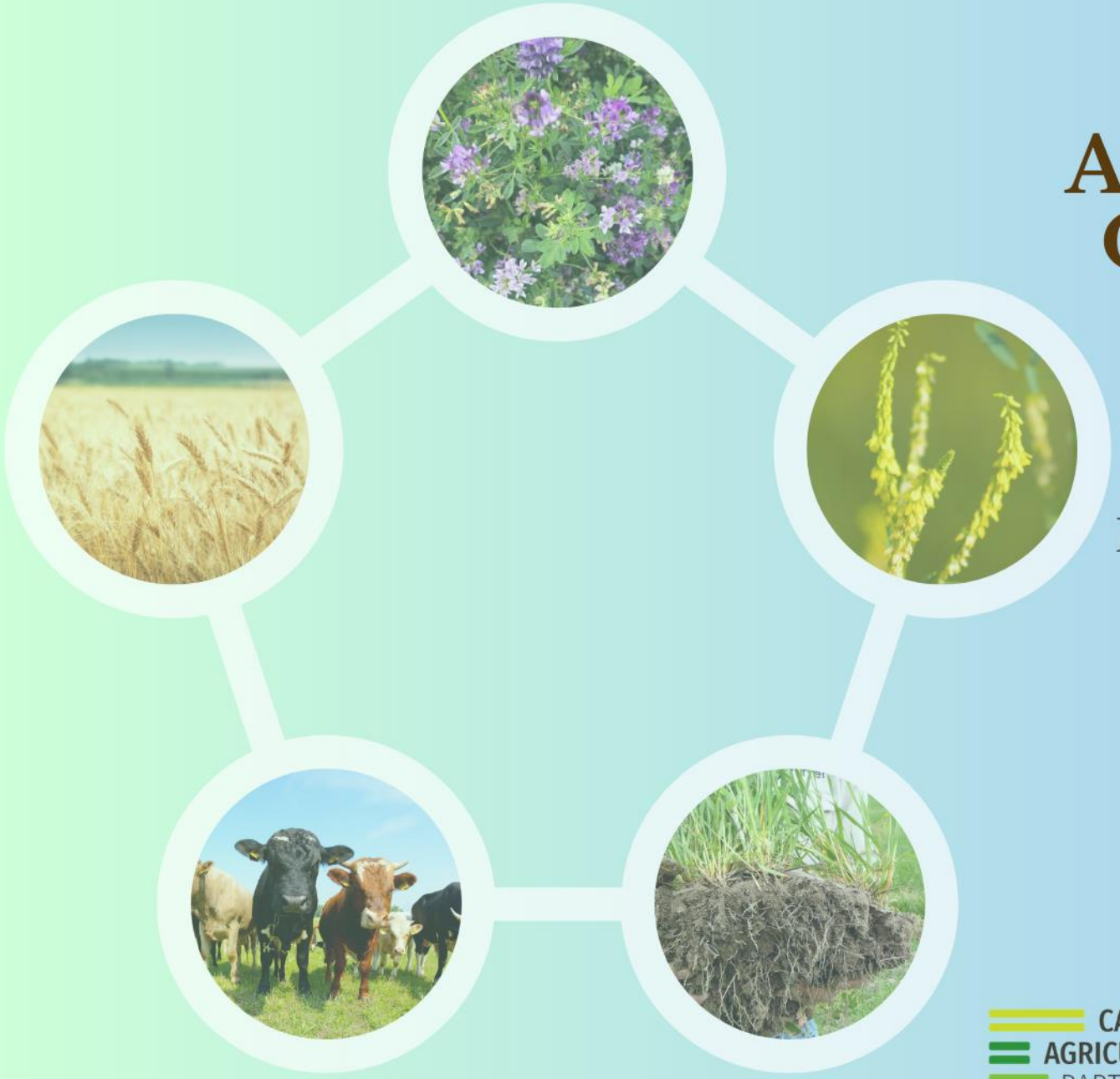


A Systems Approach to Organic Agricultural Production

With Dr. Martin Entz,
Natural Systems Agriculture Lab, U of M

Learning Systems for Organic Agriculture

CANADIAN AGRICULTURAL PARTNERSHIP
PODF PRAIRIE ORGANIC DEVELOPMENT FUND
Sask Organics Organically Grown in Saskatchewan
Canada

PODF
PRAIRIE ORGANIC DEVELOPMENT FUND

- Investment platform established to develop organic agriculture and marketing in the Canadian Prairies

- Builds resilience in the sector by investing in
  - organic provincial associations (Capacity Fund); and
  - high impact programs (Innovation Fund) related to marketing, research, policy, education and capacity development that have broad public benefit to the organic sector.

www.organicdevelopmentfund.org

Martin Entz, PhD

Professor of Cropping Systems, Natural Systems Agriculture Lab, University of Manitoba

Martin Entz is professor in the University of Manitoba's Plant Science department where he leads the Natural Systems Agriculture lab. He received his PhD from the University of Saskatchewan in 1988 and worked as a farm manager and research agronomist before embarking on his academic career.

"The goal of my program is to discover new ways of farming ecologically; to empower farmers with knowledge to design organic and ecological farming systems adapted to where they live; and to engage students in this exciting process". He leads the Glenlea study – Canada's oldest organic-conventional farming systems comparison study, which is in its 32nd season.

In 2011, Martin started Canada's first farmer participatory wheat and oat breeding program focussed on organic production. "Farmer involvement is an important part of my research program."

Martin teaches courses in crop production and often hosts field-based "Summer Institutes" on sustainable agriculture.

Martin has led agricultural projects in Central America and Zimbabwe, and his lab is currently engaged in "Nature-positive agriculture" in East Africa.

Learning systems

- **Adapt or else (learning so we *can* adapt)**
- **Understanding the place where we came from – tradition**
- **Ways to learn effectively**
- **Thinking in systems**
- **Ecological knowledge**
- **Knowledge generation for organic agriculture (a co-design approach)**

Whole farm seminar series
Dr. Martin Entz
University of Manitoba

Effortful learning usually signals not only deeper learning, but more durable long-lasting knowledge. It's analogous to weight training. Lifting heavier weights which require more effort will build more muscle in much the same way investing more effort in grappling with new information builds stronger, deeper knowledge.

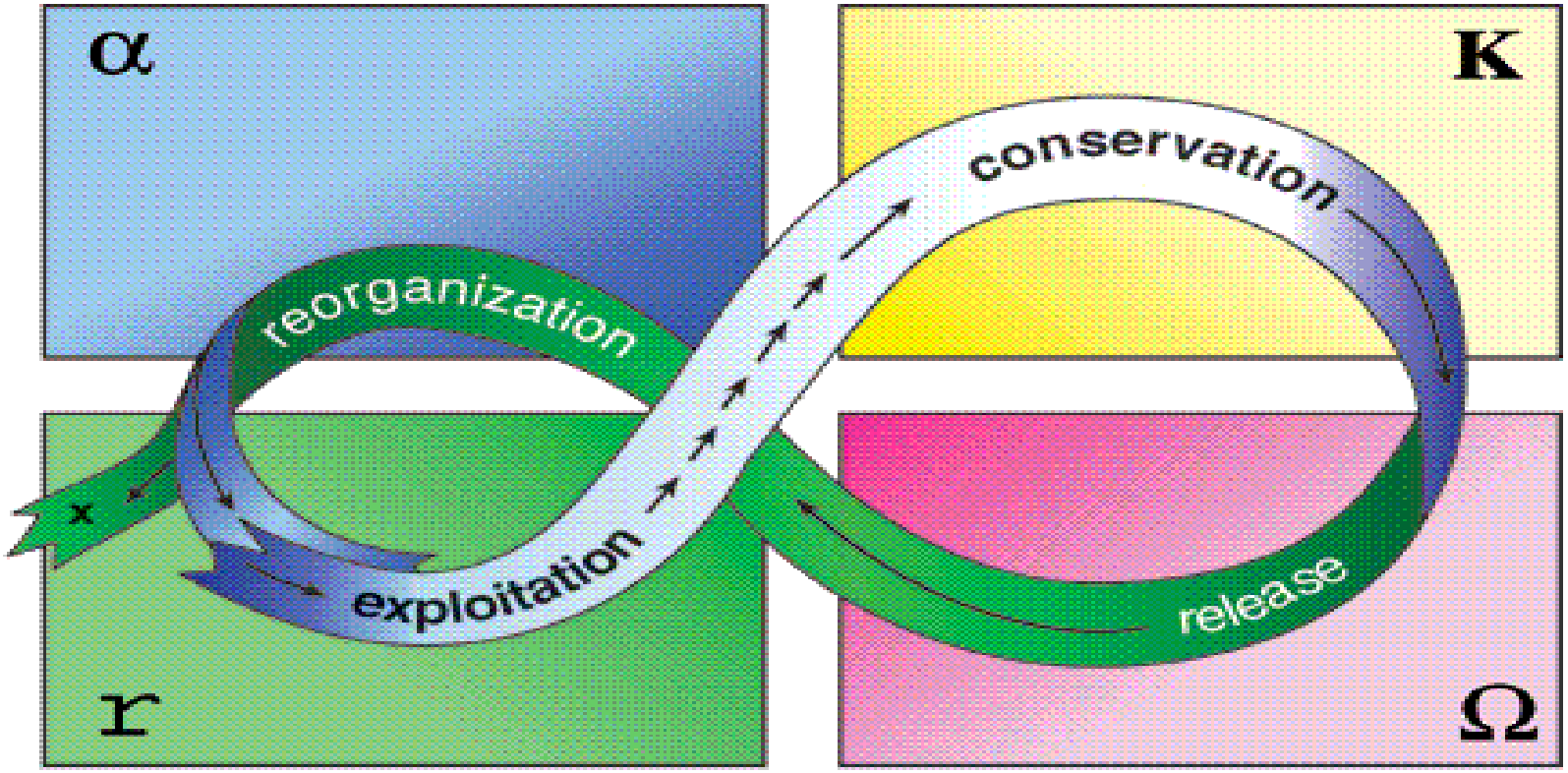
https://www.youtube.com/watch?v=XPllm-gtrMM

