UF/IFAS Extension

The Journey to Sustainability Begins with Education

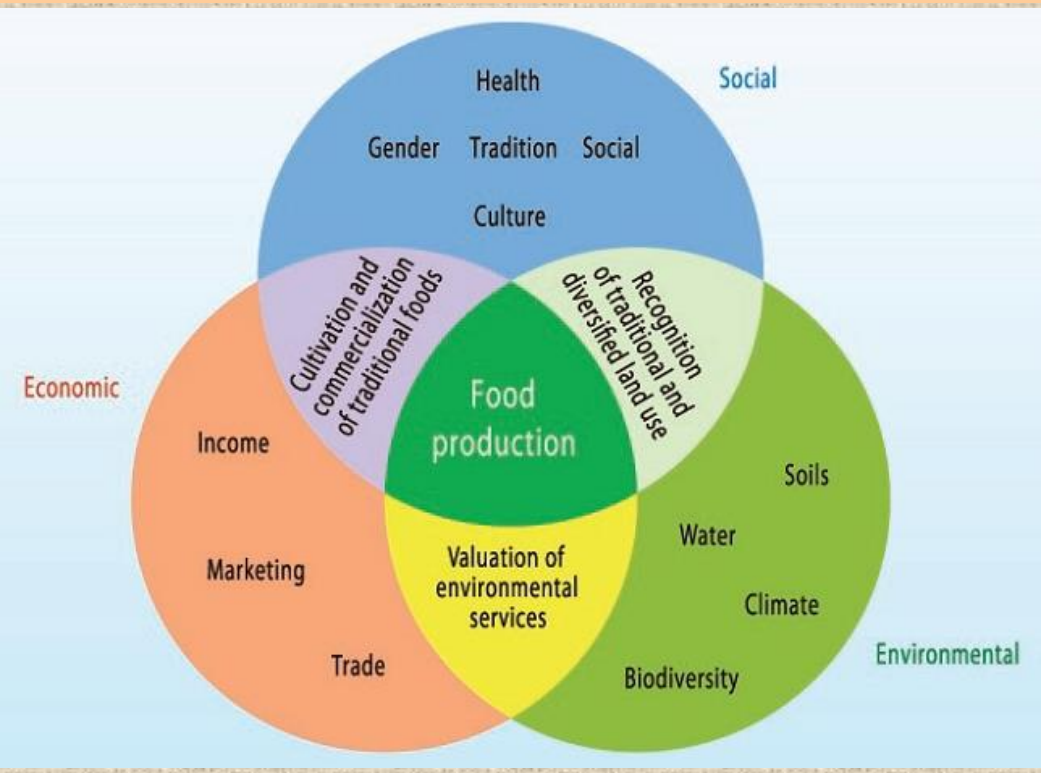
Sarasota County
scgov.net | 941.861.5000 | TV19

UF/IFAS Sarasota County Extension
6700 Clark Road
Twin Lakes Park
Sarasota, Florida 34241
(941) 861-5000

UF UNIVERSITY of FLORIDA
IFAS Extension

AGROECOLOGY: THE SCIENCE OF SUSTAINABLE AGRICULTURE & FOOD SYSTEMS

Part One



Robert Kluson, Ph.D.

Ag/NR Extension Agent III

UF/IFAS Extension Sarasota County

http://www.groundswellinternational.org/how-we-work/agroecological-farming/

Outline

- Topics of this course
  - Part 1
    - Introductory Activity
    - Definitions/History/Pioneers
    - Ecosystem and Agroecosystem Science
    - Environmental Agroecology
    - Instructor Introduction
  - Part 2
    - Social and Economic Agroecology
    - Resilient Food Systems
  - Part 3
    - Agroecology and the Right to Food Report
    - Climate Change Resilience

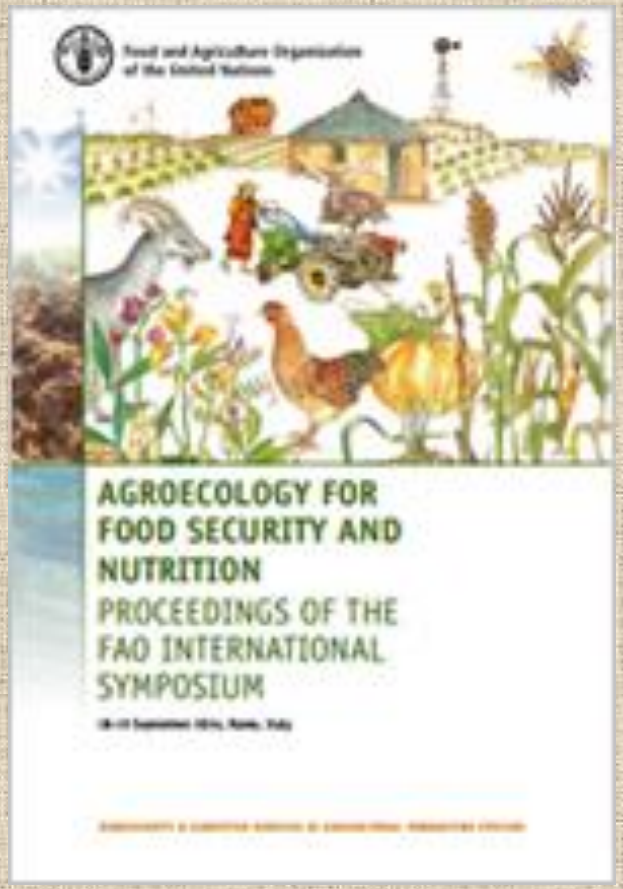
Introduction

Watch the short video “Food By the Numbers: Feeding Our Hungry Planet” at https://www.youtube.com/watch?v=CB9Enh6yP0w

Introductory Activity (20 min.)

- World Café Format
  - Collaborative
  - Respectful
- Answer the following:
  - What is a farm?
  - How is it sustainable?
  - Who are the farmers?
  - How will it feed a projected world population of 9 billion in 2050?

Agroecology and Sustainable Local & Global Food Systems



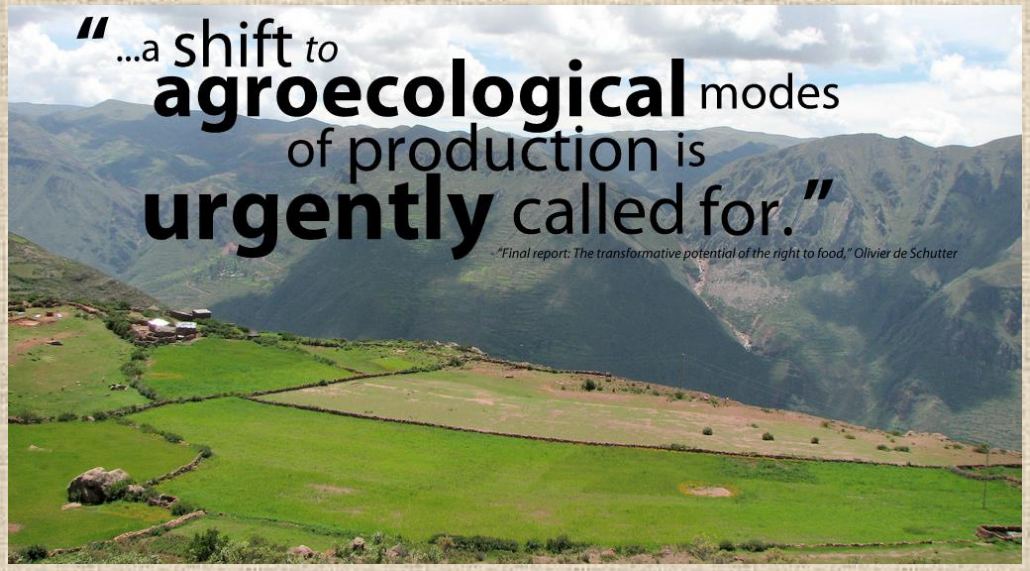
Watch the short video “Summary of the International Symposium on Agroecology for Food Security and Nutrition“ at http://www.fao.org/about/meetings/afns/en/

Agroecology and Sustainable Local & Global Food Systems

"Agroecology and the Right to Food"

Report presented at the 16th Session of the United Nations Human Rights Council, March 8, 2011

Olivier de Schutter, UN Special Rapporteur



Watch the short video "Olivier de Schutter: What is agroecological farming? And why should it be upscaled? " – see https://www.youtube.com/watch?v=938PECAJ920

http://www.srfood.org/en/report-agroecology-and-the-right-to-food

What Is Agroecology?

- Agro – Ecology
- Agro = Agriculture = the science, art, or occupation concerned with cultivating land, raising crops, and feeding, breeding, and raising livestock; farming.
  - from Late Latin agricultura "cultivation of the land," compound of agri cultura "cultivation of land," from agri, genitive of ager "a field" and cultura "cultivation".
- Ecology = the branch of biology dealing with the relations and interactions between organisms and their environment, including other organisms.
  - coined by German zoologist Ernst Haeckel (1834-1919) as Okologie, from Greek oikos "house, dwelling place, habitation" and -logia "study of" .

http://www.dictionary.com/

What Is Agroecology?

- Refers to ecosystems which are characterized by aspects such as nutrient cycling, population regulation, energy flows and a dynamic equilibrium.
- These characteristics apply to natural ecosystems, and, in a much altered form, also to manmade or agricultural ecosystems.
- The magnitude of the differences between natural and agricultural ecosystems depends mainly on the human manipulations
- Includes the idea that the agricultural practices are both site-specific and specific to the socio-economic position of the (type of) farmer or farm family applying them.

- InterDev, an international Natural Resources Management & Ag Development Program, see http://www.fao.org/docs/eims/upload/207703/fiche%20WP3.pdf

What Is Agroecology?

- The application of ecology to the design and management of sustainable agroecosystems.
- A whole-systems approach to agriculture and food systems development based on traditional knowledge, alternative agriculture, and local food system experiences.
- Linking ecology, culture, economics, and society to sustain agricultural production, healthy environments, and viable food and farming communities.

  - Stephen Gliessman, Professor Emeritus, Center for Agroecology and Sustainable Food Systems, Univ. of CA-Santa Cruz

http://www.agroecology.org/index.html

What Is Agroecology?

- Agroecologists do not always agree about what agroecology is or should be in the long-term
- Definitions of agroecology, can be distinguished largely by the specificity with which one defines the term "ecology", as well as the term's potential political connotations

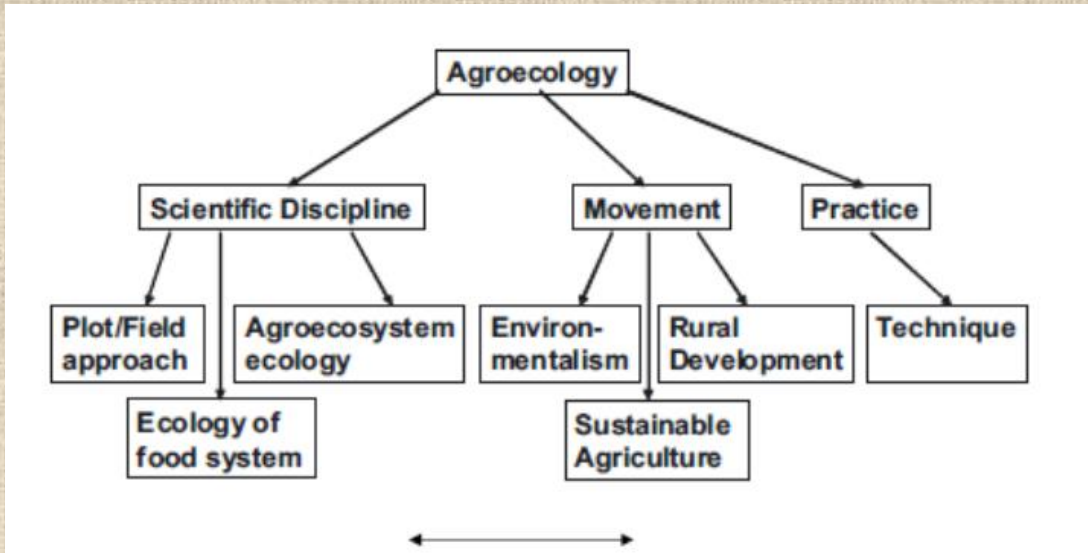


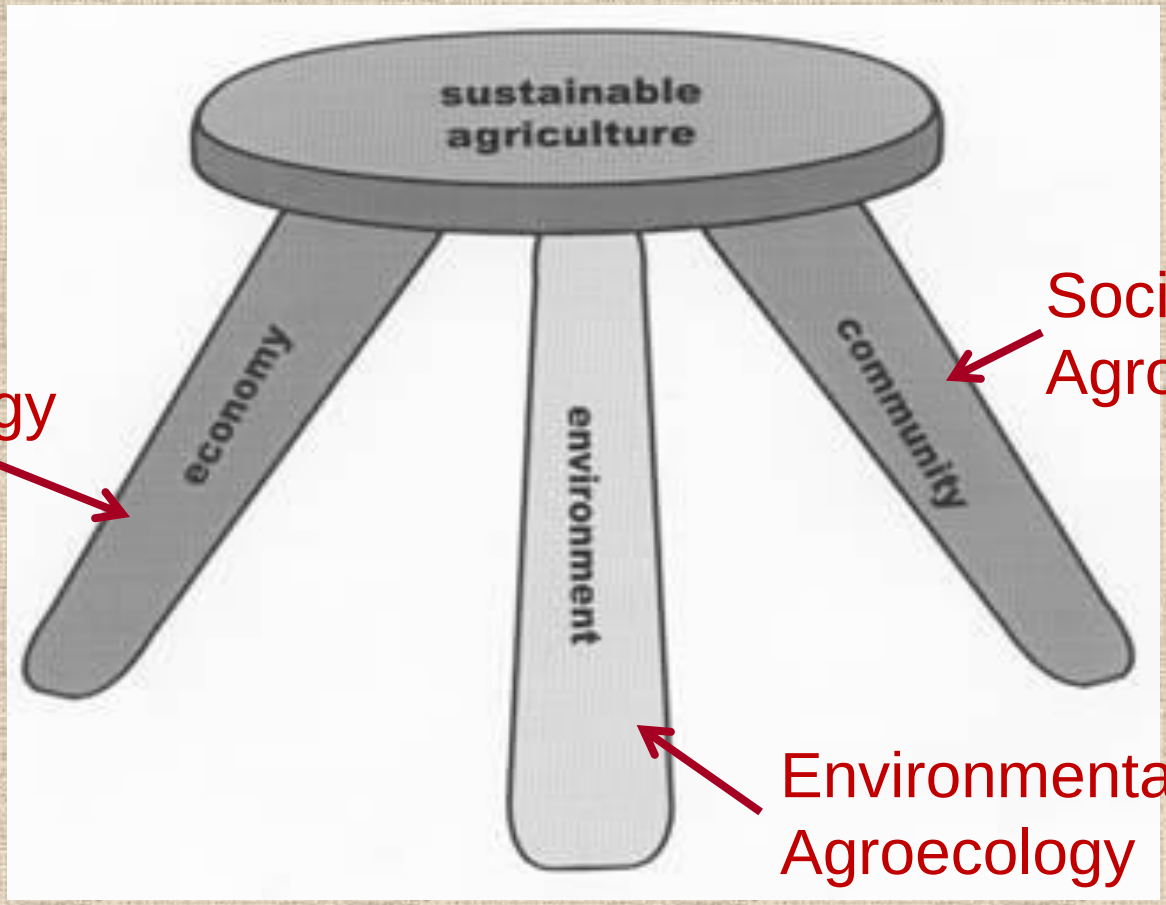
Figure 1. Diversity of current types of meanings of agroecology.

http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1927&context=agronomyfacpub

What Is Agroecology?

- The scales & dimensions of the science of agroecology have changed over the past 80+ years of its historical development across the world from the plot & field scales to the farm & agroecosystem scales.
- One definition refers to the "-ecology" part of "agroecology" narrowly as the natural environment and its ecological processes.
- A more common definition of the word refers to the study of the interactions between plants, animals, humans and the environment within agricultural systems
- Three approaches presently persist:
  - investigations at plot and field scales
  - investigations at the agroecosystem and farm scales
  - investigations covering the whole food system.

What Is Agroecology?



