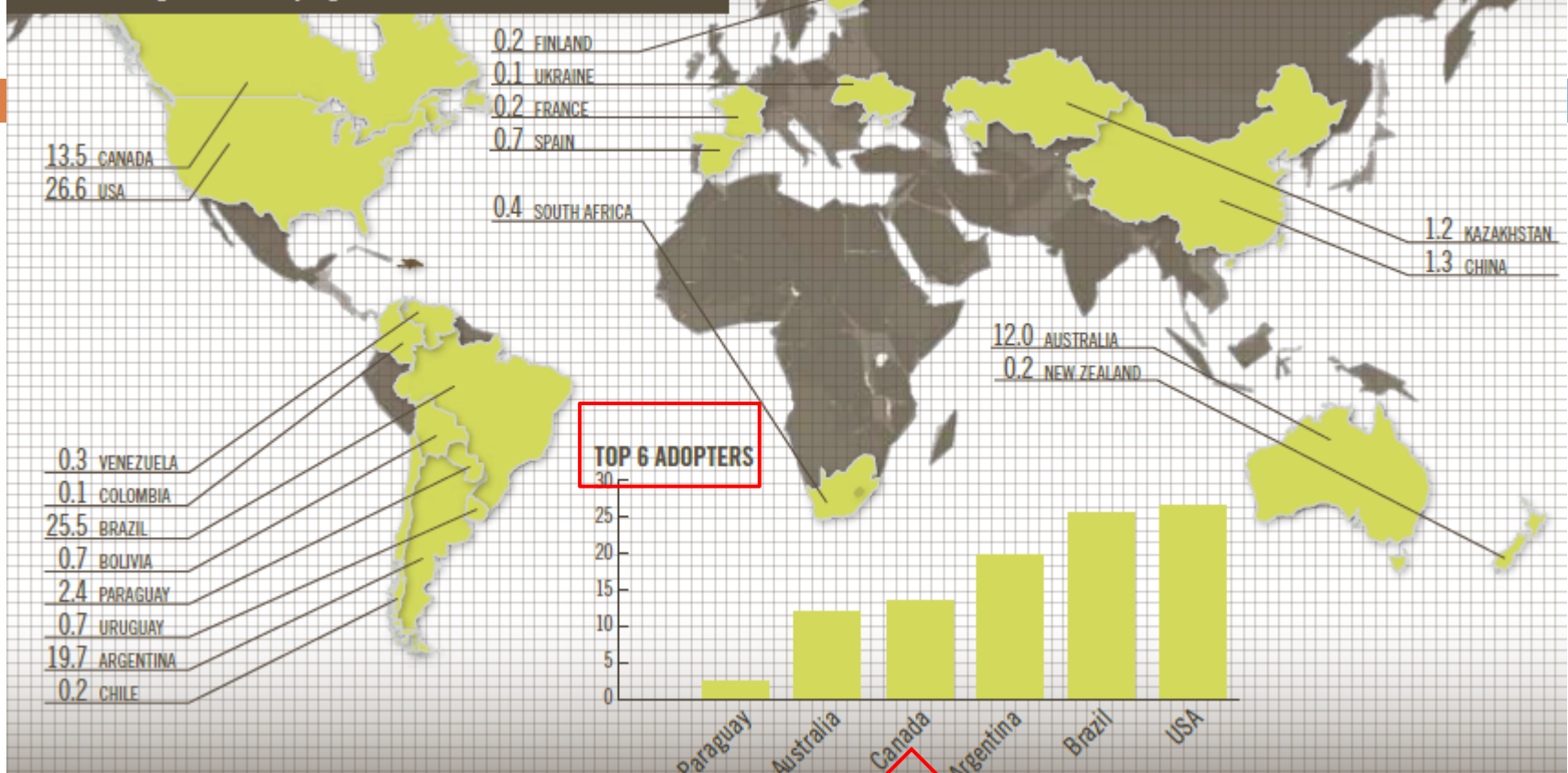
1. Inhibit germination of weed seeds;
2. Minimize build up of pests → reducing need for herbicides and pesticides, respectively;
3. Increase crop yields;
4. Lower labour costs and machinery costs;