All farms need a Learning Plan

Adapting to new circumstances

- Adapt or die (lesson from nature)
- Requires learning new information

Stages of Adaptation



Allocate your attention efficiently. Focus on one task only, don't divide your attention in ways that are hard, but unhelpful. Instead, challenge yourself to think deeply, conceptually about what you are studying.

Align your purposes to the goal. Be clear about what knowledge and skills you want to learn.

Organize information that you are trying to learn.

Identify the models, organizational patterns, and other conceptual tools used by teachers and use them yourself to organize new information. Ask: "How does my teacher think about this topic, field, problem, etc.?" Intentionally experiment with thinking "like an expert".

Actively elaborate on and connect what you are learning to what you know. Think of your own examples to illustrate and explore concepts introduced in the course.

To make your knowledge more durable, vary your studying in terms of locations, situations (alone, with others), modalities (oral, visual, verbal).

Space your studying over time. Interleave your studying to enhance your memory of it.

Draw a representation (image) of the information you are learning. Make charts that organize information, sketch out processes, create flow charts, make a mind map of key concepts and their relations to clarify your understanding.

https://mcgraw.princeton.edu/undergraduates/resources/resource-library/how-people-learn

Field day example: July 12, 2023
Manitoba Organic Alliance and Ducks Unlimited, Ste. Rose du Lac, MB.
Boulanger Organic Farms

Base knowledge

Desirable difficulties, spacing for reflection

You, the teacher

Marc Boulanger

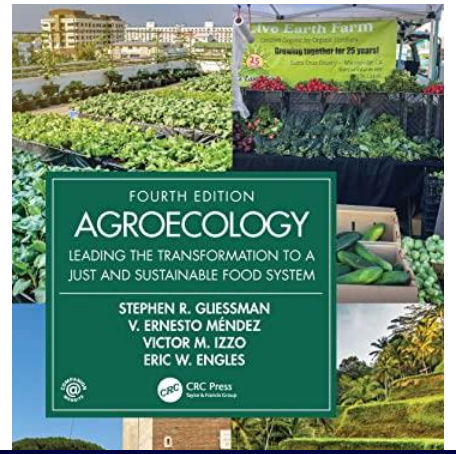
What are our learning goals?

Level 1. Increase efficiency of conventional practices

Level 2. Substitute conventional practices with alternative practices

Level 3. Redesign the system so that it functions on basis of a new set of ecological relationships

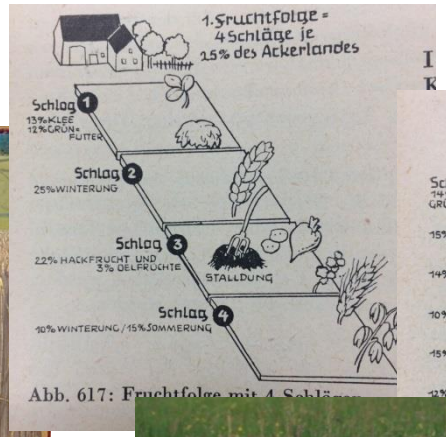
Level 4. Re-establish more direct relationship between people who produce and eat food.