Economic Agroecology

Social Agroecology

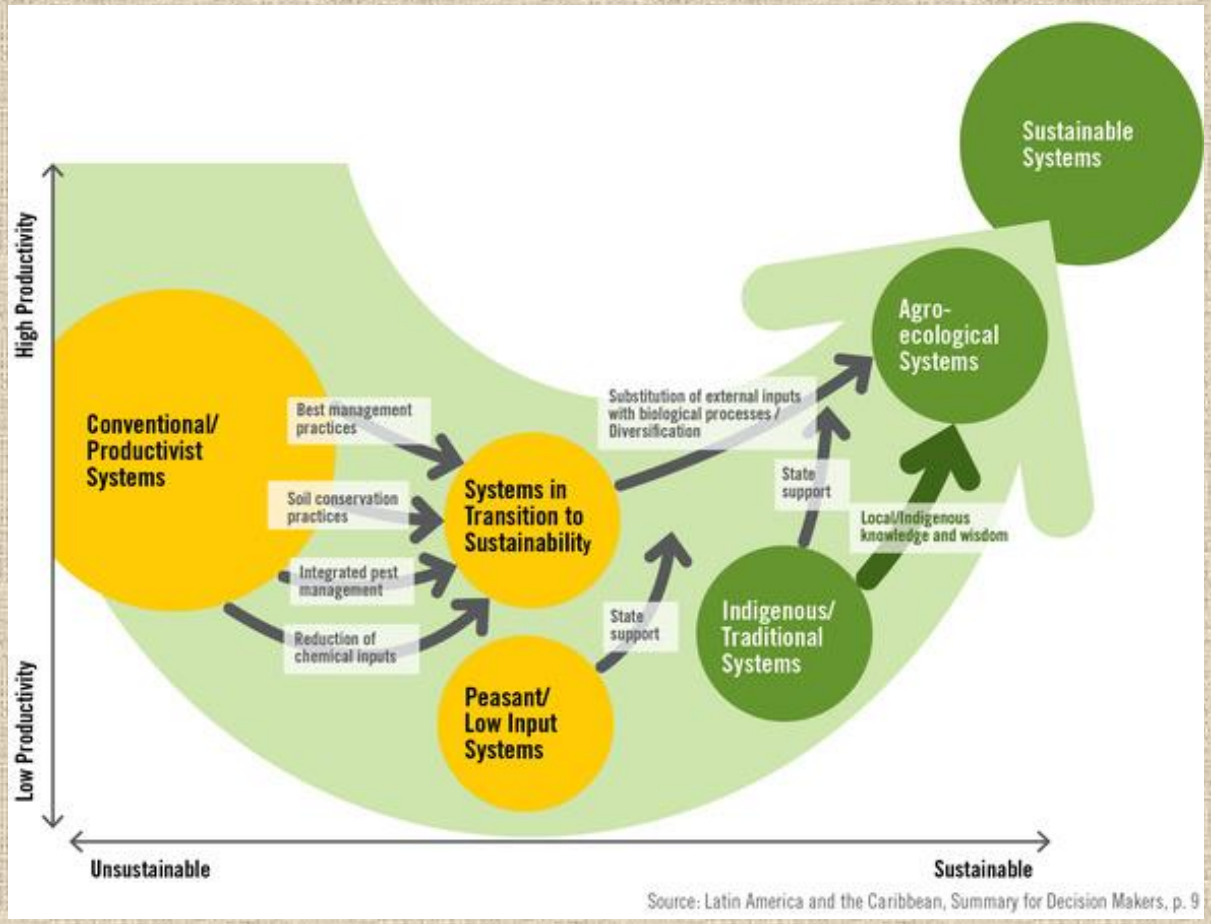
Environmental Agroecology

Agroecology provides the science for the practices to achieve the goals of sustainable agriculture.

What Is Agroecology?

- Agroecology provides the knowledge and methodology for developing a sustainable agriculture that is:
  - Environmental sound
  - Socially equitable
  - Economically viable
- Agroecological design achieves:
  - Improved overall biological efficiency
  - Biodiversity preservation
  - Maintenance of productivity and self-regulating capacity

What Is Sustainable Agriculture?



Sustainable agriculture is the agro-ecological evolution in agriculture, food production & consumption.

http://www.globalagriculture.org/report-topics/agroecology.html

What is Sustainable Agriculture?

1990 U.S. Farm Bill Definition

- Satisfy human food and fiber needs
- Enhance environmental quality and the natural resource base
- Efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls
- Sustain the economic viability of farm operations
- Enhance the quality of life for farmers and society as a whole.

https://www.nal.usda.gov/afsic/sustainable-agriculture-definitions-and-terms

What is Sustainable Agriculture?

- Sustainable agriculture is
  - "the management & conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations
  - conserves land, water, & plant & animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable"

www.fao.org/3/a-i3940e.pdf

Why Agroecology?

Miguel Alteri, Ph.D.,
Professor, UC-Berkeley
Expertise: Best Pracitces of Agroecological Knowledge and Technologies
https://ourenvironment.berkeley.edu/people/miguel-altieri

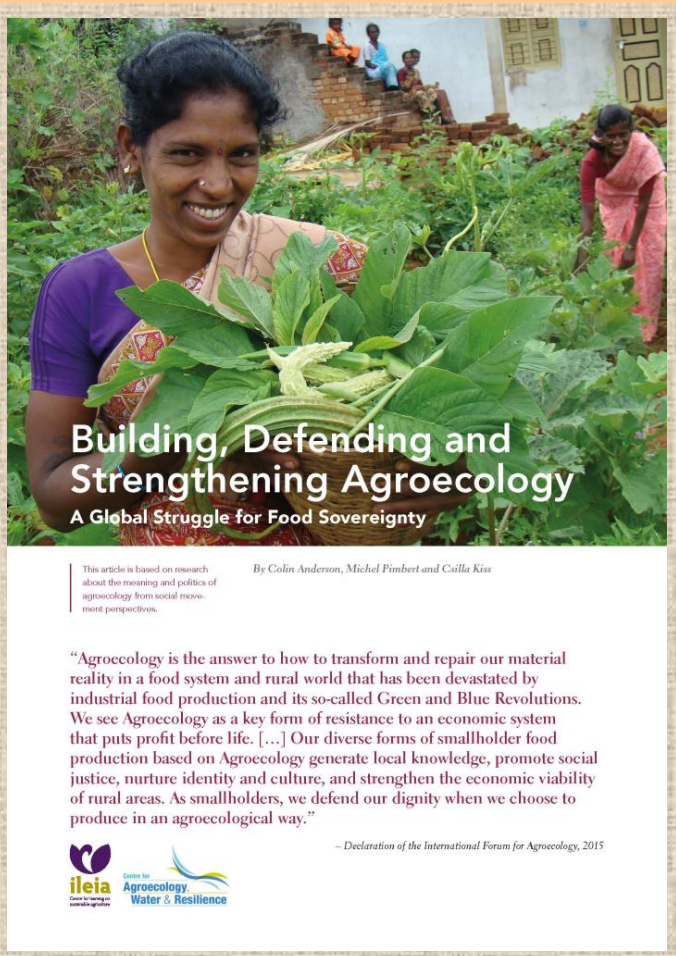
See the short video “Why is agroecology the solution to hunger and food security? at https://www.youtube.com/watch?v=2yFvD8wuLmU&t=25s

Why Agroecology?

- Agroecology addresses these unsustainable impacts of conventional agriculture:
  - Soil degradation
  - Overuse of water & damage to hydrological systems
  - Pollution of the environment
  - Destruction of natural habitat
  - Dependence of external inputs & nonrenewable resources
  - Production of greenhouse gases and loss of carbon sinks
  - Loss of genetic diversity
  - Loss of local control over agriculture production
  - Increasing vulnerability and risk
  - Global inequality
  - Externality negative impacts

Voices & Images of Agroecology

- See the video "Agroecology: Farmers' Perspective" at https://www.youtube.com/watch?v=GO7e5yrQuEI



- See the video "Agroecology: Voices from Social Movements" at https://www.youtube.com/watch?v=Ab82gAfh554

Short History of Agroecology

- Origins of its 2 sciences of ecology & agronomy have been relatively separate
  - Ecology = study of natural systems (pure science)
  - Agronomy = study of agriculture (applied science)
- Science of crop ecology (1920s) = early instance of 'cross-fertilization' of the 2 sciences
  - Focus = where crops were grown and their optimal ecological conditions
  - 1928; K.Klages; "Crop ecology & geography" curriculum
  - 1939; H.Hanson; "Ecology in agriculture'

Short History of Agroecology

- After WWII
  - Ecology = moved more into pure science direction
  - Agronomy = moved into mechanization and Ag chemicals development
- Late 1950s
  - Maturing of the ecosystem concept in ecology prompted renewed interest in crop ecology & a framework for examining agriculture
  - 1956; G.Azzi; “Agricultural ecology”

Short History of Agroecology

- 1960s and 1970s –
  - Factors for increased interest in ecology of Ag
    - Intensification of community & population ecology research
    - Systems-level approaches in ecology
    - Increase in environmental awareness
  - Foundations of agroecology
    - 1962; R. Carson; Silent Spring
    - 1965; W. Tishcler; “Agrarokologie” (Agroecology)
    - 1973; D.H. Janzen; “Tropical agroecosystems”
    - 1977; O.L. Loucks; “Emergence of research on agroecosystems”
    - 1979; G.Cox & M.Atkins; “Agricultural ecology: an analysis of world food production systems:

Short History of Agroecology

- 1980s – 1990s
  - Agroecology emerged as a distinct methodology for the study of agroecosystems
    - 1983; M. Alteri; “Agroecology”
    - 1984; R. Lowrance, et.al.; “Agricultural ecosystems:unifying concepts”
    - 1990; S. Gliessman; “Agroecology: researching the ecological basis for sustainable agriculture”
    - 1992; J. Vandemeer; “The Ecology of Intercropping”
    - 1995; Edens et al.; “Sustainable agriculture and integrated farming systems”
    - 1998; S. Gliessman; Agroecology: Ecological Processes in Sustainable Agriculture.

Short History of Agroecology

- 2000s – Present
  - Agroecology expanded as a strategy for global agroecosystems sustainability
    - 2002; T. Dalgaard, et.al.; “Agroecology, scaling, and interdisciplinarity”
    - 2003; C. Francis, et.al.; “Agroecology: the ecology of food systems”
    - 2007; S. Gliessman; “Agroecology: the ecology of sustainable food systems”

Agroecology: Concepts and Principles

- Ecosystem Concept from Ecology Science
  - A functional system of complementary relations between living organisms and their environment, delimited by arbitrarily chosen boundaries, which in space and time appears to maintain a steady yet dynamic equilibrium.
  - It is the unifying concept of agroecology = the idea that farms are “agroecosystems” and should mimic the functioning of local ecosystems with tight nutrient cycling, complex structure, and enhanced biodiversity conservation.

Short History of Ecosystem Science

Cowles

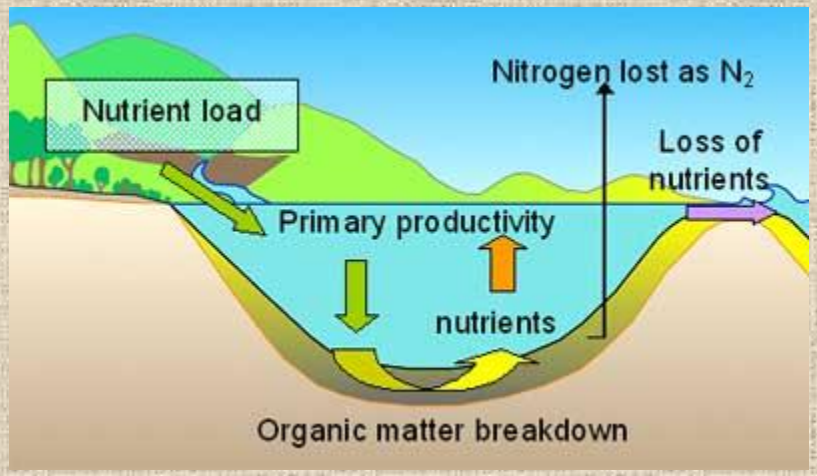
Tansley

❖ Arthur Tansley, 1935,

- The father of the modern concept of the *ecosystem*
- *"The elegance of the idea of the ecosystem is that it is comprehensive, including within itself all those elements physical, chemical and biological, which could conceivably affect the organisms being studied."* (Evans 1976)
- It included the "organism" concept of earlier researchers. The ecosystem idea was also shared by a number of other scientists

Short History of Ecosystem Science

- Stephen Forbes, 1887
  - "Lake as a Microcosm" publication on aquatic system science
  - Acknowledged by the National Academy of Sciences as "the founder of the science of ecology in the U.S."



https://en.wikipedia.org/wiki/Stephen_Alfred_Forbes

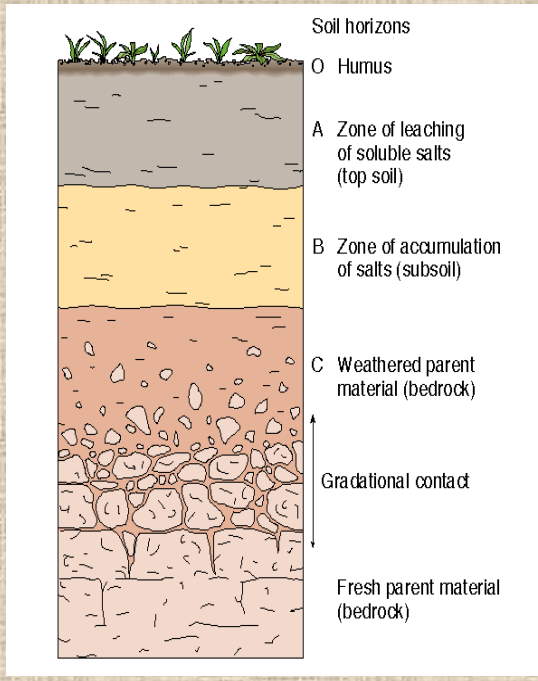
Short History of Ecosystem Science

❖ F. Clements, 1900

- Developed the 'organism' concept of vegetation communities that have successional stages ending with a climax community
- Contested by other scientists whose data does not support this, e.g. Cowles, Cooper
  - plants and animals do not act as one assemblage-- much variability in their range
- Idea is still around in various forms, e.g., Gaia concept of Lovelock and Margulis

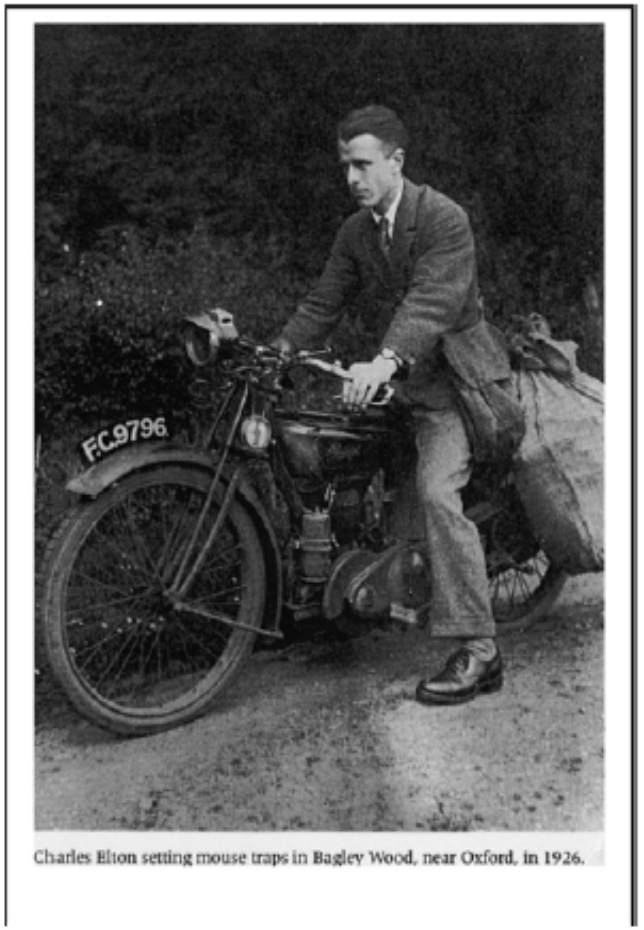
Short History of Ecosystem Science

- V. Dokuchaev, 1900
  - The father of soil science
  - Introduced the idea of *the soil as a natural body with* 5 factors of soil genesis
    - Parent material
    - Biology
    - Climate
    - Topography
    - Time
  - His ideas were quickly taken up by a number of soil scientists, including Hans Jenny.



Short History of Ecosystem Science

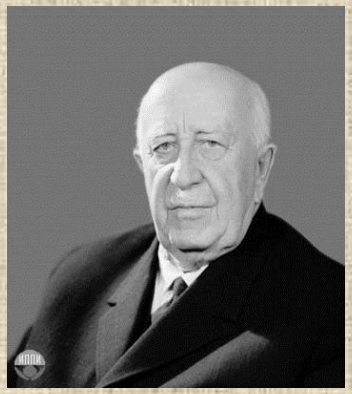
- Trophic interactions
  - Charles Elton (1900-1991)
    - Oxford University
    - Laid groundwork for trophic dynamics
      - Niche: role of an animal in a comm. (what it eats and who it is eaten by)
      - Food chain (pyramid): links different niches; fundamental organizational unit of all communities; food chain forms a pyramid where each successive level has fewer, larger animals
      - Food cycle: complex trophic interactions
    - Focused on transfer of matter, not energy; but laid groundwork for studies of energy transfer thru ecosystems



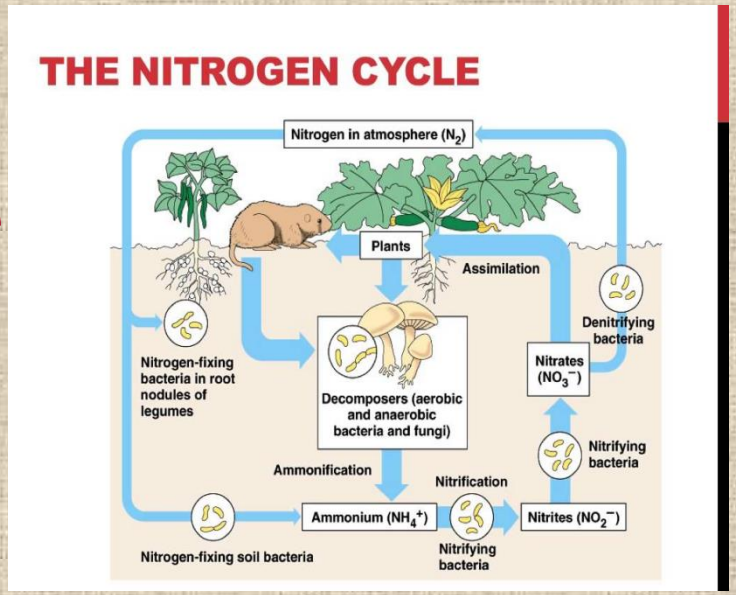
Charles Elton setting mouse traps in Bagley Wood, near Oxford, in 1926.