<http://www.cbf.org/how-we-save-the-bay/issues/agriculture/best-management-practices/chesapeake-farmers-reducing-pollution-and-improving-business>

NO-TILLAGE ADOPTION WORLDWIDE [IN MILLIONS OF HECTARES]

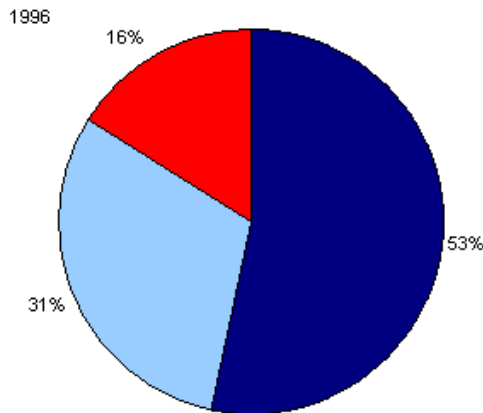
About 105 million hectares worldwide are now farmed using conservation agriculture or no-till farming. Users are mostly large-scale farmers.



http://insights.ifpri.info/files/2012/06/infographic_notillage.pdf

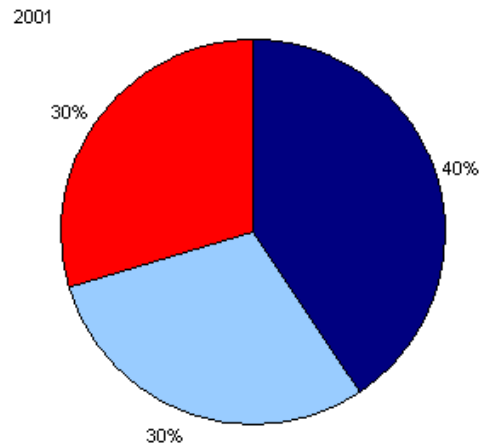
Source: R. Derpsch and T. Friedrich, "Development and Current Status of No-Till Adoption in the World," paper presented at the 18th Triennial International Soil Tillage Research Organisation conference, Izmir, Turkey, June 15-19, 2009.

- **Despite advantages of No-Till Agriculture**, conventional tillage still dominates worldwide:
 - Reluctance to change from what has worked for decades;
 - Lack of knowledge on damage to soil via plough-based techniques;
 - Complex management skills required to successfully transfer over to No-Till
- **Canada (16% No-Till in 1996 → 46.7% in 2006)**



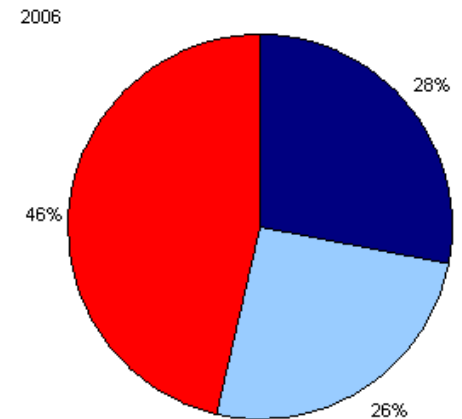
■ Conventional ■ Conservation ■ No-till

Source: Statistics Canada, Census of Agriculture, 1996 to 2006.