Stephen Gliessman, Ivette Perfecto and others

Northern European Farming Systems

1600 1800 1900 1944



3-crop rotation

7-year crop rotation

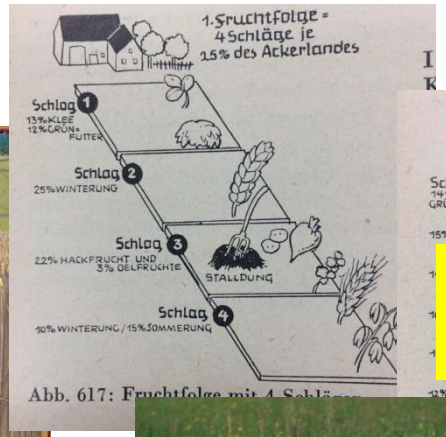
2-crop rotation

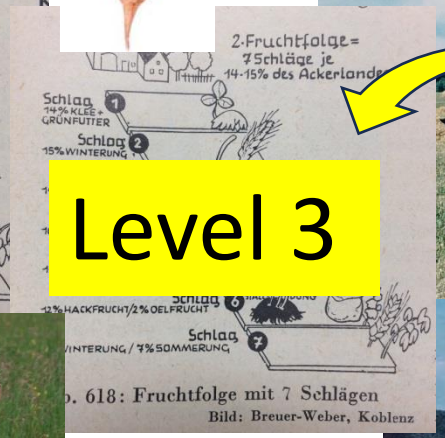
Norfolk 4-year crop rotation

Fertilizer instead of rotation

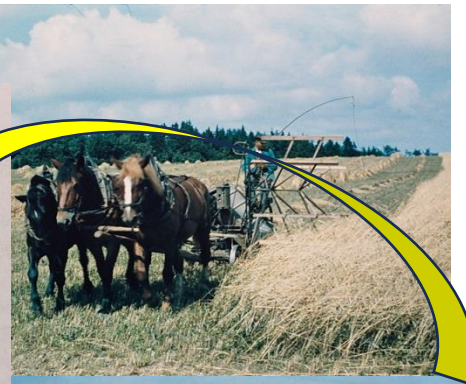
Northern European Farming Systems

1600 1800 1900 1944





Level 3



Level 2

3-crop rotation

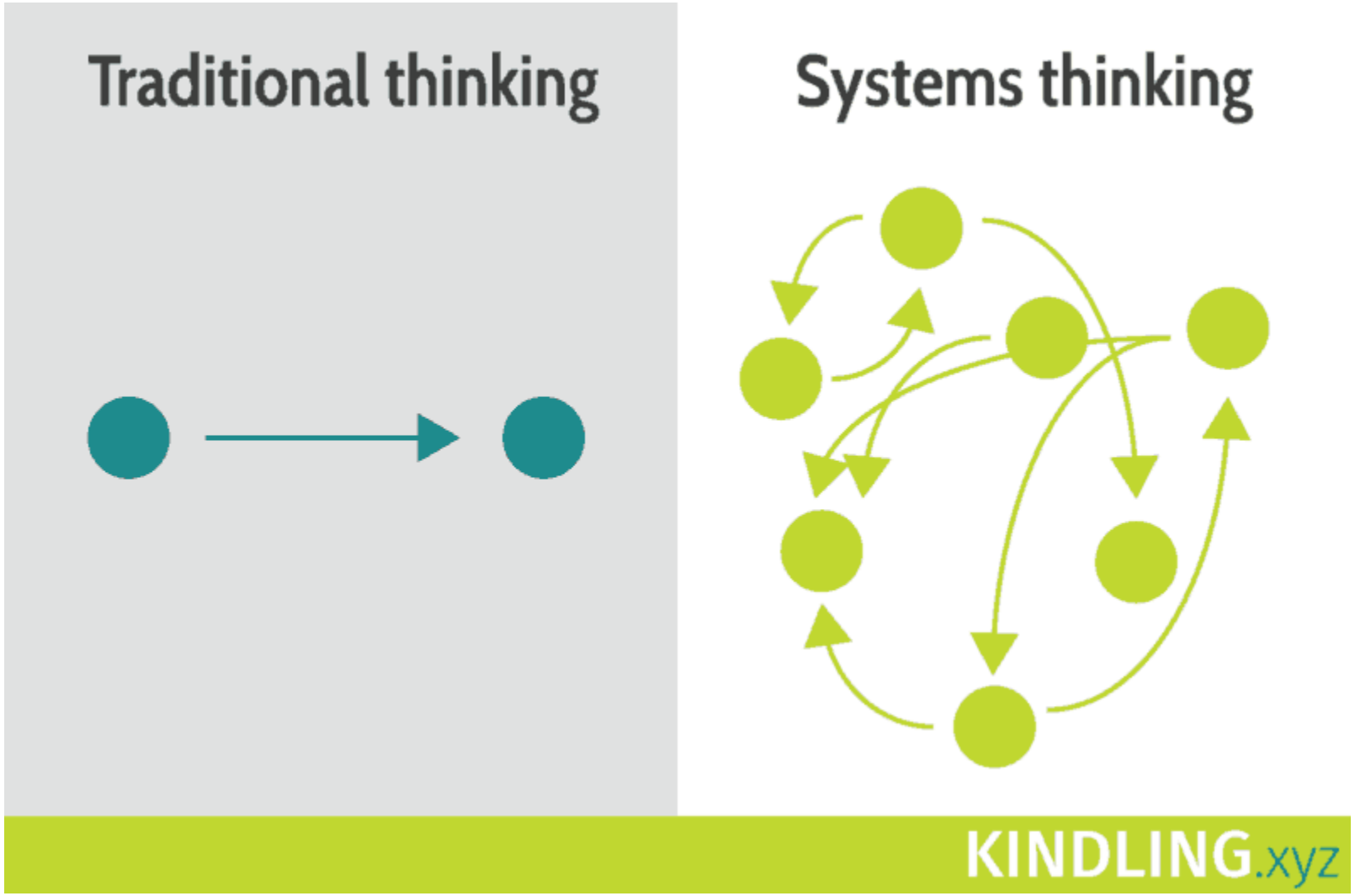
7-year crop rotation

2-crop rotation

Norfolk 4-year crop rotation

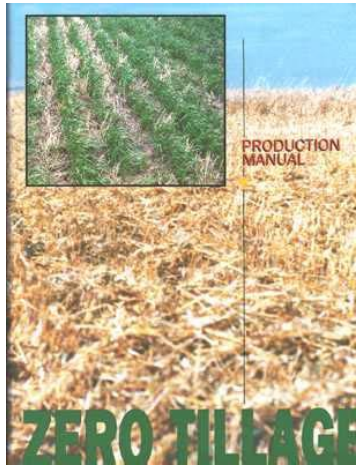
Fertilizer instead of rotation

Therefore, we need systems thinking

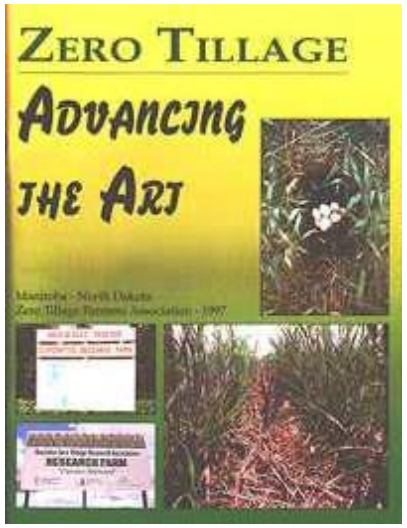


We can do this! We have proved it!