Short History of Ecosystem Science

- Sukachev 1945
  - "biogeocoenosis" = biogeochemical cycling or nutrient cycling via biological and abiotic interactions

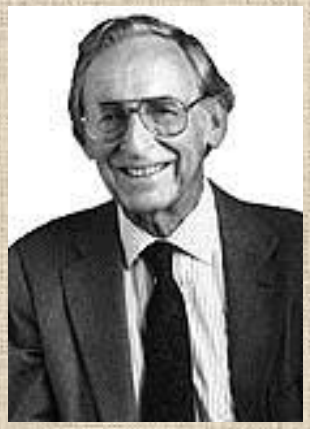


  - "It is a major task of natural science to deepen its knowledge of existing relationships to discover the underlying patterns with a view to controlling them on behalf of man."



Short History of Ecosystem Science

Eugene Odum, *Introduction to Ecology* text (1953)



- Defined ecology as the structure and function of ecosystems
- Influenced by others developing ideas energy flow and nutrient cycles, which he systematized and explained well
- Formulated the concept of emergent properties of ecosystems
- Heavily influenced by brother, Howard, an Electrical Engineer

Example Diagram of Ecosystem Energy Flow, Using Electrical Engineering Symbols

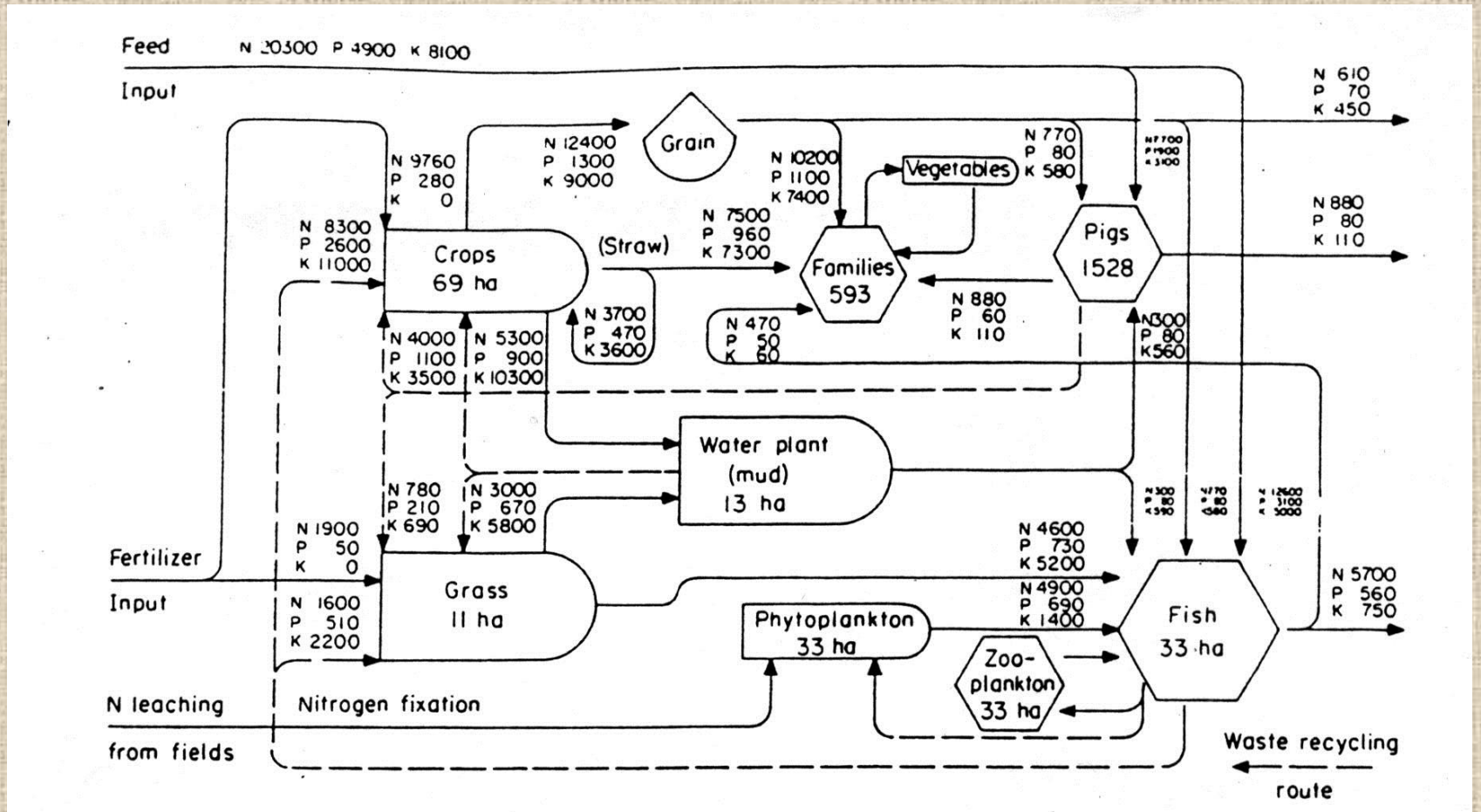


Fig. 3. Nutrient flows for the whole farming ecosystem including families of human beings (totals in kg for 115 ha).

Short History of Ecosystem Science

C.S. Holling

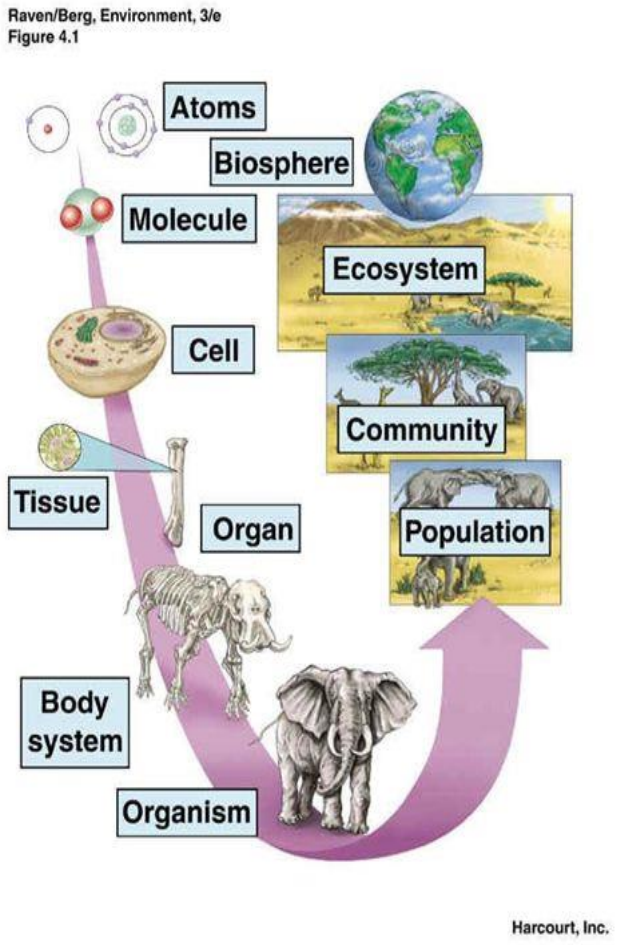
photo by Lee Gass

- He first introduced in 1973 the concept of resiliency in order to describe the persistence of natural systems in the face of changes in ecosystem variables due to natural or anthropogenic causes
- He also introduced other important ideas in the application of ecology and evolution, such as adaptive management, the adaptive cycle, and panarchy.
- More recently his work on the cross-scale structure and dynamics of ecosystems has been highly influential, e.g., panarchy is the structure in which systems, including those of nature and of humans, as well as combined human-natural systems, are interlinked in continual adaptive cycles of growth, accumulation, restructuring, and renewal.

https://en.wikipedia.org/wiki/C._S._Holling

Ecosystem Science

Emergent Property



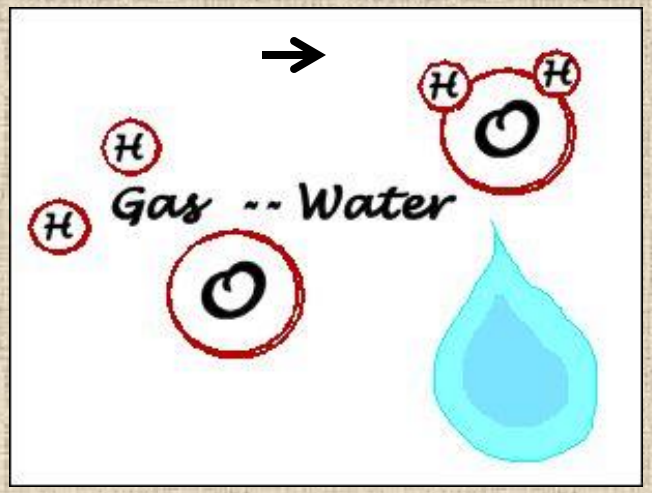
Each level of organization has **emergent properties.**

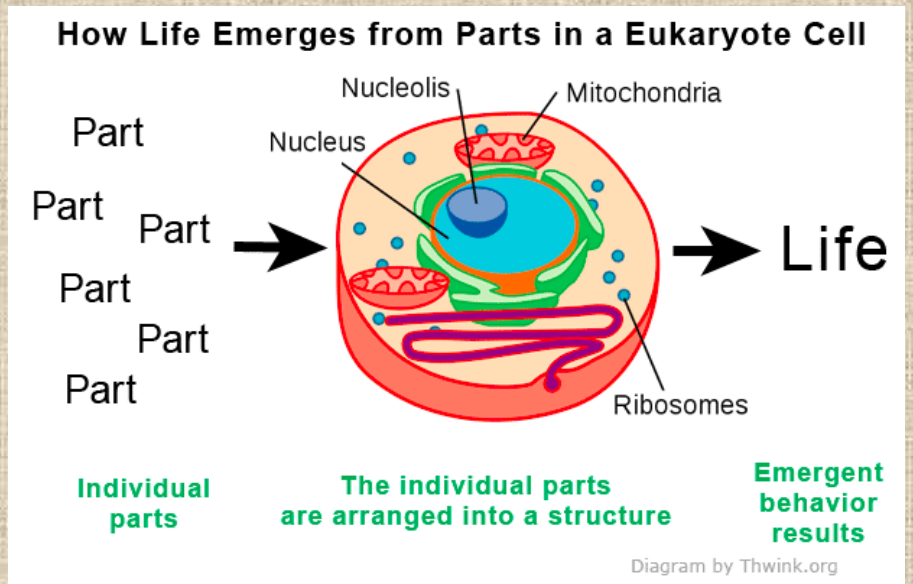
What the heck is an emergent property?

Quality that appears as biological complexity increases as it goes up a level and determined by interactions between individual parts

Ecosystem Science

“Emergent Property” Examples





Examples where knowledge of the parts does not predict the properties of the whole

Ecosystem Science

Biotic Organization

1. Population: all the members of a species inhabiting a given location
2. Community: all the interacting populations in a given area
3. Ecosystem: the living community and the physical environment functioning together as an independent and relatively stable system

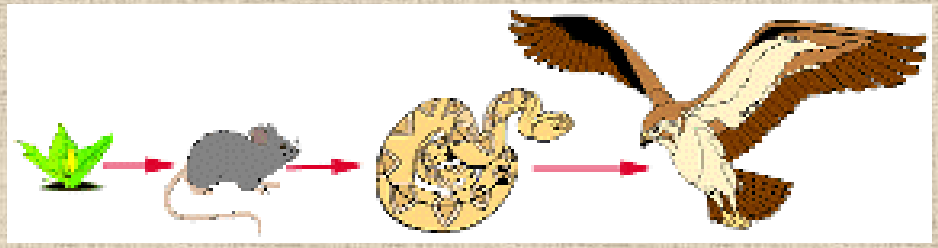
Watch the short video “What Is An Ecosystem” – see https://www.youtube.com/watch?v=O3CZFfyed3M

Ecosystem Science

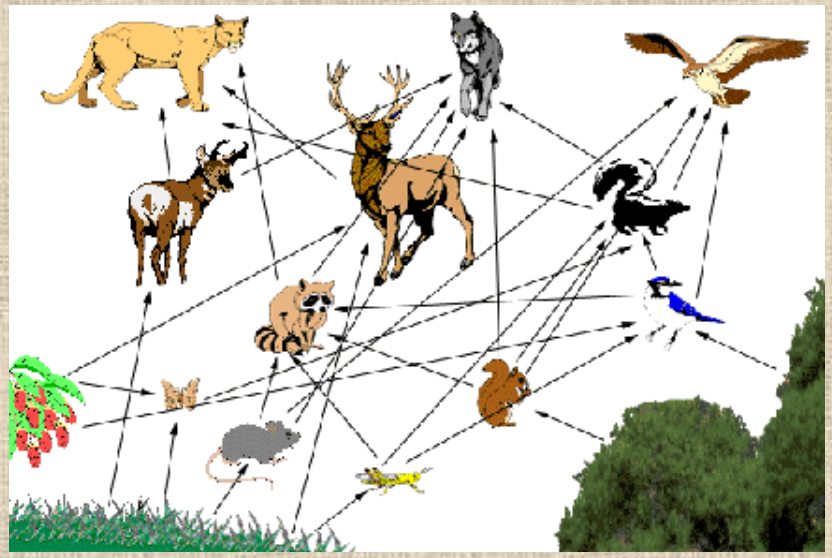
Trophic Structure

- Definition:
  - Feeding relationships among the species
  - Within a food web/chain
  - Within a single ecosystem

food chain

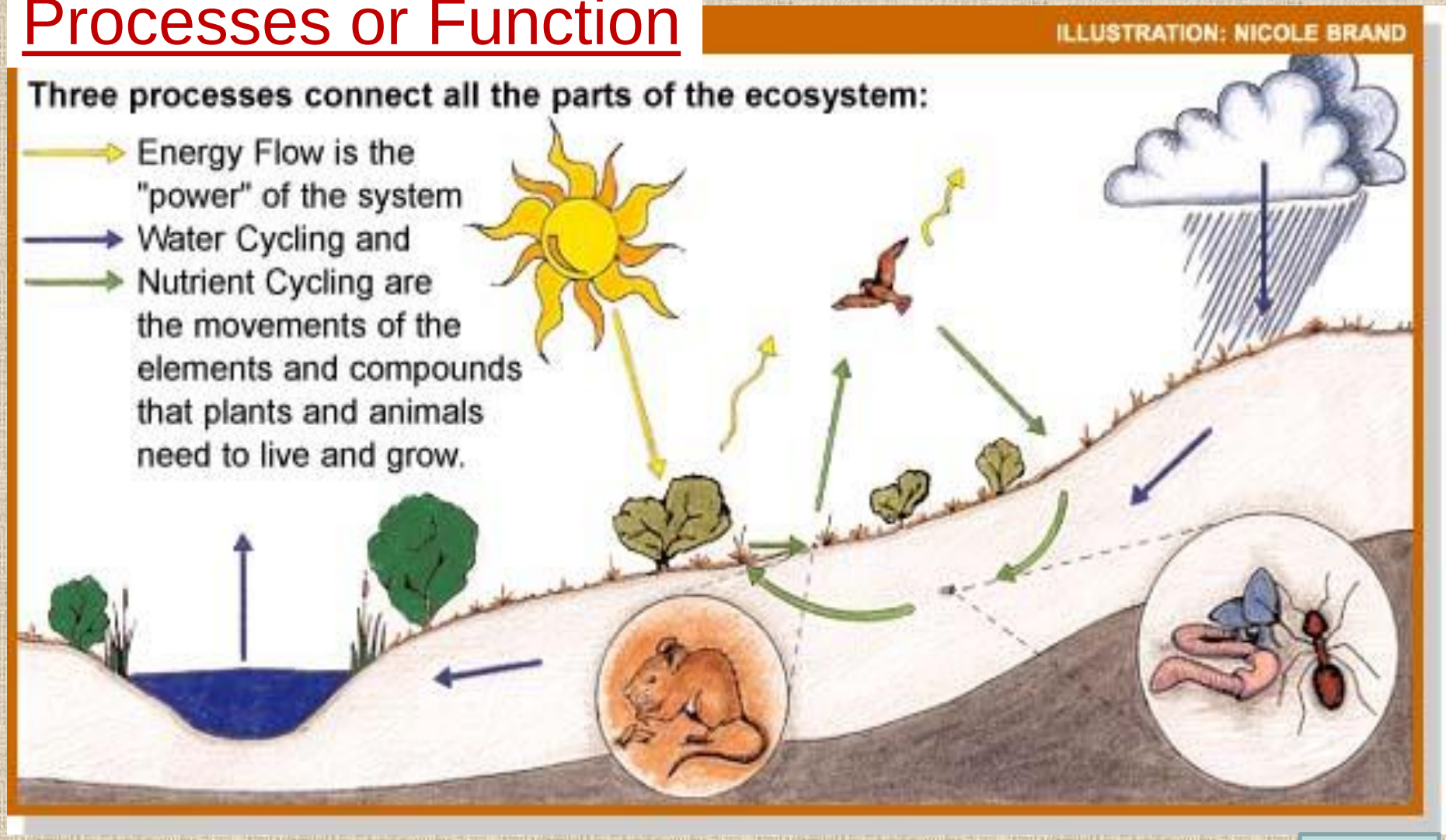


food web



Ecosystem Science

Processes or Function

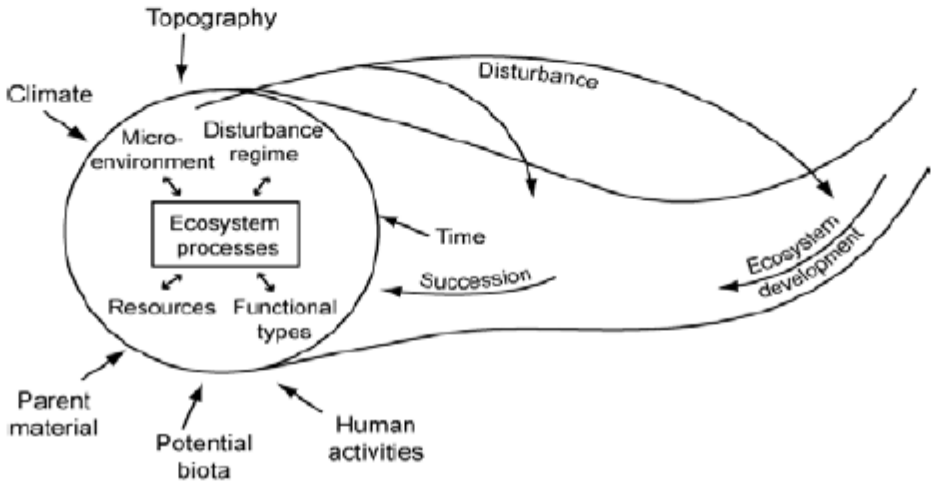


Watch the short video "How the ecosystem works" at
https://www.youtube.com/watch?v=o_RBHfjZsUQ