■ Conventional ■ Conservation ■ No-till

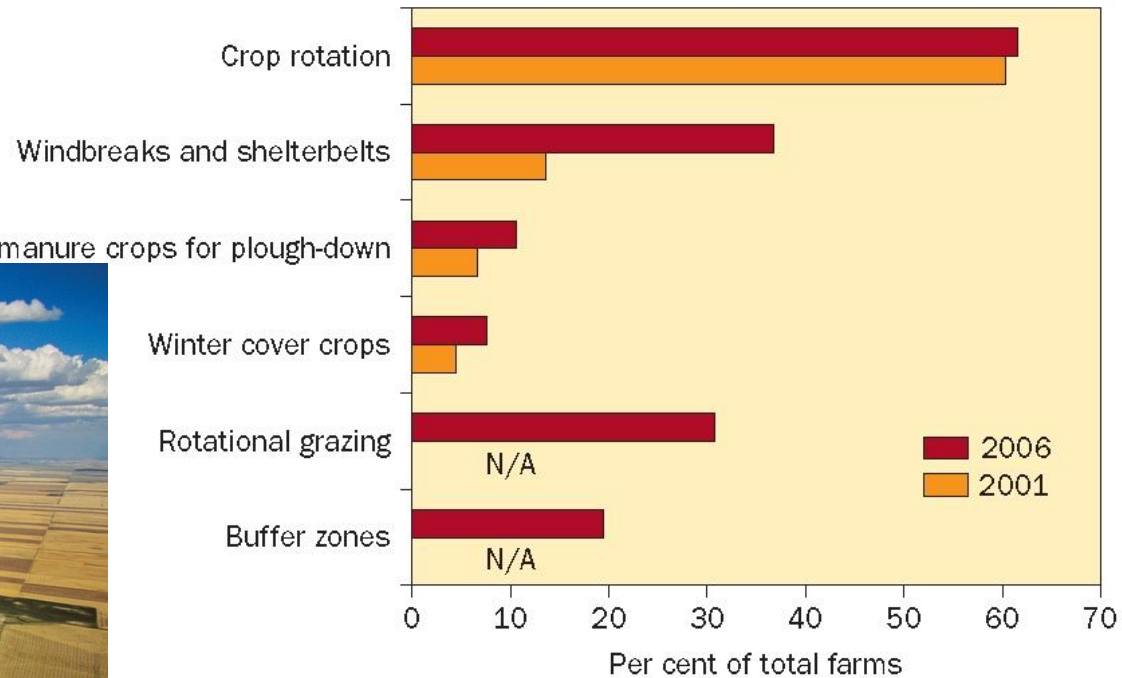
Source: Statistics Canada, Census of Agriculture, 1996 to 2006.



■ Conventional ■ Conservation ■ No-till

Source: Statistics Canada, Census of Agriculture, 1996 to 2006.

Other conservation practices (change in)



Soil conservation practices, 2001 and 2006. Source: Statistics Canada

Strip farming: different crops planted in strips parallel to slope; crops harvested at different times to provide some protection against erosion.

From: Dearden and Mitchell (2012)

Organic Agriculture ... one sustainable approach

- It combines current approaches to sustainable agriculture (including IPN, IPNS and No-Till Agriculture) and other management strategies into a single approach;
- It is a production management system that aims to **promote and enhance ecosystem health**;
 - ▣ Based on minimal use of external inputs, relying more on locally available resources
 - ▣ Minimizes air, water and soil pollution;
- **Standards** are set to **regulate organic agriculture** with respect to pesticide and fertilizer use; GMOs; sewage sludge, etc...
- Has become a **large industry in Canada** and elsewhere ... now a \$50 billion per year industry worldwide, but ...
- **Still not a solution for global food security** for poorer nations.

Looking Ahead to the next lecture, **post-midterm and post-Study Week**

Read ahead (Chpt. 11, Water, pp. 374 →)

“Human Interventions in the Hydrologic Cycle”

References

- Dearden, P and Mitchell, B. 2012. *Environmental Change and Challenge*, Fourth Edition, Don Mills, Ontario: Oxford University Press {Chapter 10: 'Agriculture'}
- Canadian Federation of Agriculture (2007). "CFA – Canadian Federation of Agriculture – Commodities". Archived from the original on 10 April 2007. Retrieved 6 April 2007