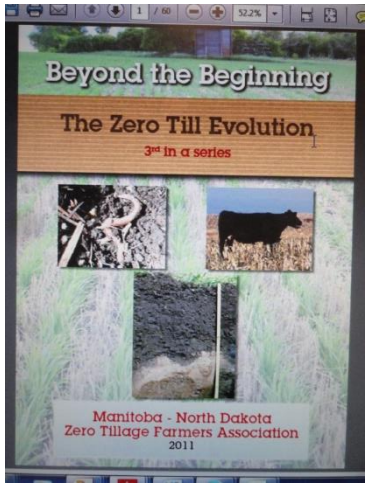
1991



1997

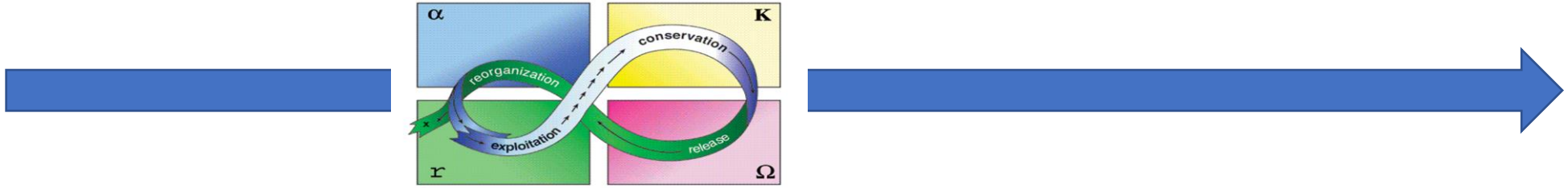


2011



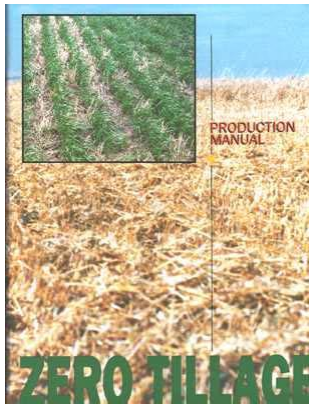
2023

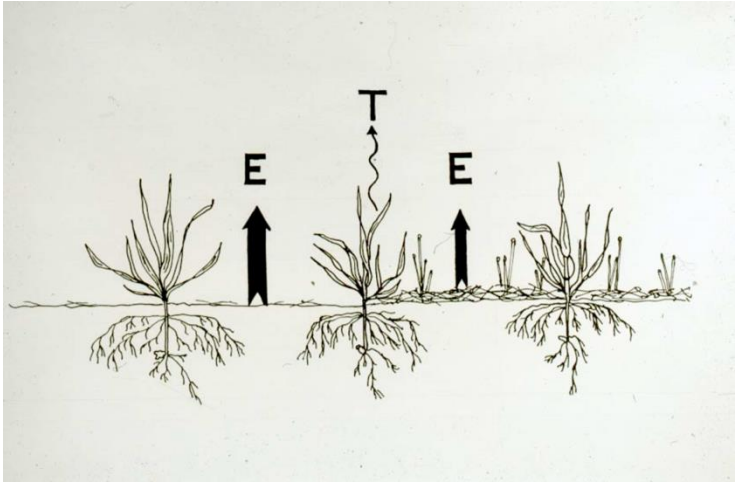
CANADA ORGANIC • BIOLOGIQUE CANADA



Mechanical era

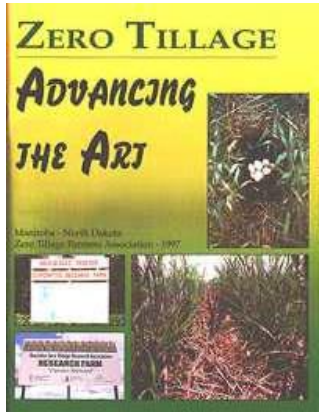
Chemical era

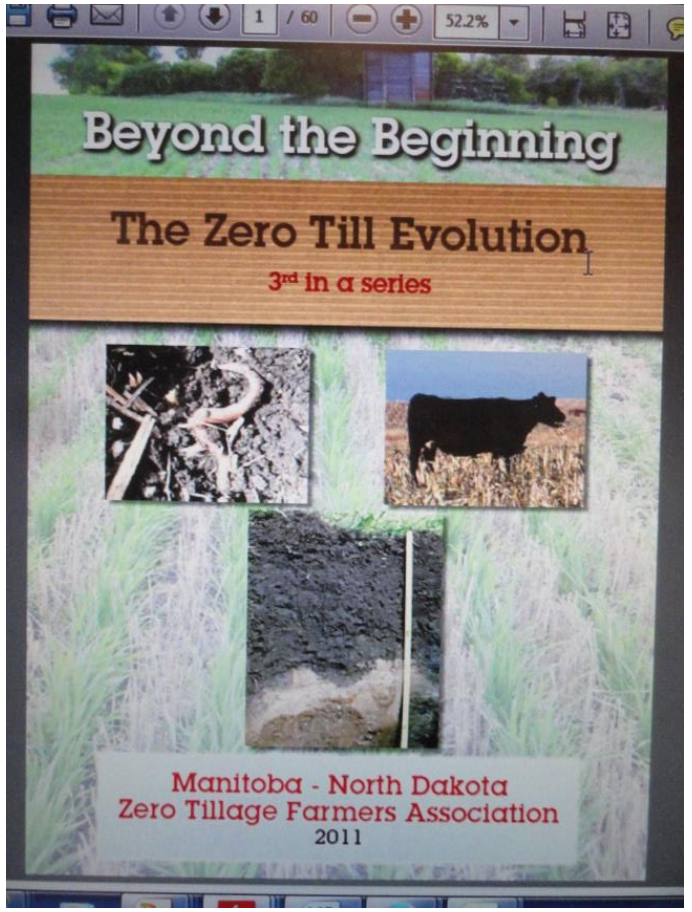




Chemical era

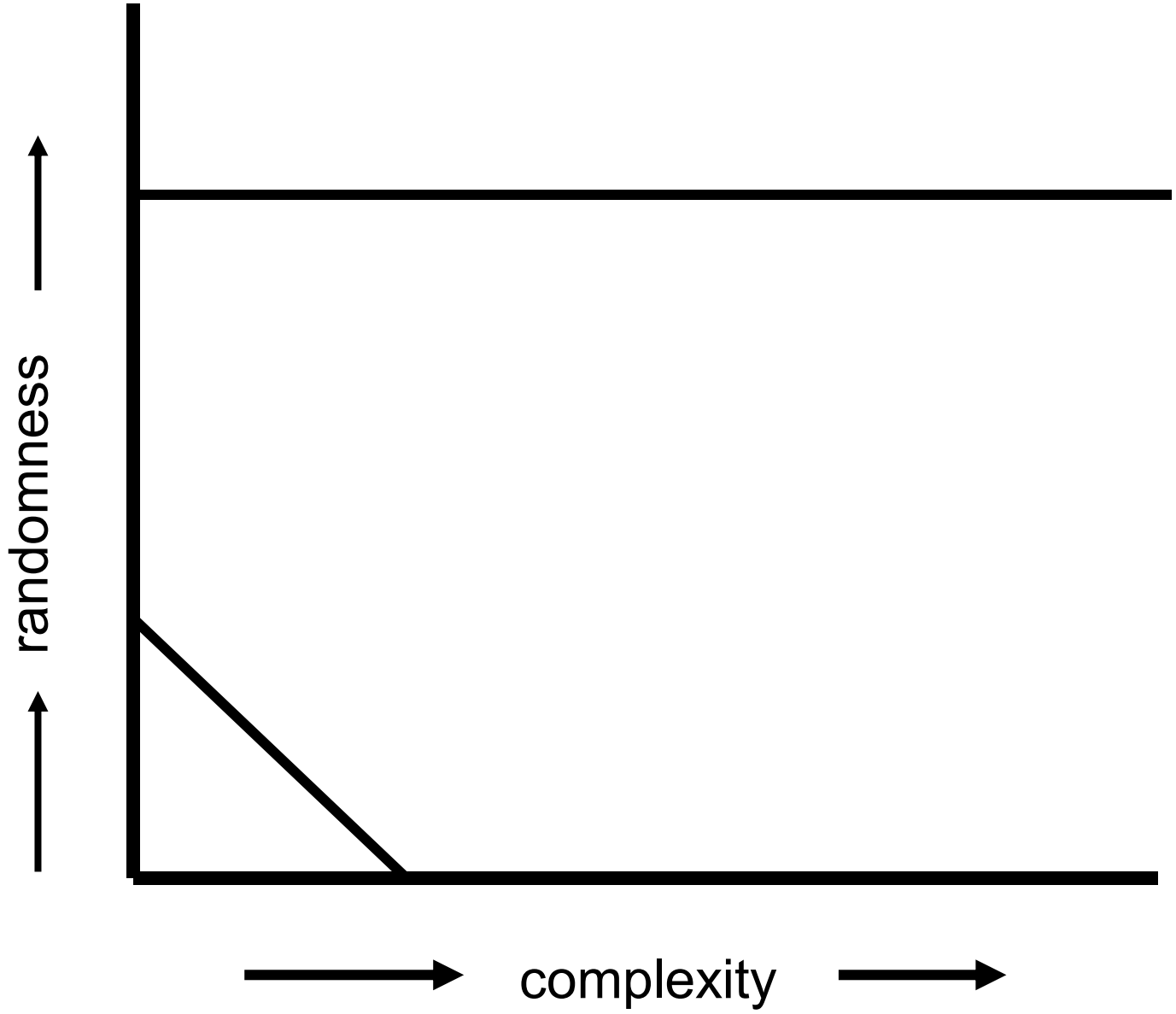
Biological era