Ecosystem Science

Ecosystem structure and function

- What controls ecosystem processes (structure & function)?
  - 5 independent state variables
    - Set the bounds for the characteristics of a given ecosystem
      - Same 5 state variables that control soil formation (Hans Jenny, 1941)
    - These factors control but are not controlled by ecosystems
  - Human activities as a 6th state variable
  - Also at least 4 "interactive controls"
    - Factors that both control and are controlled by ecosystem characteristics



Ecosystem Science

Biodiversity

- Genetic
  - Increased adaptation capacity
- Species
  - Multiple species at the same trophic level perform similar ecological roles to increase resiliency to disturbances
  - Increased processes
- Landscape
  - Increased habitats

1. The three levels of biodiversity are genetic diversity, species diversity, and ecosystem diversity

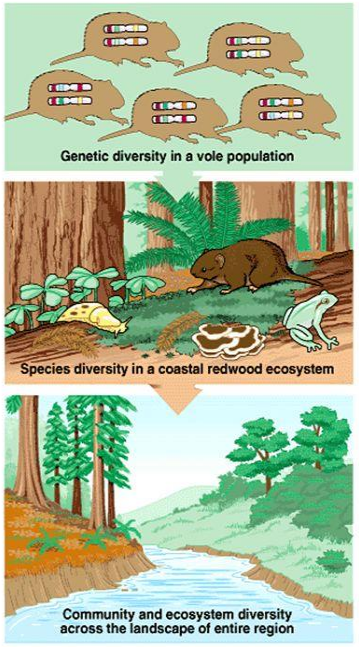


Fig. 55.1

Ecosystem Science

Homeostasis

Homeostasis = Balance

- An ecosystem regulates itself.
- ***Homeostasis*** is the dynamic equilibrium among the living members of an ecosystem, against environmental conditions, such as wind rainfall, nutrient availability, air quality, and climate.

Ecosystem Science

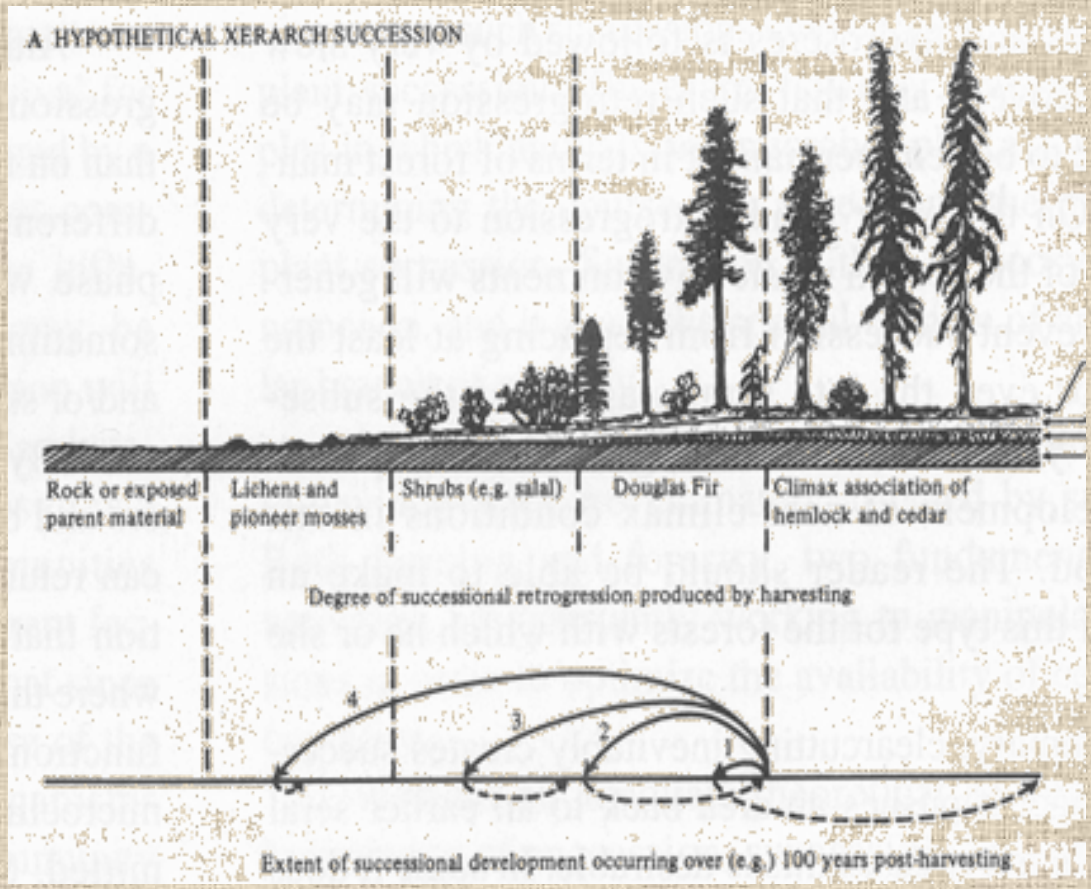
Carrying Capacity

- the maximum number of organisms the resources of an area can support
- The carrying capacity of the environment is limited by the available abiotic and biotic resources, as well as the ability of ecosystems to recycle the residue of dead organisms through the activities of bacteria and fungi.

Ecosystem Science

Succession

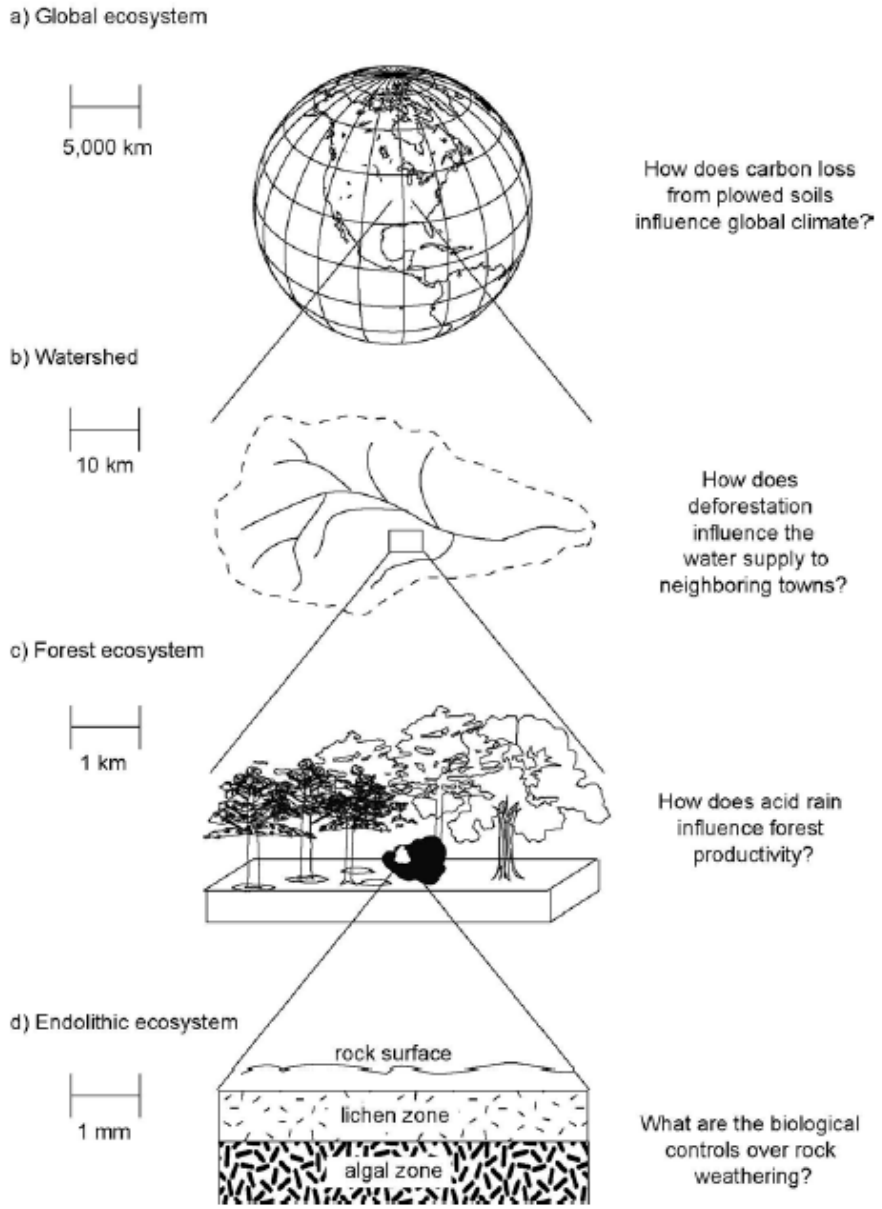
- Chronological distribution of organisms within an area
- The sequence of species within a habitat or community through time
- Shared:
  - Time
  - Single area



Ecosystem Science

Spatial scale

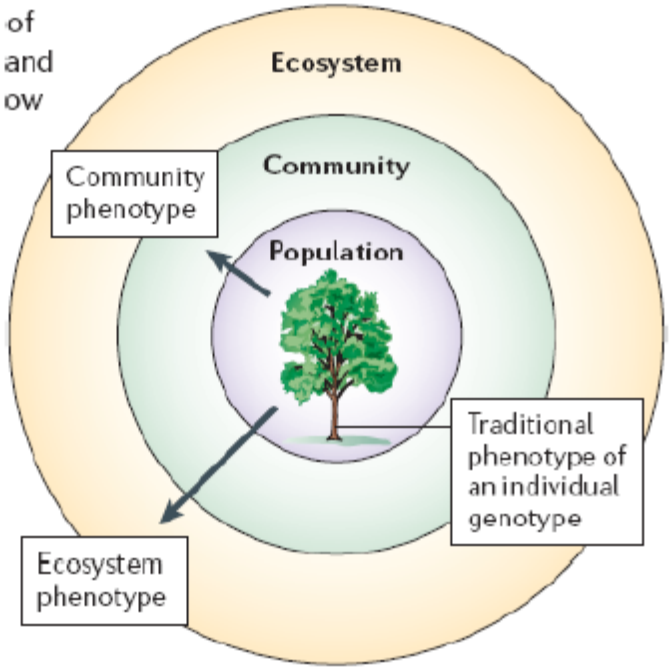
- Distribution in space
  - Boundaries of ecosystems can be defined at different scales



Ecosystem Science

Temporal Scale

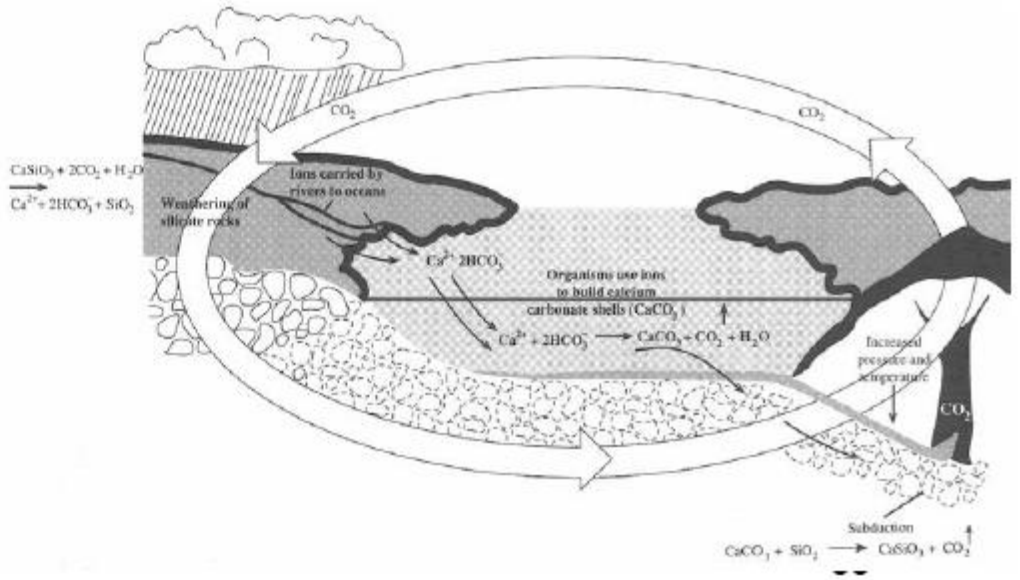
- Instantaneous (sec)
- Seasonal (yr)
- Successional (10 to 100s yrs)
- Evolutionary (100s to 1000s yrs)
  - Natural selection controls inter- and intraspecific variability in ecosystem processes



Ecosystem Science

Temporal Scale

- Instantaneous (sec)
- Seasonal (yr)
- Successional (10 to 100s yrs)
- Evolutionary (100s to 1000s yrs)
- Geologic (1,000s to 1,000,000s yrs)



Ecosystem Science

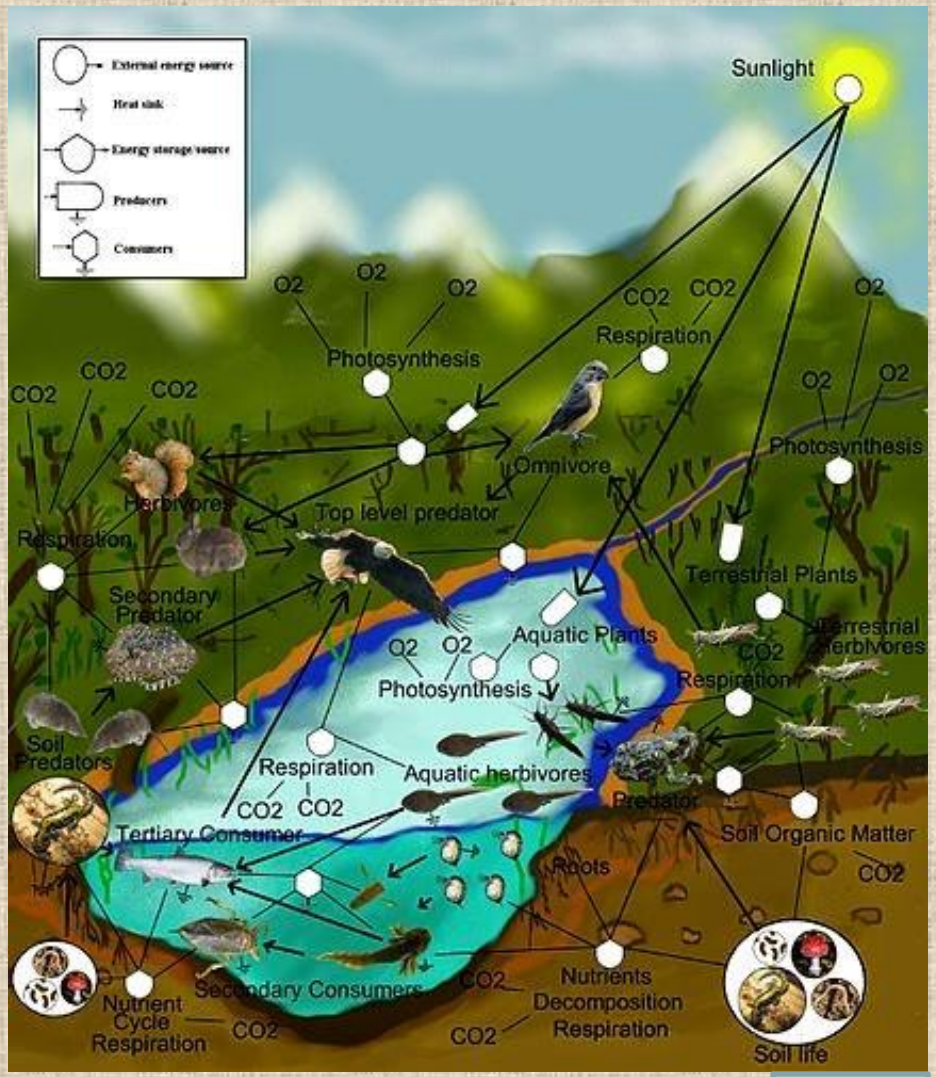
Temporal Scale

- Shift from viewing ecosystems as static (equilibrium) to dynamic (nonequilibrium)
  - Unbalanced inputs/outputs
  - External and internal forcing factors
  - No single stable state
  - Disturbance is the norm
  - Legacy of past events
  - Human activities exert pervasive influence
- Steady state → balance between inputs and outputs shows no trend over time
  - Acknowledges temporal and spatial variation as normal
  - "Balance" does not mean that inputs = outputs, but rather that there is no change in the balance over time

