Agroecology and Agroecosystems & Reality Cheques

Gliessman & Pretty

Current Problem:

- Modern agriculture has lost the balance needed for long-term sustainability
- Excess dependence on fossil fuels and external inputs
- Overusing and degrading the soil, water, and cultural resources

Sustainable Agriculture:

- Not an individual practice
- Discussions about it must go beyond what happens at any individual farm

Natural and Traditional Ecosystems

- Traditional Ecosystems:
  - Provide many examples of how a culture and its local environment have coevolved with processes that balance the needs of the people, expressed as ecological, and socio-economic factors.
  - Many traditional agroecosystems are very sophisticated examples of application of ecological knowledge.
- Natural Ecosystems:
  - Reference systems for understanding ecological basis for sustainability.
  - The greater structural and functional similarity of an agroecosystem to the natural ecosystem the greater likelihood the agroecosystem will be sustainable.

Farms as pools along a Stream

- Agriculture is a stream, with farms at different points along it (pools)
- Things flow into and away from each pool
- It becomes hard to control what comes into your pool from other areas
- "Upstream impacts" : labour availability and cost, market access for what is produced, legislated policies that determine water use, pesticide use etc. . .
- "Downstream impacts" : Soil erosion, groundwater depletion, inappropriate or inefficient use of pesticides and fertilizers.

Agroecosystem

- Definition must move beyond view of agriculture involving solely on increased yields and improved profit margins
- Instead: Practices and technologies evaluated on contributions to the overall sustainability of farm system, look at complex set of biological, physical, chemical, ecological and cultural interactions.
- Foundation of Agroecology:
  - Concept of the ecosystem:
    - 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.

Agroecosystem Continued

- System created when human manipulation and alteration of an ecosystem take place to establish agricultural production

- Changes result in qualities referred to as the emergent qualities or properties of systems.

- There are four key emergent qualities:
  - Energy Flow
  - Nutrient Cycling
  - Population regulating mechanisms
  - Dynamic Equilibrium

Emergent Qualities

- Energy Flow
  - Many sources of energy are derived from human-manufactgured sources and are most often not self-sustaining. Agroecosystem then becomes through-flow system with high levels of fossil fuel input and energy directed out of the system.
  - Biomass is then not allowed to accumulate in the system.
  - For sustainability: renewable sources of energy must be maximized (organic detritus returned to the soil serves as an energy source for micro-organisms that are essential for nutrient cycling)

Emergent Qualities

- Nutrient Cycling:
- Biomass productivity in natural ecosystems is linked to the annual rates at which nutrients are able to be recycled.

- Modern agriculture has come to rely upon nutrient inputs from petroleum-based sources to replace losses from the system with harvest or as a result of leaching or erosion from reduction of permanent biomass levels within the system.

- Sustainability: leaks be reduced to a minimum and recycling mechanisms be reintroduced and strengthened.
  - Find ways to return nutrients consumed in agricultural products back to the fields.

Emergent Qualities

- Population regulating Mechanisms:
- Combination of biotic interactions and limits set by availability of physical resources, population levels of organisms are controlled and eventually link to and determine productivity of ecosystem

- Sustainability: Requires reintroduction of diverse structures and species relationships that permit the functioning of natural control and regulation mechanisms.

Emergent Qualities

- Dynamic Equilibrium:
- Species richness/diversity of mature ecosystems allows some resistance to all but very damaging disturbances.
- System stability is fluctuating, and promotes establishment of equilibrium that functions on basis of sustained resource use that ecosystems can maintain indefinitely and shift if the environment changes.
- Overemphasis on maximizing harvest outputs upsets former equilibrium- leads to dependence on outside interference.

- Sustainability: emergent qualities of system resistance and resiliency must play a determining role in agroecosystem design and management.

agroecosystems. Agroecosystem properties are most appl
farm scale and for the short- to medium-term time frame

Emergent ecological property	Natural ecosystem	Agroecosystem type		
		Traditional	Conventional	Sustainable
Productivity (process)	medium	medium	low/med	med/high
Species diversity	high	med/high	low	medium
Structural diversity	high	med/high	low	medium
Functional diversity	high	med/high	low	med/high
Output stability	medium	high	low/med	high
Biomass accumulation	high	high	low	med/high
Nutrient recycling	high	high	low	high
Tropic relationships	high	high	low	med/high
Natural population regulation	high	high	low	med/high
Resistance	high	high	low	medium
Resilience	high	high	low	medium
Dependence on external human inputs	low	low	high	medium
Autonomy	high	high	low	high
Human displacement of ecological processes	low	low	high	low/med
Sustainability	high	med/high	low	high