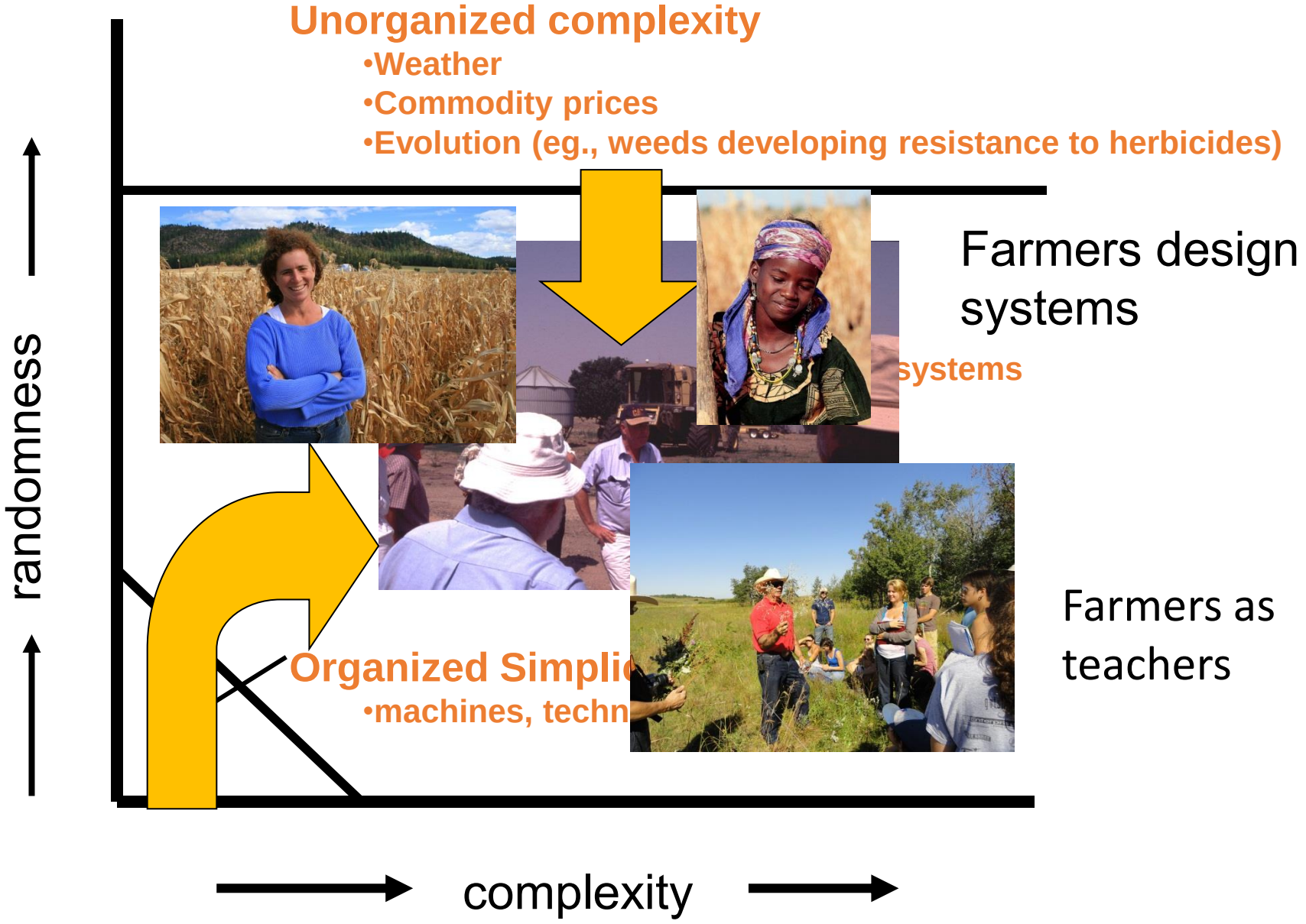


Adapt the roller to new situations

Sorry folks, but some theory may help

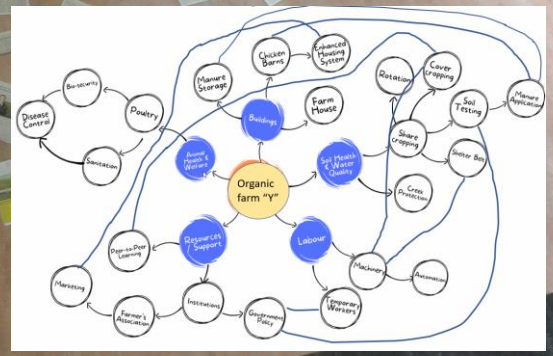


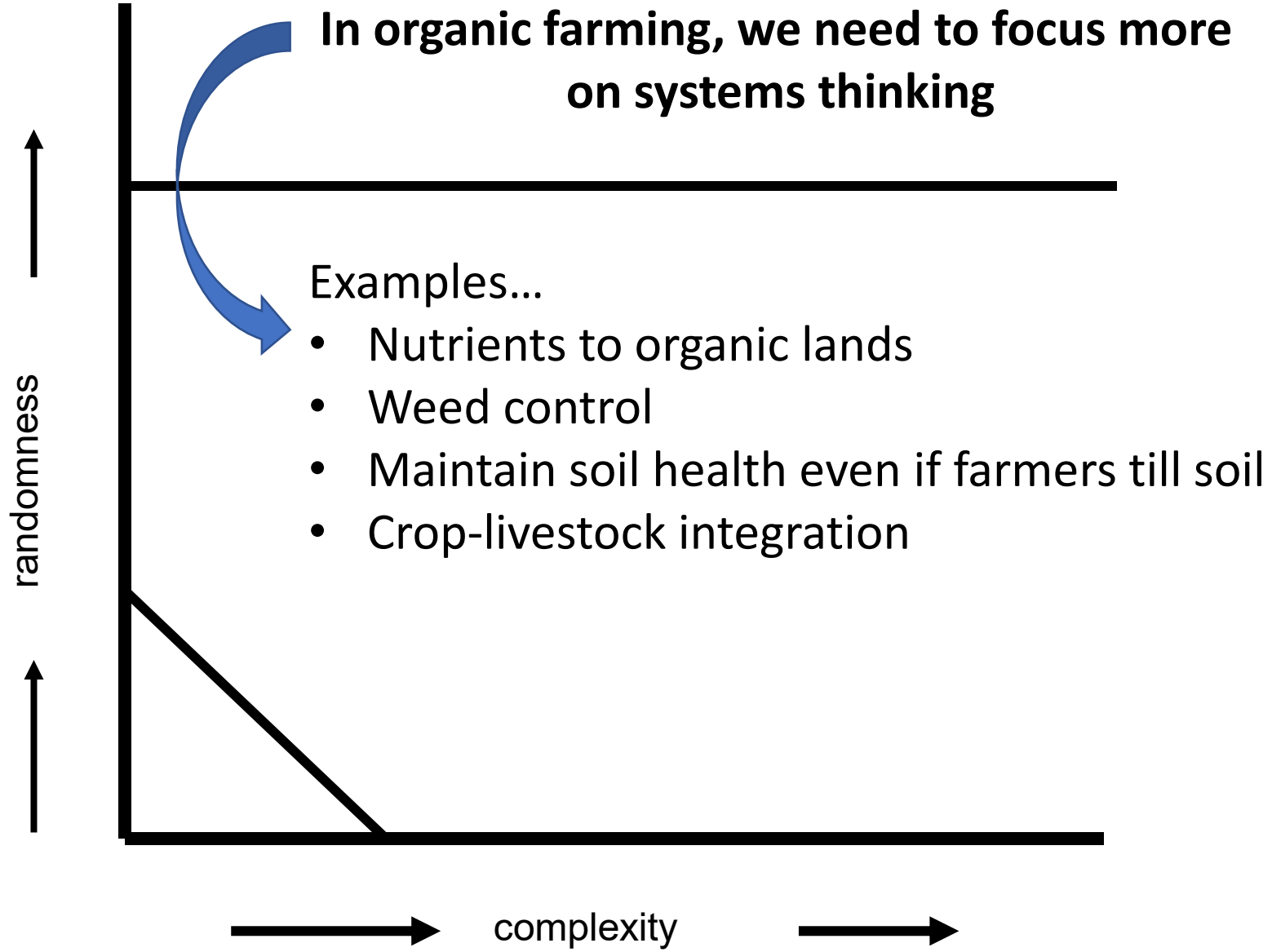
Weinberg, 1975. *An Introduction to Systems Thinking* Wiley Interscience, New York



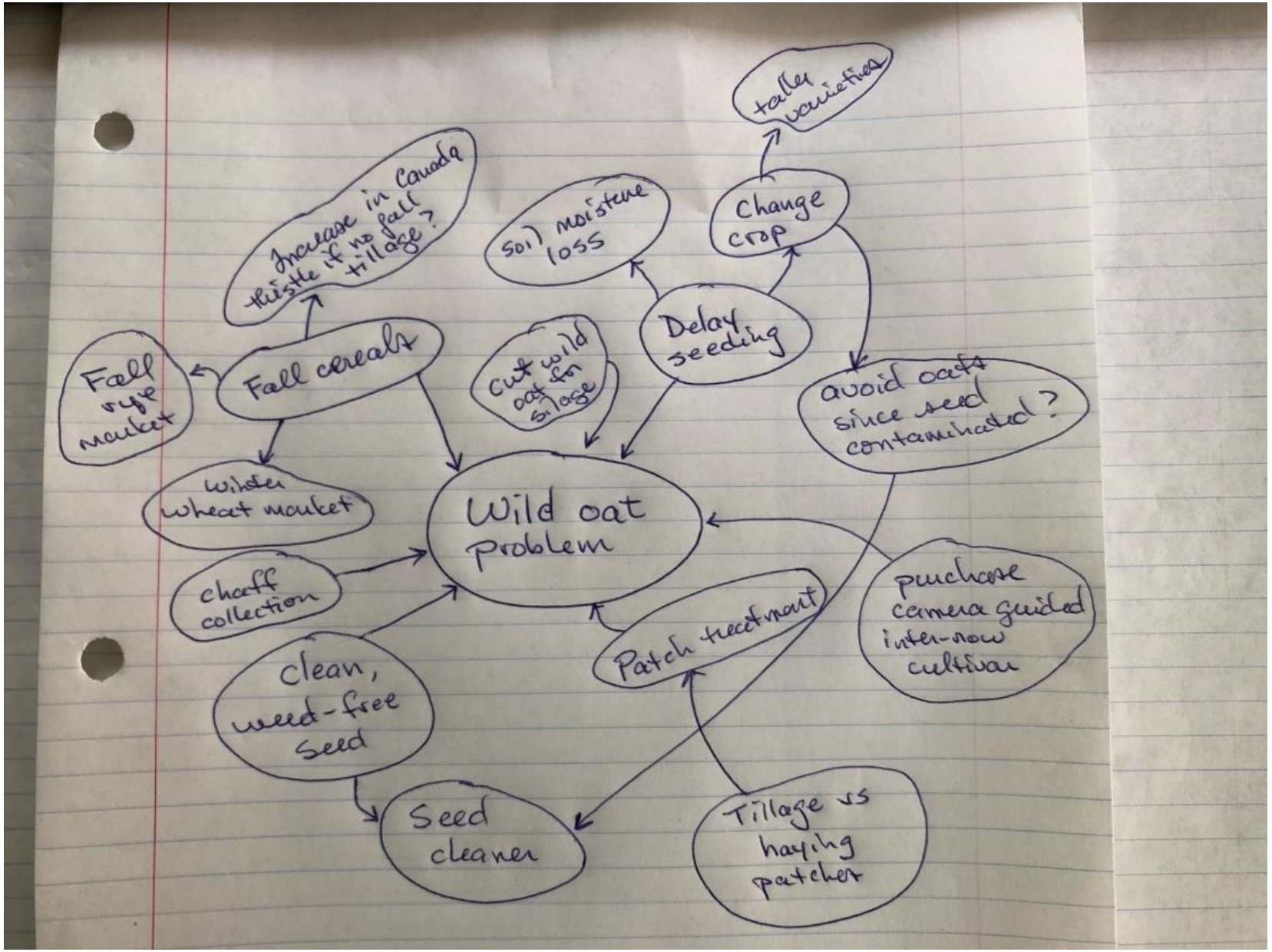
Weinberg, 1963. *An Introduction to Systems Thinking* Wiley Interscience, New York