Ecosystem Science

Resiliency

- the ability of an ecosystem to maintain its structure and function over long periods of time and regain its normal structure and function after disturbances.
- the product of functional feed-back loops of the biotic and abiotic components of an ecosystem



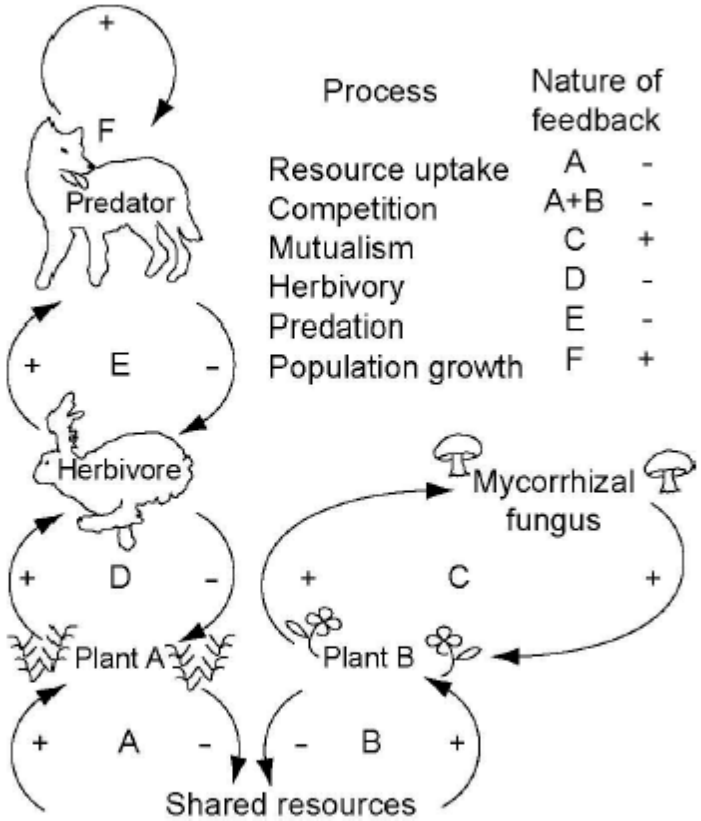
Watch a short video “Feedback loops: How nature gets its rhythms“ – see https://www.youtube.com/watch?v=inVZoI1AkC8

http://animals-partner.blogspot.com/2014/12/resilience-ecology.html

Ecosystem Science

Ecosystem Feedbacks

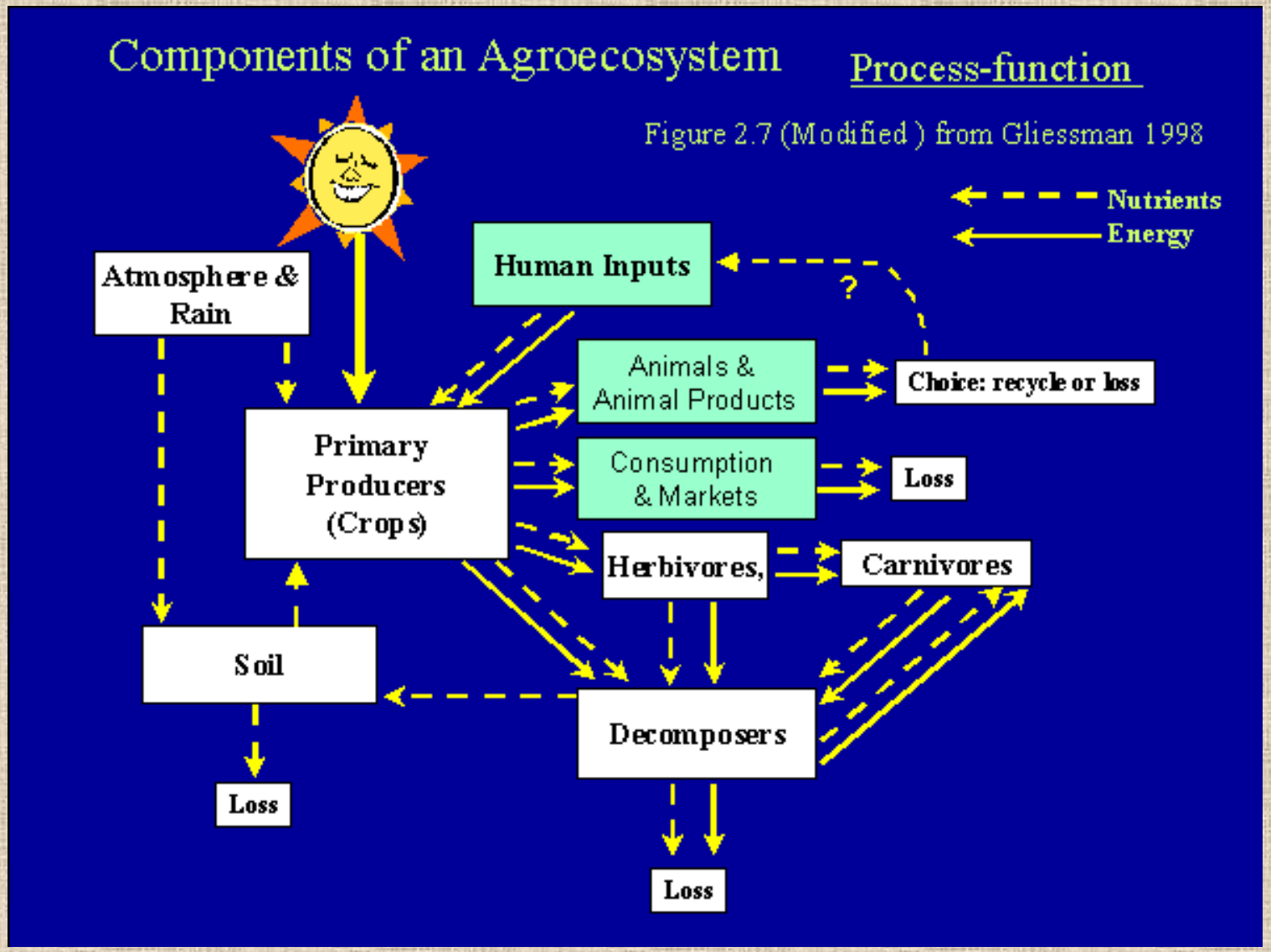
- Feedbacks regulate the internal dynamics of ecosystems
  - Can be negative (stabilizing) or positive (amplifying)
    - Negative feedbacks act as a balance to maintain ecosystems in current state
      - Negative when 2 components have opposite effect on each other
    - Provide stability in the face of change, where stability is a function of:
      - Resistance (ability to resist change)
      - Resilience (ability to return to pre-existing conditions)
  - Threshold: critical level of one or more ecosystem controls that, when crossed, causes abrupt ecosystem change



Process	Nature of feedback	
Resource uptake	A	-
Competition	A+B	-
Mutualism	C	+
Herbivory	D	-
Predation	E	-
Population growth	F	+

Agroecosystem Science

Study of Structure and Processes of an Agroecosystem



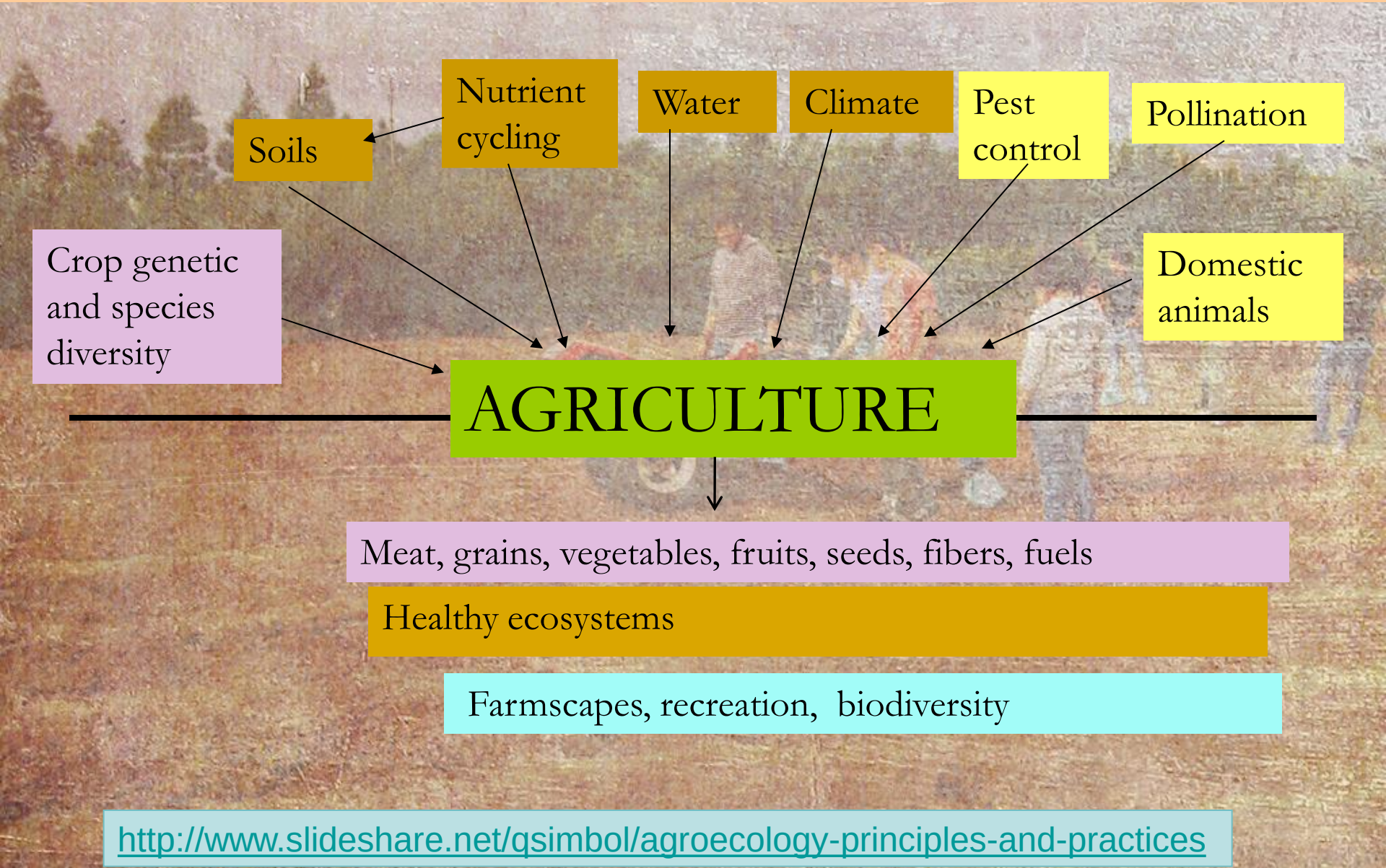
Agroecosystem Science

Study of Design & Management Goals

AGROECOSYSTEM VS. NATURAL ECOSYSTEM

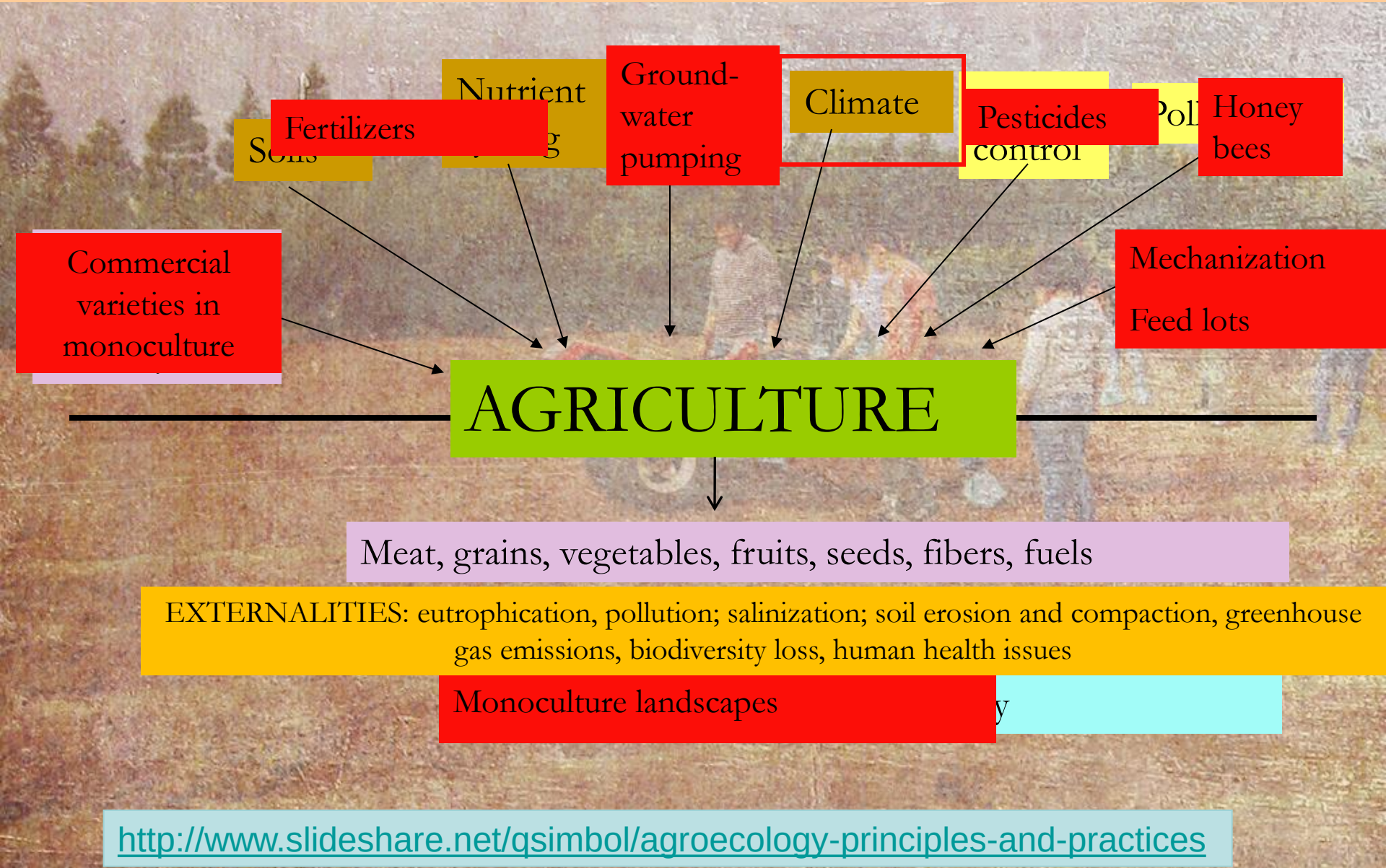
- Natural ecosystem is closed, or at least, unmanaged ecosystem
  - Closed ecosystem—all elements recycled through ecosystem—not often pure closed ecosystems anymore—humans frequently involved
- Agroecosystem is an open ecosystem, or managed ecosystem:
  - Producer moves plants, animals, environmental factors (fertilizers, feed) in & out of ecosystem
  - Will not continue on its own without management
  - If left alone, would progress toward closed ecosystem, but probably not the same as original ecosystem before agriculture without human input again