Source: Modified from Odum (1984), Conway (1985), Altieri (1995), and Gliessman (1998)

Table 11.1 *Guiding principles for the process of conversion to sustainable agroecosystems design and management*

Shift from through-flow nutrient management to recycling of nutrients, with increased dependence on natural processes, such as biological N fixation and mycorrhizal relationships
Use renewable sources of energy instead of non-renewable sources
Eliminate the use of non-renewable off-farm human inputs that have the potential harm the environment or the health of farmers, farm workers or consumers
When materials must be added to the system, use naturally occurring materials instead of synthetic, manufactured inputs
Manage pests, diseases and weeds instead of 'controlling' them
Reestablish the biological relationships that can occur naturally on the farm instea of reducing and simplifying them
Make more appropriate matches between cropping patterns and the productive potential and physical limitations of the farm landscape
Use a strategy of adapting the biological and genetic potential of agricultural plan and animal species to the ecological conditions of the farm rather than modifying the farm to meet the needs of the crops and animals
Value most highly the overall health of the agroecosystem rather than the outcom of a particular crop system or season
Emphasize conservation of soil, water, energy and biological resources
Incorporate the idea of long-term sustainability into overall agroecosystem desig and management

urce: modified from Gliessman, 1998

- “We must first establish the ecological basis of sustainability in terms of resource use and conservation, including soil, water, genetic resources and air quality. Then we must examine the interactions among the many organisms of the agroecosystem, beginning with interactions at the individual species level and culminating at the ecosystem level as our understanding of the dynamics of the entire system is revealed.”

A Damaging Myth:

- Consumers expect cheap food
- Reality: We pay three times for our food- once at the till, once through taxes used to subsidise farmers and ag development, and once to clean up the environmental and health side-effects.
- It appears cheap because of costs being hidden:
  - Damage caused to environment by certain systems of ag.
  - Damage to human health by certain systems of ag.

Industrialized Systems Vs. Sustainable systems

- Add up real costs of producing food and:
  - Modern industrialized systems of production perform poorly in comparison with sustainable systems.

History of Support for Sustainability

- 1945: “to farm properly you have got to maintain soil fertility; to maintain soil fertility you need a mixed farming system”. (Astor and Rowntree review of Ag)
- However some called for a ‘specialized and mechanized farming”
  - Subsidies to encourage increases in food production took precedence/more easily applied to simplified systems
  - 1947 Agriculture act : modern simplified agriculture, stepped away from farming valuing nature’s assets.

Five Types of Assets- Show Agriculture's Multifunctionality

- Natural Capital: Produces nature's goods and services, comprises food farmed and harvested or caught from the wild.
- Social Capital: yields a flow of mutually beneficial collective action, contributing to the cohesiveness of people in their societies. Assets: values and attitudes, relations of trust, reciprocity and obligations…
- Human Capital: total capability residing in indiviudals based on stock of knowledge skills, health and nutrition.
- Physical Capital: store of human made material resources.
- Financial capital: accounting concept, serves as facilitating role.

Sustainable Agriculture Systems

- Have a positive effect on multiple forms of capital:
  - Diverse agricultural system enhances on-farm wildlife for pest control contributes to wider stocks of biodiversity- simplified modernized systems do not.
  - Sustainable agriculture also contributes to: clean water, wildlife, carbon sequestration in soils, flood protection and landscape quality.

Externalities

- Costs of using environment are called externalities.
- They are side effects of economic activity, external to markets so- costs are not part of the prices paid by producers or consumers.
- When these costs are not included in prices- distorts the market by encouraging activities that are costly to society even if the private benefits are substantial.

Studies done on Externalities

- Negative externalities of Agriculture have been studied in China, Germany, the Netherlands, the Philippines, the UK and the US.
- Philippines: modern rice cultivation was costly to human health. Investigated health status of rice farmers exposed to pesticides, and estimated monetary costs of significantly increased health problems.
- Found: modern, high pesticide systems suffer twice, returned less per hectare than the integrated pest management strategies, and cost the most in terms of health. Any positive production benefits of applying pesticides were overwhelmed by the health costs.