Farm newspaper articles focus less on systems than on individual parts or markets



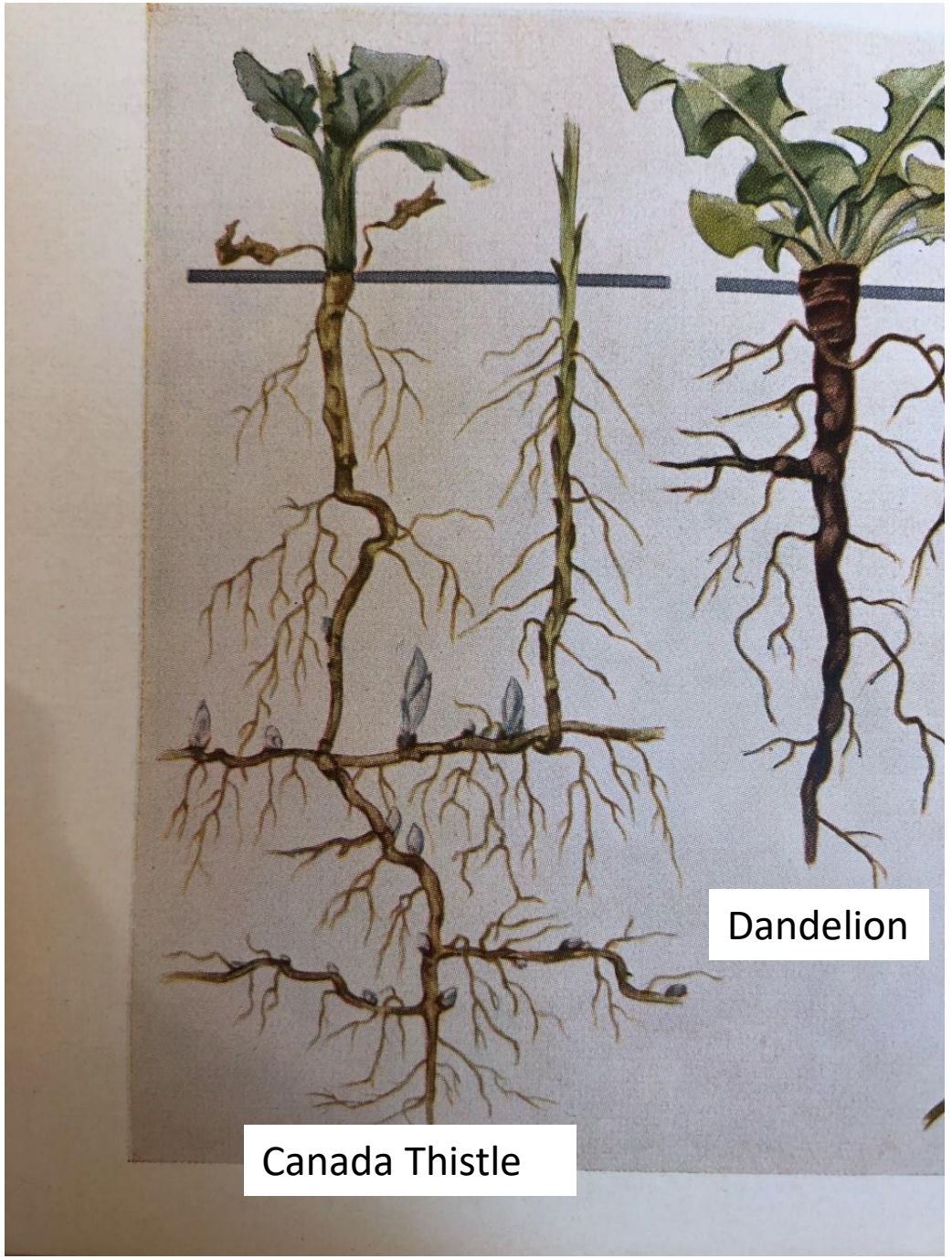

In organic farming, we need to focus more on systems thinking
Examples…
• Nutrients to organic lands
• Weed control
• Maintain soil health even if farmers till soil
• Crop-livestock integration
randomness
complexity

Wild oat mind map



Draw a mind map for management of:

Canada Thistle
vs
Dandelion

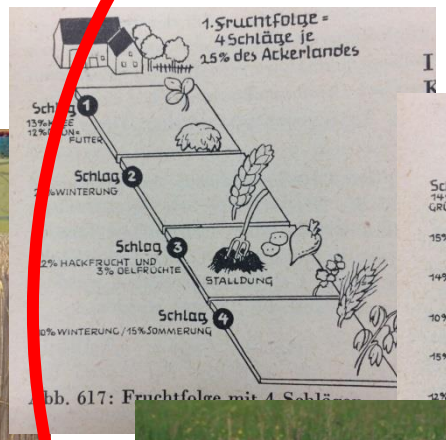


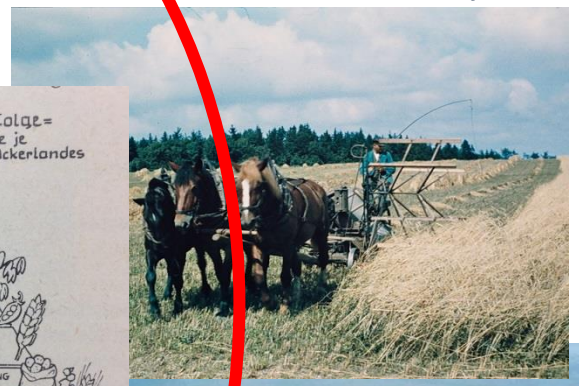
Ecological knowledge

Knowledge of species of both animals and plants, and biophysical characteristics of the environment through space and time. Example is a rancher who tracks the pasture and rangeland condition alongside the health of the grazing animals.

What ecological knowledge required in the 7 year rotation?

1600 1800 1900 1944





3-crop rotation

7-year crop rotation

2-crop rotation

Norfolk 4-year crop rotation

Fertilizer instead of rotation

Examples of ecological knowledge for organic farming

- Nitrogen fixation using legume plants
- Intercropping grain crops to increase yield and reduce disease problems
- Crop rotation to control Canada Thistle

- A **population** is a group of organisms of the same species living together in the same area at the same time.

Population of fababean plants

- A **community** is defined as all of the populations that live in the same place at the same time.

Fababean/oat community

- **Abundance** is the total number of individuals of a species that live in a specific area. For example, how many Canada thistle shoots per unit area in the field?

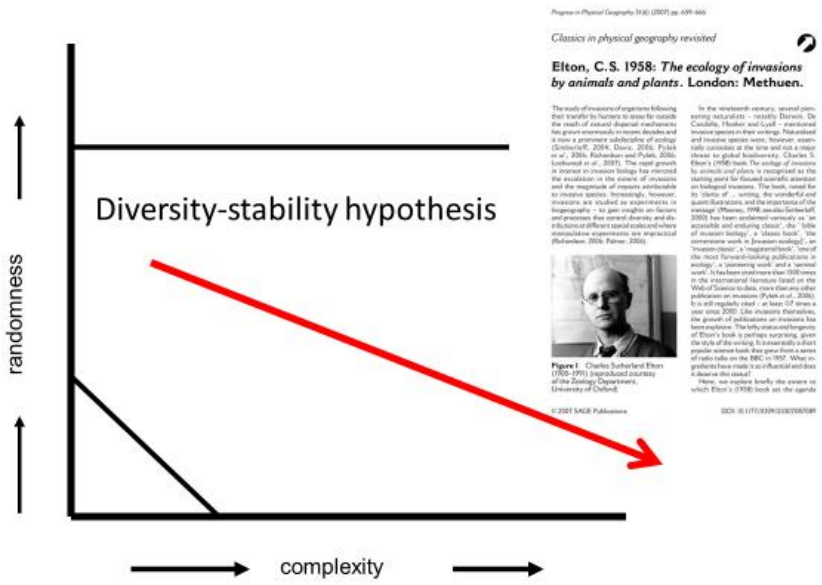
What is the abundance of cattle grazing on a 80 acre green manure field?

- **Species richness** is the number of species in a given area. Richness of plant species increases the accumulation of soil carbon.

Number of species in a field

An **ecosystem** is all the biotic (living) and abiotic (non-living) components that interact within an area at once. Think of a farm, or even a farm field, as an ecosystem. Use a mind map to show the parts and the connections within that farm ecosystem.