Environmental Agroecology: Addressing Industrial Agriculture Impacts



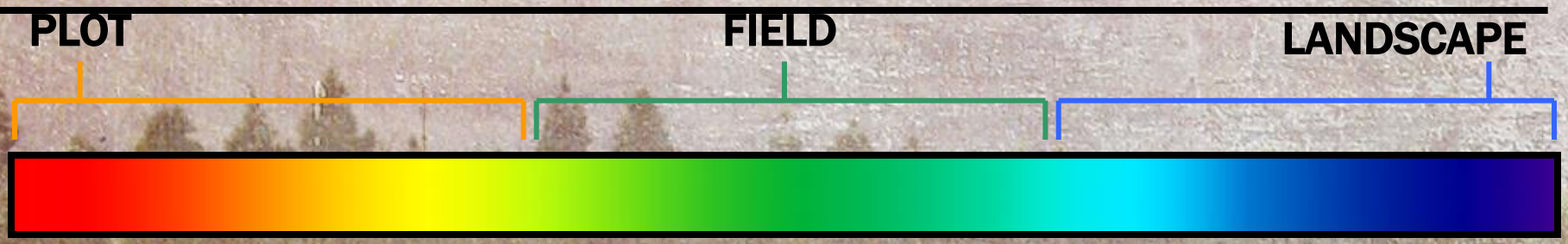
http://www.slideshare.net/qsimbol/agroecology-principles-and-practices

Environmental Agroecology: Addressing Industrial Agriculture Impacts



http://www.slideshare.net/qsimbol/agroecology-principles-and-practices

Environmental Agroecology: Restoring Ecological Services in Farms

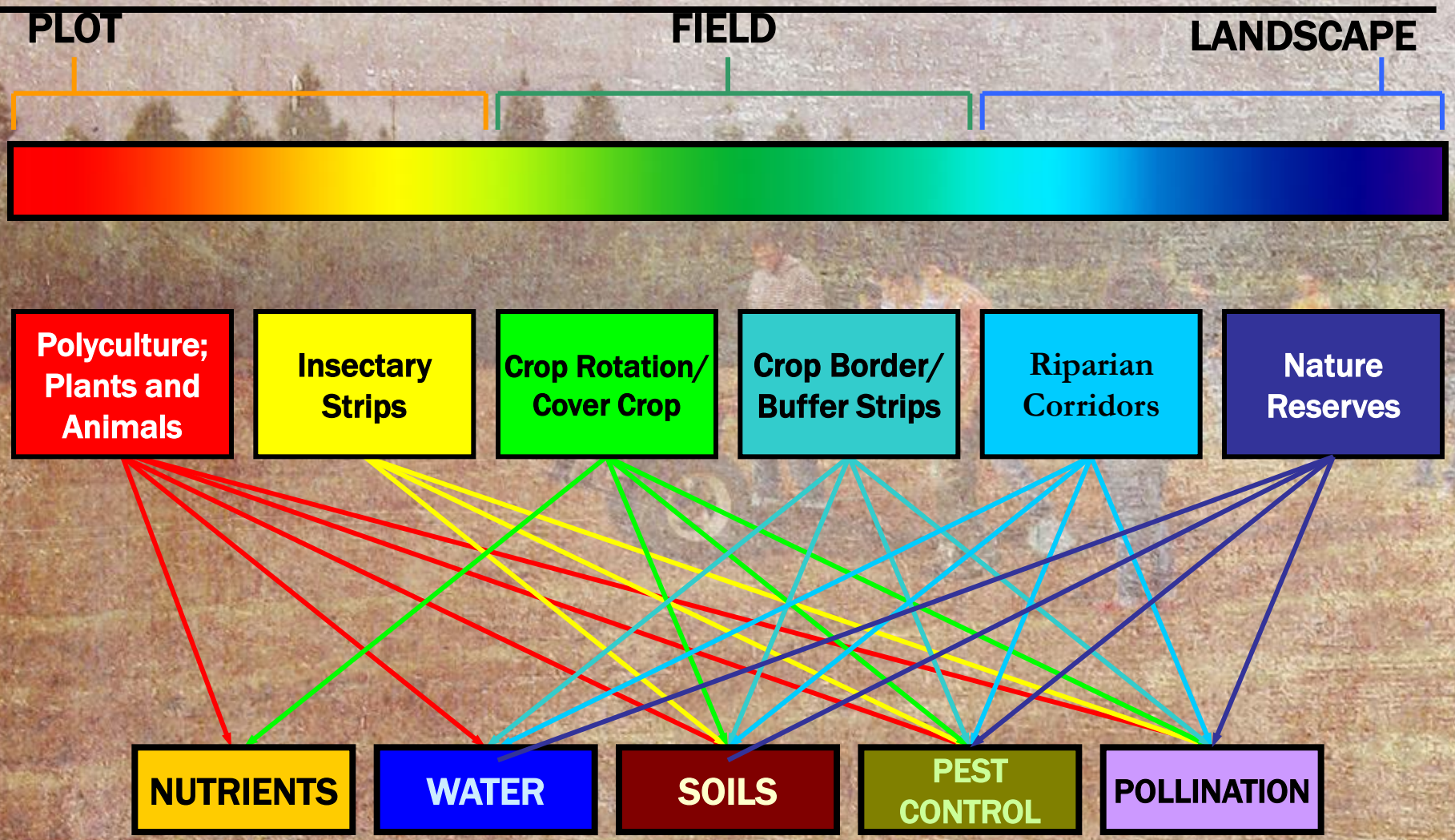


Polyculture; Plants and Animals	Insectary Strips	Crop Rotation/ Cover Crop	Crop Border/ Buffer Strips	Riparian Corridors	Nature Reserves

NUTRIENTS	WATER	SOILS	PEST CONTROL	POLLINATION

http://www.slideshare.net/qsimbol/agroecology-principles-and-practices

Environmental Agroecology: Restoring Ecological Services in Farms



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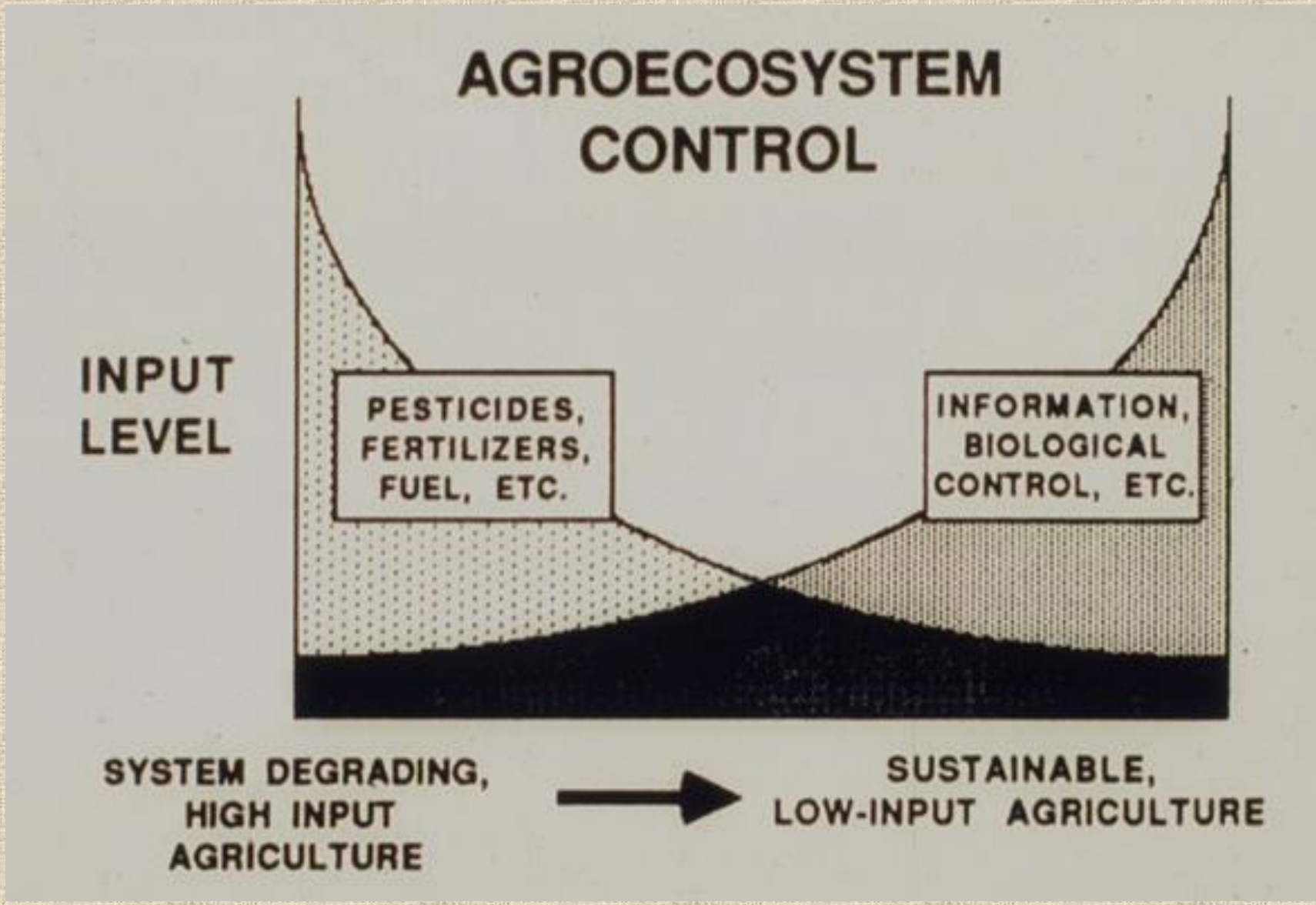
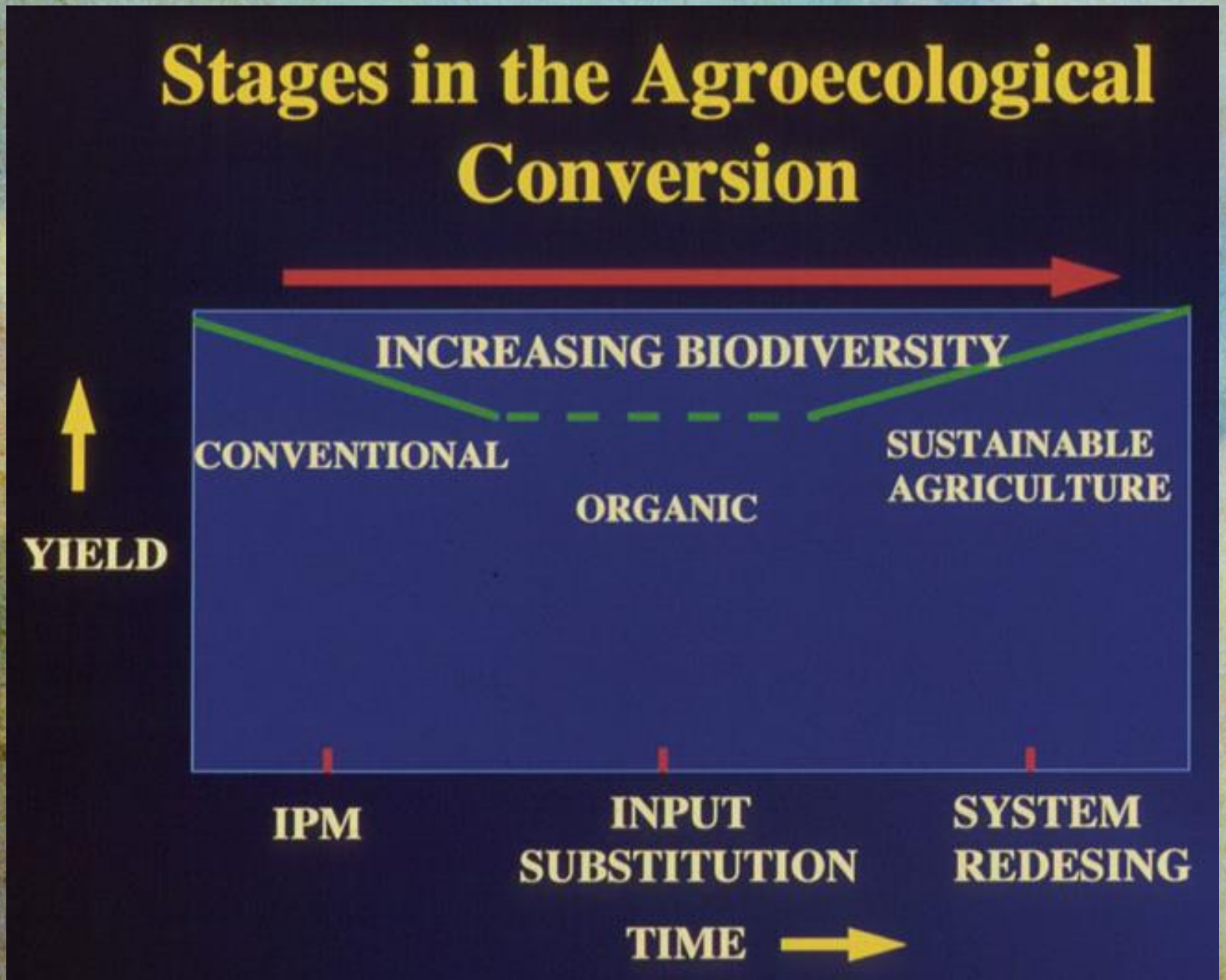
Environmental Agroecology



Environmental Agroecology



http://www.slideshare.net/qsimbol/agroecology-principles-and-practices

Environmental Agroecology

- Recognition of the whole systems nature of food, feed, & fiber production
- Promoting ‘emergent properties’ of ecosystems
  - definition: all systems are composed of components. Once these components are assembled as subsystems into the ecosystem, they take on new properties, i.e., those of the system.
- Balancing functional interactions of environmental/social/economic systems

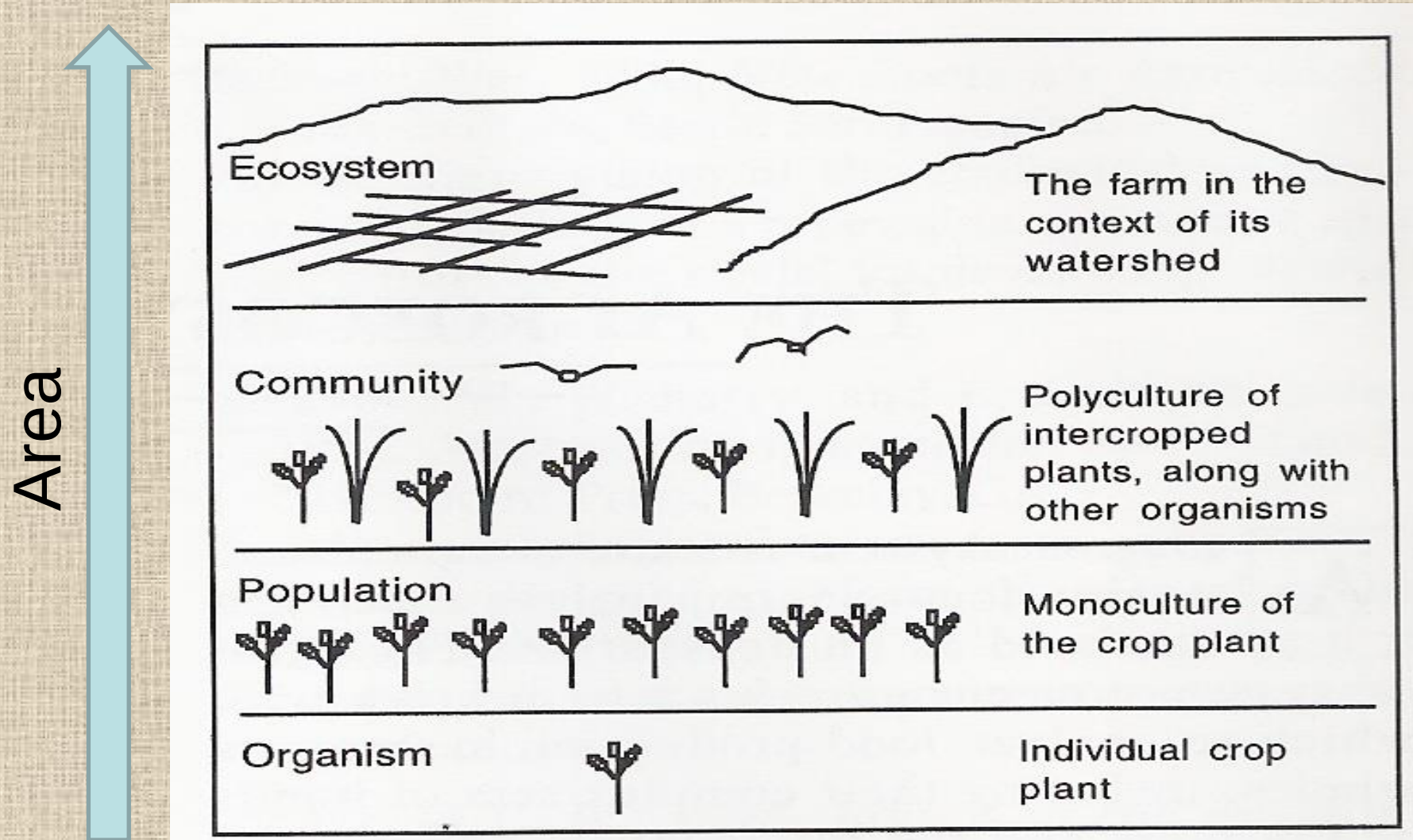
Environmental Agroecology

- Emergent Property Example: Soil Health

Watch the short video "The Science of Soil Health: Systems in Agroecology " – see https://www.youtube.com/watch?v=jpMr1-STc38

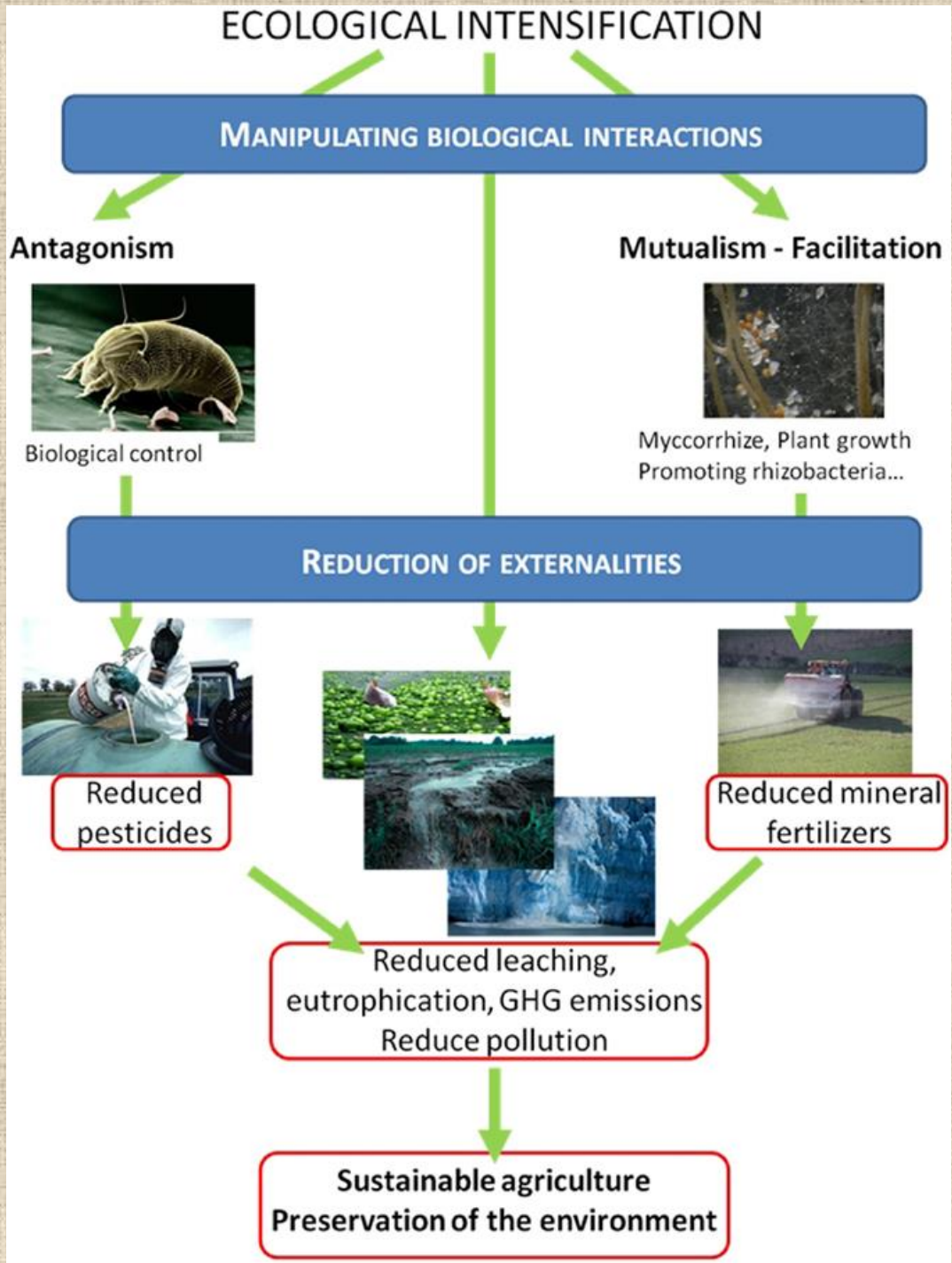
Agroecosystem Spatial Emergent Property

Different Levels of Functional Agroecosystems w/ Increasing Production Area



Agroecosystem
Spatial
Emergent
Property
Example:

Environmental
Benefits



Agroecosystem Spatial Emergent Property Example: Environment Benefits

Loess Plateau, early September 2009. 14 Years after restoration began. (http://blogs.worldbank.org/voices/its-all-connected-landscape-approaches-to-sustainable-development)

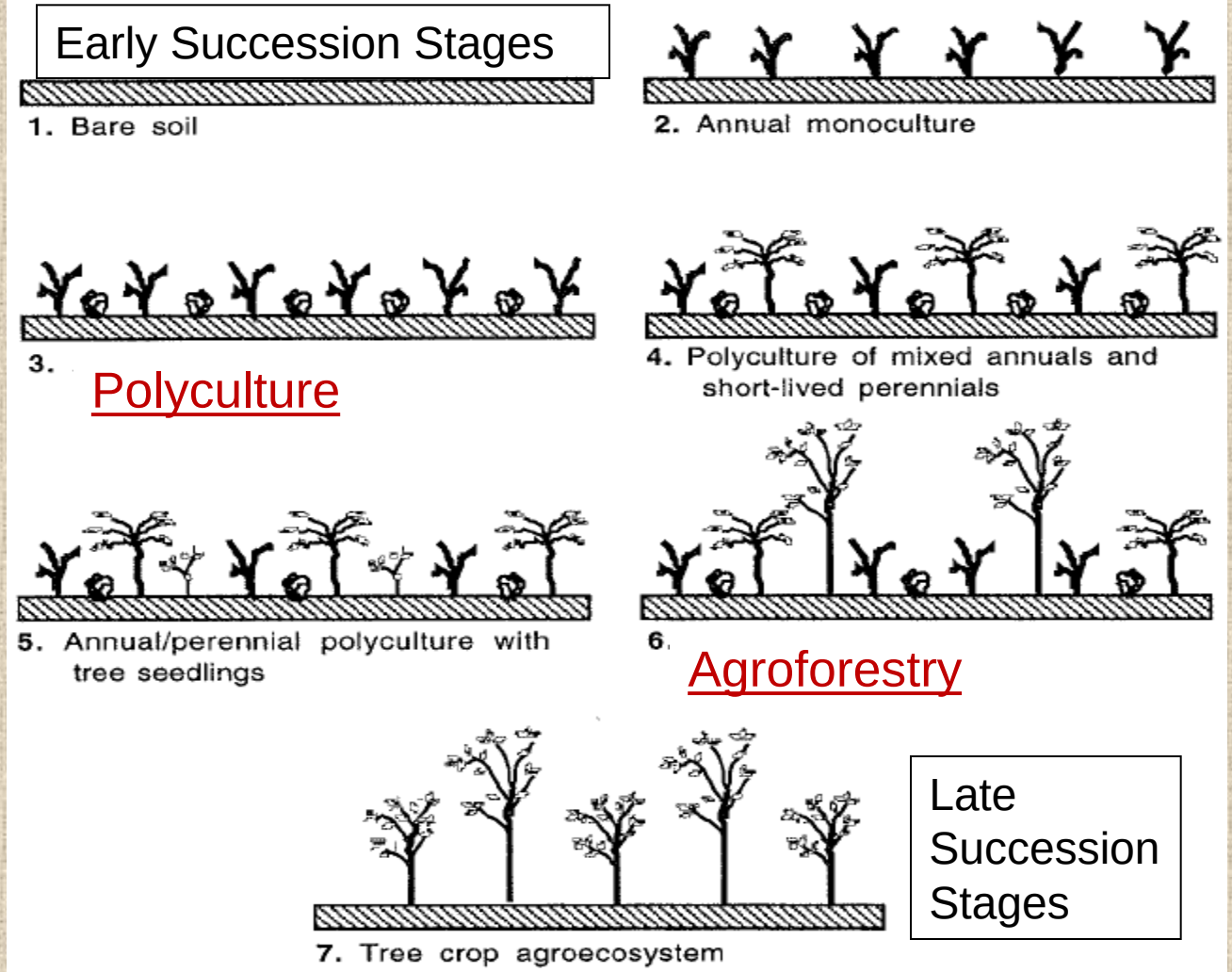
See the video “Agroecology in China” at https://www.youtube.com/watch?v=sK8JNXHcBMA

See the video “Agroecology in Ethiopia” at https://www.youtube.com/watch?v=mbEM6DCTK3Y

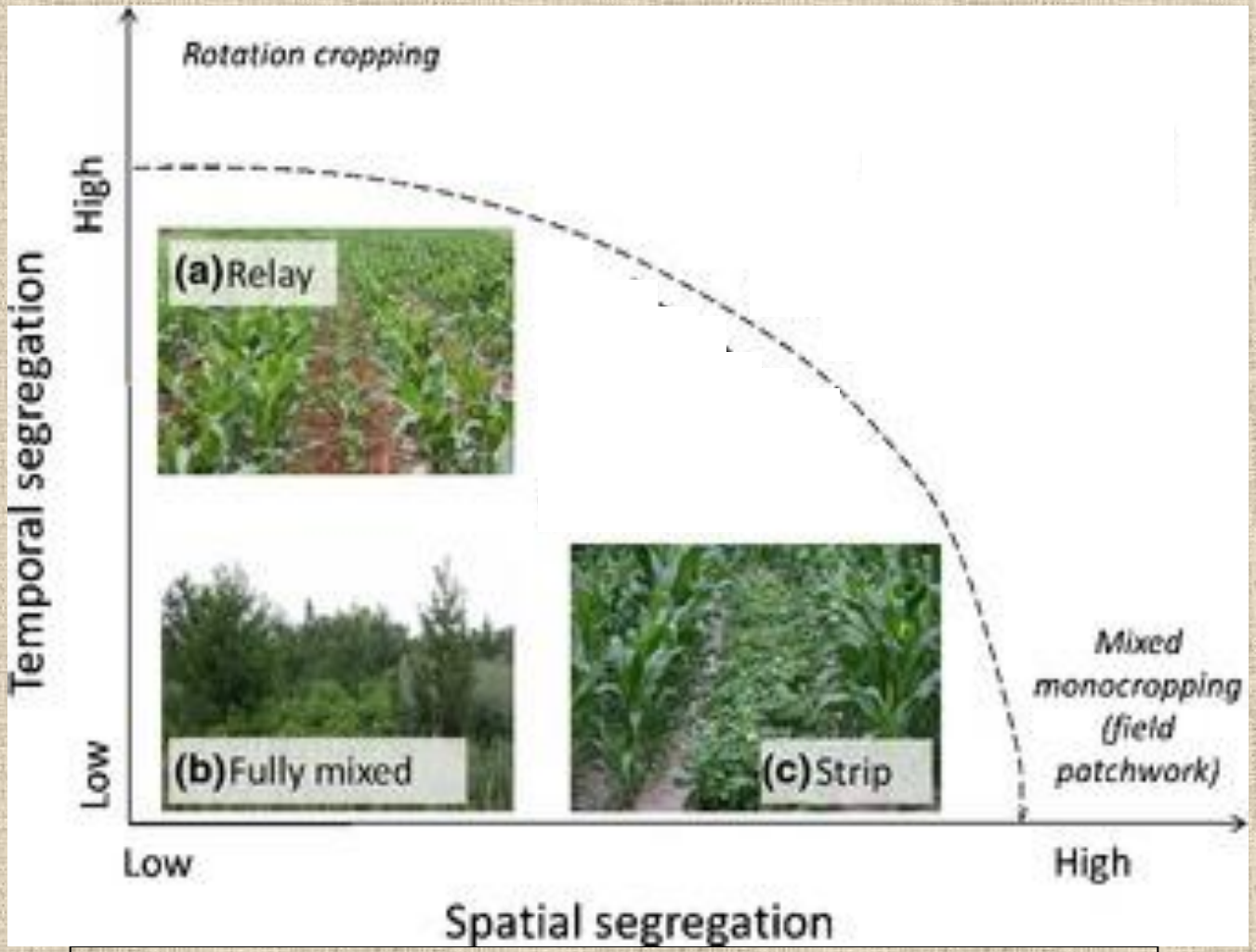
Agroecosystem Temporal Emergent Property

Different Levels of Functional Agroecosystems w/ Increasing Production Time

Time

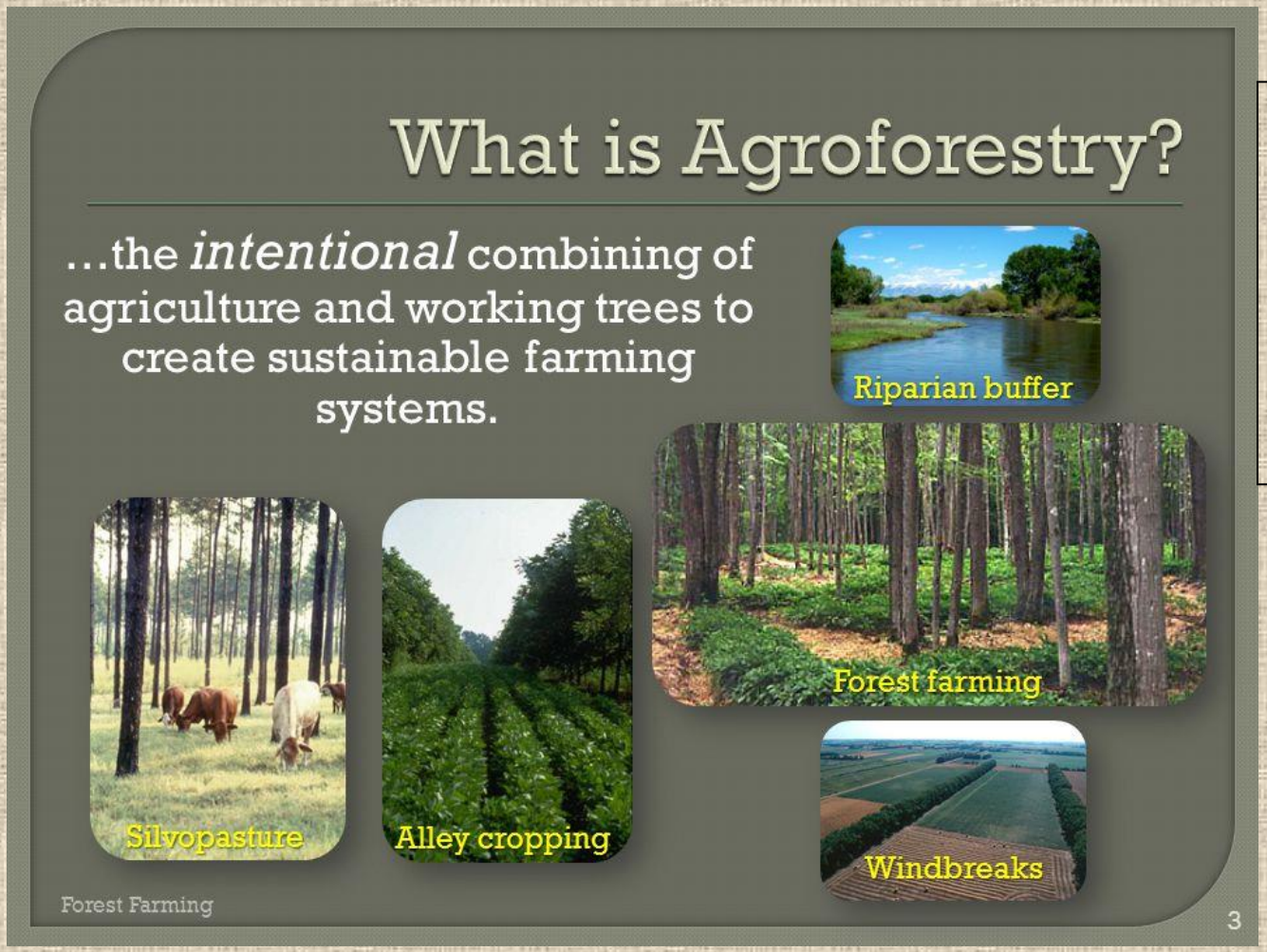


Environmental Agroecology: Polyculture Systems



http://www.slideshare.net/ElisaMendelsohn/intercropping-principles-and-production-practices