Biodiversity is the variation of species in an ecosystem. How many plant species are growing in a pasture?



Classics in physical geography revisited

Elton, C.S. 1958: *The ecology of invasions by animals and plants*. London: Methuen.

Weinberg, 1975. *An Introduction to Systems Thinking* Wiley Interscience, New York

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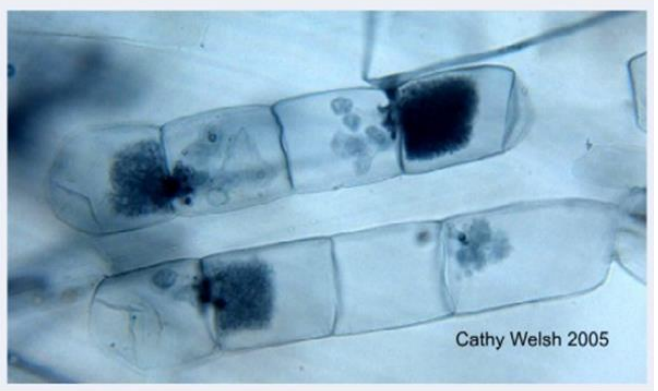
Biodiversity is the variation of species in an ecosystem. How many plant species are growing in a pasture?

Ecosystem services are services and resources provided by the ecosystem. For example, wetlands provide groundwater recharge, which keeps farm wells producing water for humans and livestock.

Wildlife habitat index

Biotic factors are living things (eg plants and animals)

Mycorrhizae are fungal associations and symbiotic relationships between plant roots and fungi. These fungi increase the area of roots. Ninety percent of land plants are naturally mycorrhizal.



Paired Arbuscules in Flax Root Cortical Cells,
note limited development of one arbuscule in each pair

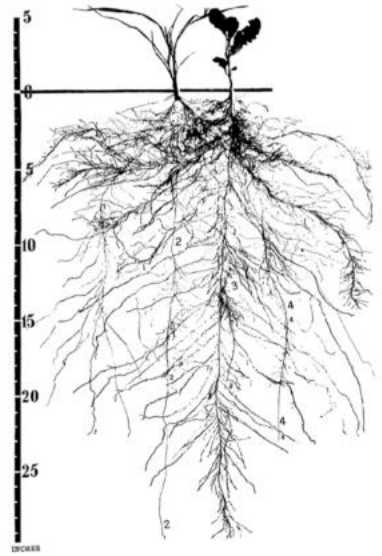
Abiotic factors are non-living things (eg. soil, water, wind, light, nutrients).

Carrying capacity is the maximum capacity of an area which can sustain a certain population size. We typically think of carrying capacity in a grazing system – how many animals/acre?

A **climax community** is a biological community that, through the process of ecological succession, has reached a steady state. A native pasture is often at its climax level.

Competition is a mutually detrimental interaction between species which share limited resources.

Interspecific competition is between individuals of different species. For example, wild oats and wheat.



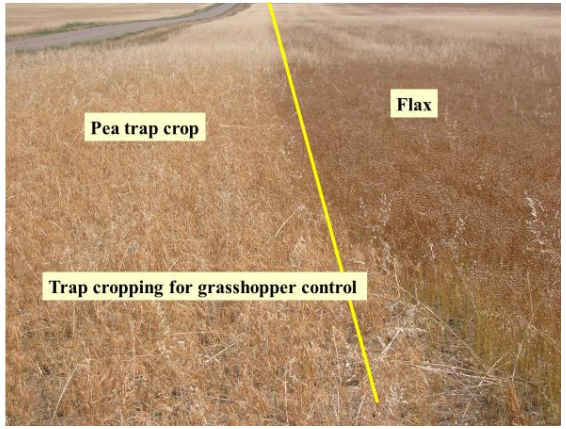
WHEAT AND WILD MUSTARD

This graphic shows root competition between Marquis wheat (on the left, with roots marked 1, 2, 3 and 4), and wild mustard, 22 days after emergence. This graphic is from Pavlychenko and Harrington, 1937: Ecology Vol. 18 No.1 Pages 62-79.

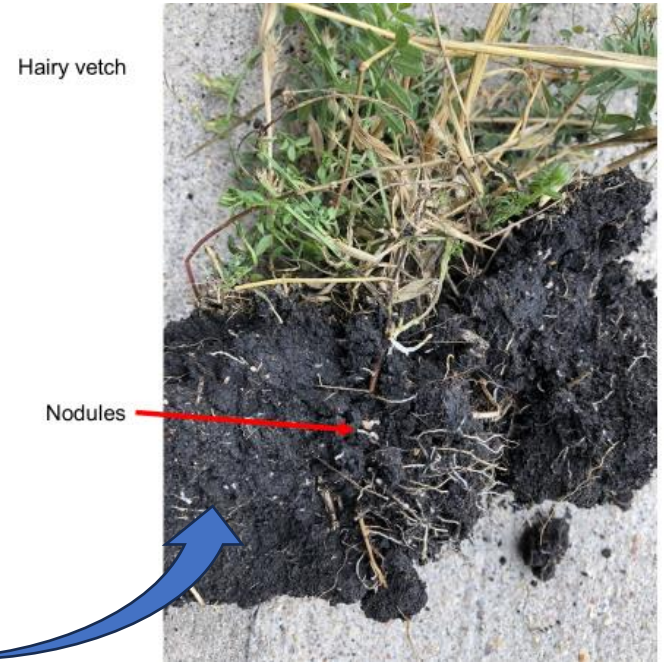
Intraspecific competition is among individuals of the same species. For example, oat plants seeded at a very high seeding rate will compete with each other.

Mutualism is when two species both benefit from a relationship. For example, certain intercrop combinations where both crops benefit, either in terms of nutrient access or pest management.

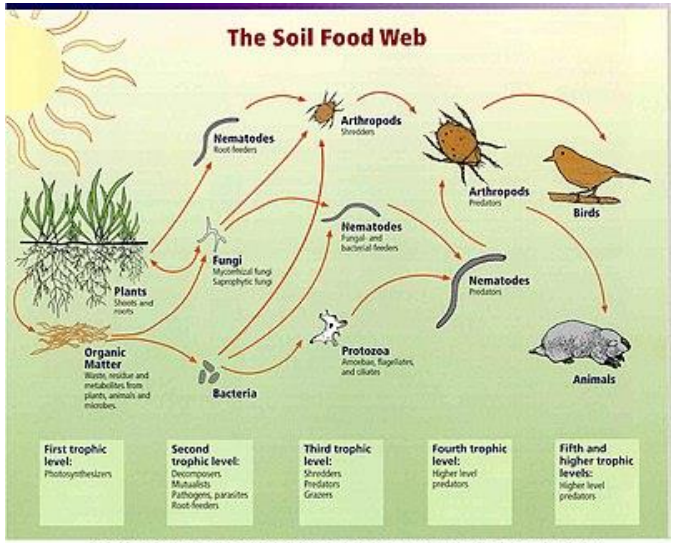
Facilitation is when one species benefits from the presence of another. For example, adding grasses to legume cover crops increases the N fixation rate of the legume plants.



Symbiosis is an interaction between two different biological organisms. One of the most popular examples of this is bacteria in nodules.

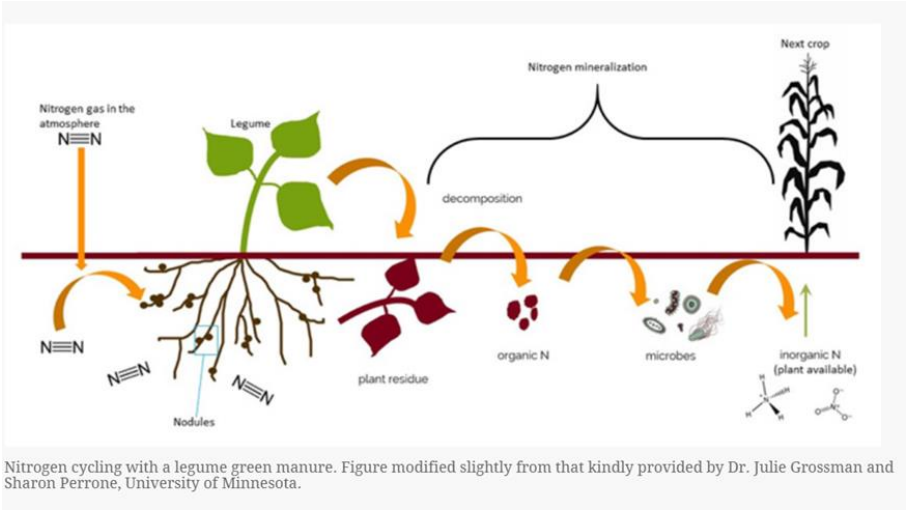


A **foodweb** is an interlocking pattern formed by a series of inter-connecting food chains. The foodweb can include beneficial (eg. crop harvest) and non-beneficial (eg. insect pest) organisms.