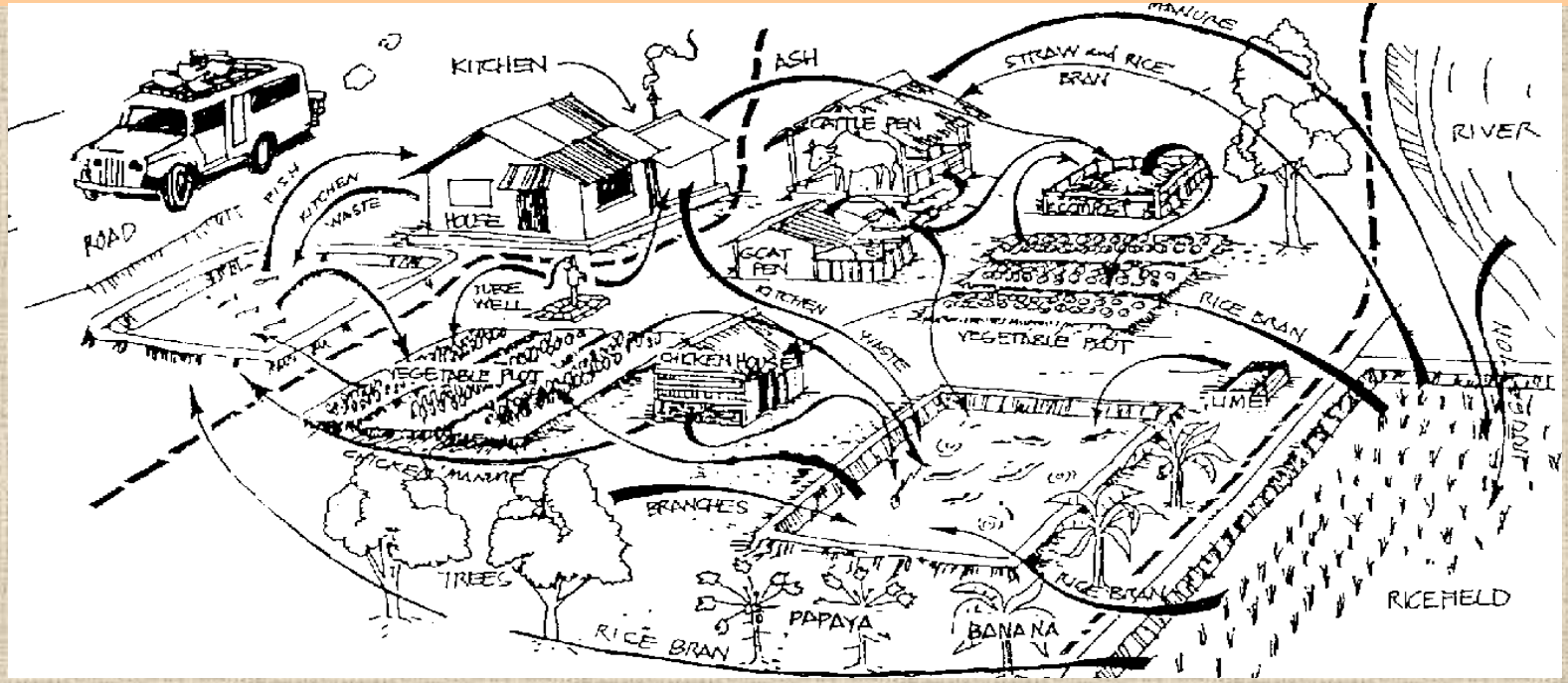
Environmental Agroecology: Agroforestry Systems



http://nac.unl.edu/

Watch videos at https://www.youtube.com/channel/UC9_rDWErZAXSqKuMewi70QA

Environmental Agroecology: Integrated Farm Systems



- Combining crop and livestock systems to:
  - maintain productivity
  - increase resource-efficiency
  - protect the environment
  - increase profitability

Watch the short video "Successful Small Scale Integrated Livestock Farm" – see https://www.youtube.com/watch?v=-8OrvLeUVl4

http://extension.oregonstate.edu/sorec/sites/default/files/Sustainable_Farming.pdf

Environmental Agroecology

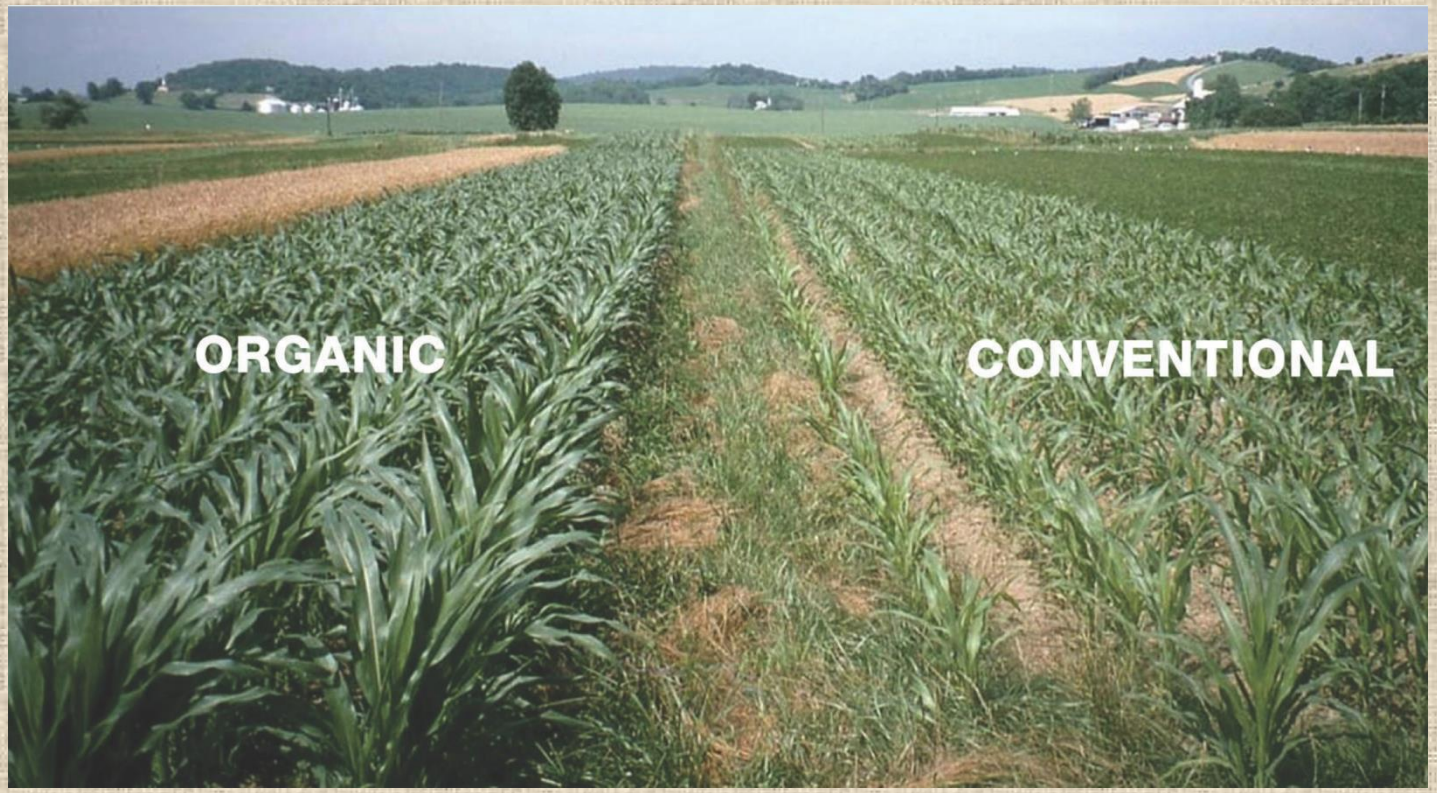
FARMSCAPING Example

- “Farmscaping” is a whole-farm approach for insect pest management & pollinator conservation.
- It can be defined as the use of hedgerows, insectary plants, cover crops, and water reservoirs to attract and support populations of beneficial organisms such as insects, bats, and birds of prey.

http://articles.extension.org/pages/18573/farmscaping:-making-use-of-natures-pest-management-services

Environmental Agroecology

Agroecosystem Resiliency



Watch the video “Using agroecological practices to enhance the resilience of organic farms to drought” – see https://www.youtube.com/watch?v=7N4z6S68wXA&t=64s

Agroecosystem Analysis

- Analyze both the immediate and future impacts of agroecosystem design and management so that we can identify the indicators in each system on which to focus the search for alternatives or solutions to problems
- Example emergent property indicators of agroecosystem sustainability
  - Energy flow
  - Nutrient cycling
  - Population regulation mechanisms
  - Resiliency to disturbance
  - Biodiversity conservation

Instructor Introduction
Robert Kluson, Ph.D.

- Academic background
  - M.S. degree in Agronomy at University of MD
  - Ph.D. program at Center for Agroecology and Sustainable Food Systems (CASFS), UC-Santa Cruz
    - Soil ecology of agroecosystems dissertation
    - Biointensive, double dug, raised bed market gardening
    - Mayan traditional agriculture & home gardens studies
    - Intercropping, organic farming, and agroforestry research
  - Researcher at University of Puerto Rico-Mayaguez Campus
    - Tropical, small scale agriculture
    - Biological nitrogen fixing crops and trees

CASFS Farm & Garden Training

Strip intercropping

Alley agroforestry

Instructor Introduction

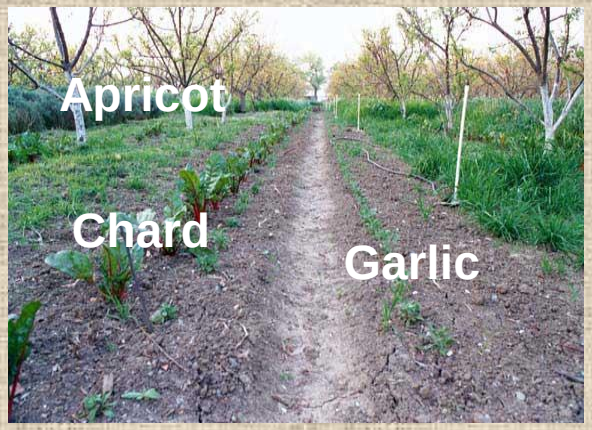
Robert Kluson, Ph.D.

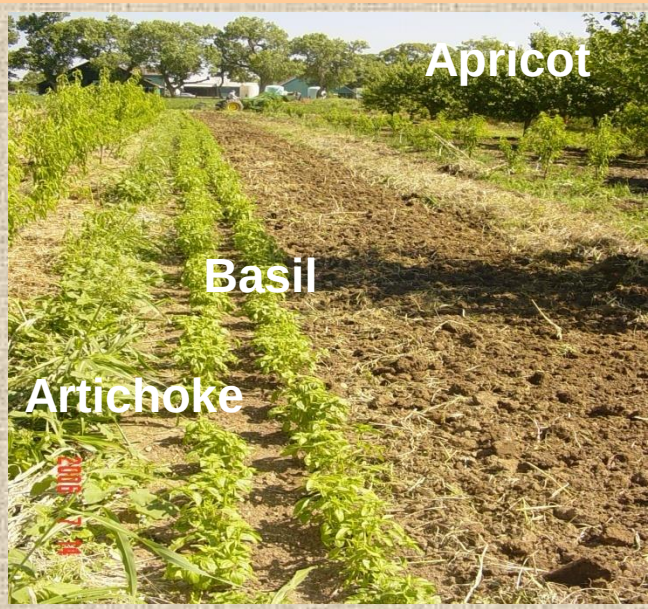
- Agroecosystem Farming Experience
  - Knoll Organic Farm, Brentwood, CA
    - 35+ years successful, small farm
    - 10 acres in size
    - growing over 50 cultivars of fruits, vegetables and herbs
    - using agroforestry-based methods of production
    - local direct marketing
    - I worked here part time for 5 years during my Ph.D. academic program

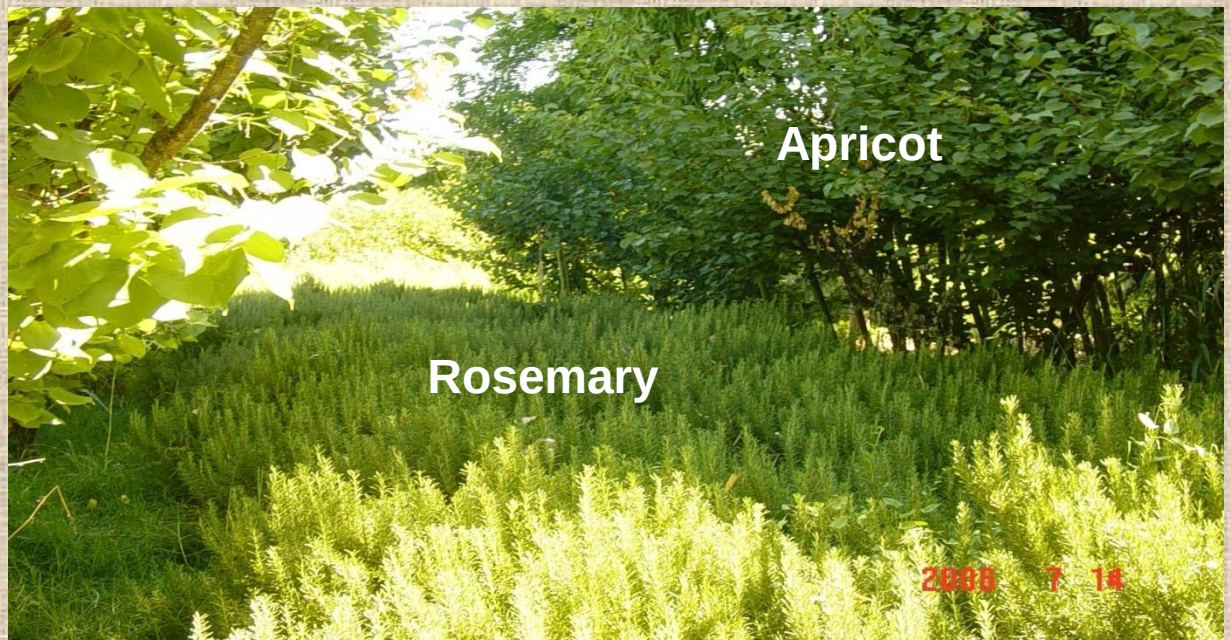
Rick & Christi Knoll

How Does The Knoll Farm Grow?

Agroforestry and Polyculture







How Does The Knoll Farm Grow?

Intensive Cover Cropping

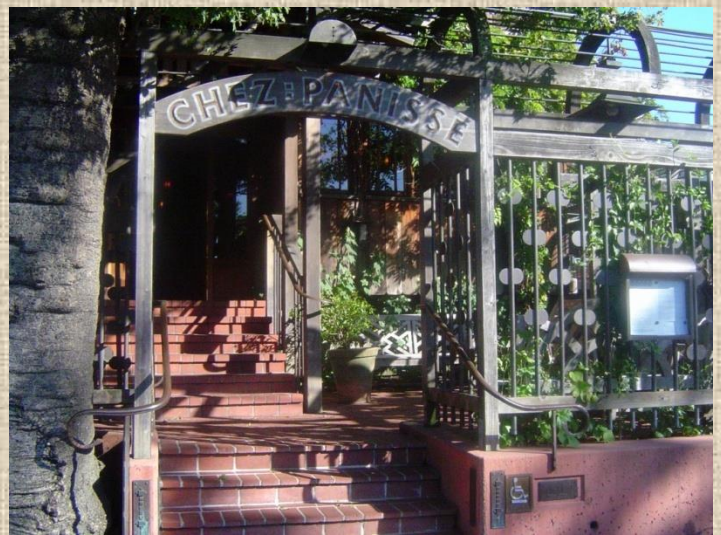
Soil “spading” – Not Conventional Tillage

Natural Pest Control

How Does The Knoll Farm Market?

Ferry Plaza Farmers Market,
San Francisco, CA

New Leaf Community Markets
Santa Cruz, CA



Chez Pannise Restaurant
Berkely, CA

References

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  - 2006. Agroecology:Ecological Processes in Sustainable Agriculture. Ann Arbor Press
  - 2015. Agroecology: The Ecology of Sustainable Food Systems. CRC Press
- Rosemeyer, M. 2003. History of Ecology, Environmental Movement and Agriculture – see http://www.authorstream.com/Presentation/aSGuest133316-1405300-history-of-ecology-the-environmental-movement-and-agriculture/
- Settle, W.H. 2001. Natural & Agro Ecosystems – see https://ic.ucsc.edu/~cshennan/envs130/ENVS130A003/index.htm
- University of Hawaii. Ecosystem Ecology History – see http://www.ctahr.hawaii.edu/littonc/PDFs/680_Lecture1-2.pdf

Online Resources

- AgriCultures Network – see http://www.agriculturesnetwork.org/
- Agroecology – see http://www.agroecology.org/
- AxiomNews. What Can Biomimicry Teach Our Systems? – see http://www.axiomnews.ca/news/3073
- Bedeaux, C & E.L. Ng. Ecosystem Resilience – see http://openlandscapes.zalf.de/OpenLandscapesWiki_Glossaries/Ecosystem%20resilience.aspx
- Center for Agroecology and Sustainable Food Systems – see http://casfs.ucsc.edu/
- Environment and Ecology. What is Agroecology? – see http://environment-ecology.com/what-is-ecology/296-what-is-agroecology.html
- Kerr Center for Sustainable Agriculture – see http://kerrcenter.com/
- Journal of Sustainable Agriculture. Agroecology as a Transdisciplinary, Participatory, and Action-Oriented Approach – see https://www.uvm.edu/.../MendezVEEtAl_AgroecologyTransdisiplinaryPARApproach...

Online Resources

- Lexicon of Sustainability. Agroecology Definition – see https://www.lexiconoffood.com/definition/definition-agroecology
- U.N.
  - FAO. International Symposium on Agroecology for Food Security and Nutrition – see http://www.fao.org/about/meetings/afns/en/
  - UNESCO. Sustainable Agriculture: Teaching and Learning for a Sustainable Future – see http://www.unesco.org/education/tlsf/mods/theme_c/mod15.html
- Youtube Videos
  - Community Agroecolology Network Shortcourse – see https://www.youtube.com/watch?v=LVXmxVLWW1E
  - Sustainable Farming through Agroecology – see https://www.youtube.com/watch?v=ObffHbRuJgc

Take Home Assignments

- Reading
  - "Agroecology and the Right to Food", Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49], 8 March 2011 – see http://www.srfood.org/en/report-agroecology-and-the-right-to-food
- Youtube Video
  - Sustainable Farming thru Agroecology" – see https://www.youtube.com/watch?v=ObffHbRuJgc&t=12s