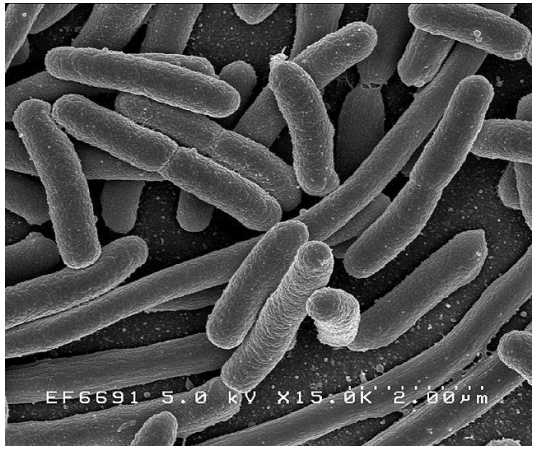


Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html

Decomposers break down decaying or dead organisms. Some agronomists have buried underwear to study how quickly soil decomposers break down the cotton cloth.

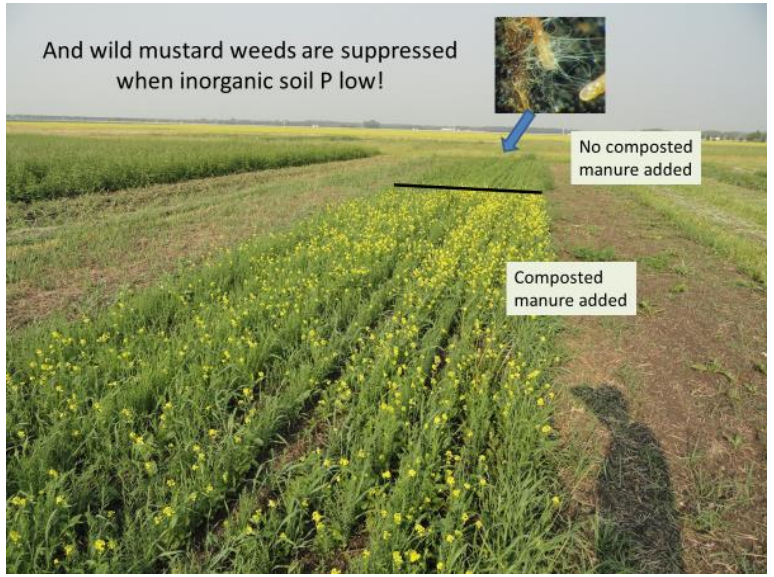


Nitrogen cycling with a legume green manure. Figure modified slightly from that kindly provided by Dr. Julie Grossman and Sharon Perrone, University of Minnesota.

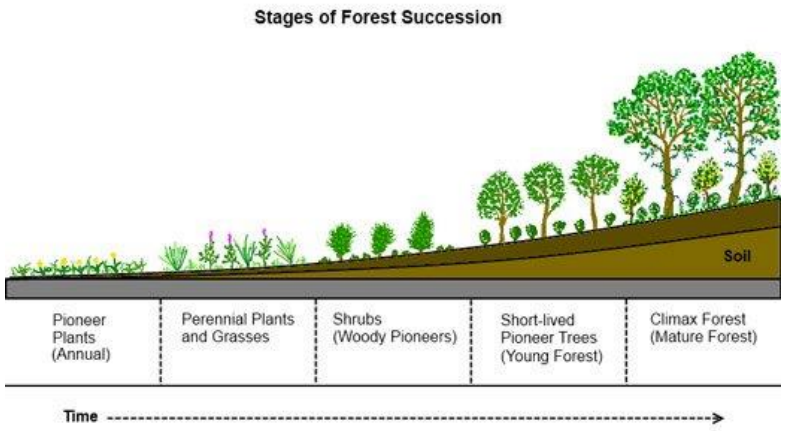


A **generalist species** can thrive under many environmental conditions and make use of a variety of different resources. Grasshoppers is an example, though the grasshopper population will build up in hot, dry cycles.

The **niche** is the role that an organism plays in an ecosystem including both the environmental conditions it needs and its interactions with other organisms. Wild mustard and redroot pigweed are non-mycorrhizal plants so their niche is soils with high levels of available phosphorous (because mycorrhizal fungi help plants access soil P).



Succession is the directional change in structure of a community gradually over time. Perennial weeds like quackgrass or Canada Thistle are later successional weeds.



Primary succession is the first step of ecological succession after an extreme disturbance, which usually occurs in an environment devoid of vegetation and other organisms. Primary succession is demonstrated when annual weeds grow in a field immediately after tillage.

R-selection is a form of selection that occurs in an environment with plentiful resources and it tends to favour individuals that reproduce early, quickly and in large numbers. The example here is annual weed species such as green foxtail or wild mustard.

Disturbance can be physical (tillage, grazing) or chemical (spraying a herbicide).

Tillage is not the only disturbance…

Development of Ecological Knowledge

Depletion crisis model

- Experience of limited resources
- Most easily discovered if living on an island
  - Eg. deplete fishery
- Crisis allows societies to learn though this is not always successful (eg. Easter Island)

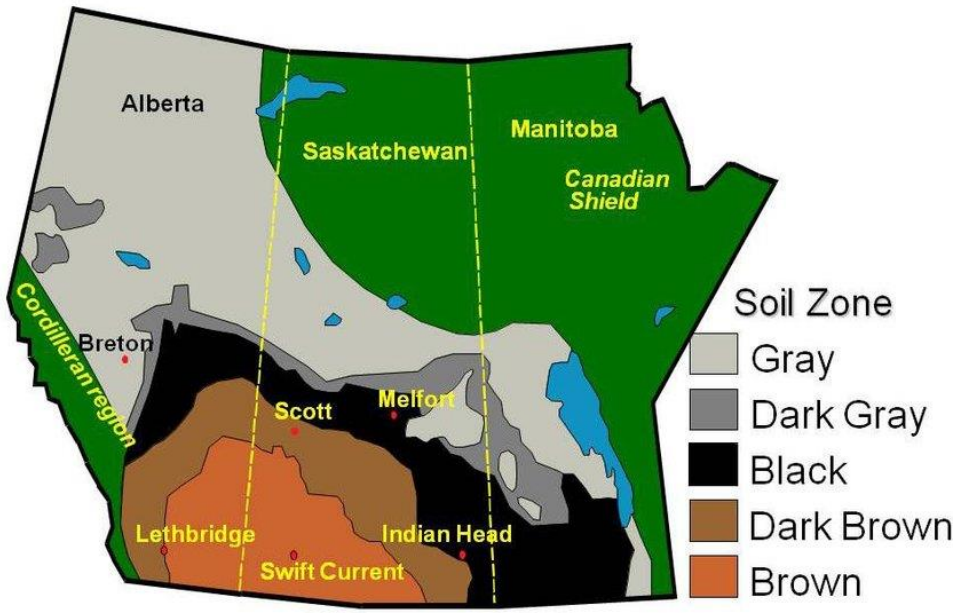
Ecological understanding model

- Cultural
- Community based
- Indigenous examples
  - Net fishery
  - Bison hunting
  - Fire culture for blueberry production

Berkes, F. and Turner, N.J., 2006. Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. *Human ecology*, *34*(4), p.479.

Co-design: Knowledge generation comes from various expert groups

Figure 15. Learning systems in organic agriculture. Left image: farmer to farmer conversation in field. Middle image: organic farm tour. Right image: organic farmers visit UM organic field day listening to (then) PhD student Caroline Halde, now Dr. Halde, Laval University.



https://organicalberta.org/

https://manitobaorganicalliance.com/

Sask Organics
Organically Grown in Saskatchewan

http://saskorganics.org/

MOA
Manitoba Organic Alliance

https://efao.ca/

EFAO
ECOLOGICAL FARMERS ASSOCIATION OF ONTARIO

Northern Plains Sustainable Ag
EDUCATION/COMMUNITY/ENVIRONMENT

https://www.npsas.org/

NORTH DAKOTA
DEPARTMENT of AGRICULTURE

https://www.nd.gov/ndda/marketing-information-division/organics

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www.organicdevelopmentfund.org

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PRAIRIE ORGANIC
DEVELOPMENT FUND

To learn more about PODF:
www.organicdevelopmentfund.org

For more organic production resources visit:
www.pivotandgrow.com