

Ecological Processes in Sustainable Agriculture

AGROECOLOGY

AGRICULTURE IS IN CRISIS



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Akibat budidaya tanaman yang salah



Kualitas air sungai menurun



What is agroecology?

- Agroecology is
 - a scientific discipline that uses **ecological** theory to study, design, manage and evaluate **agricultural systems** that are productive but also resource conserving
 - concerned with the maintenance of a productive agriculture that sustains yields and optimizes the use of local resources while minimizing the negative environmental and socio-economic impacts of modern technologies..

Agroecology

Science, technology, object, goal & motivation

Gliesman 2000:

"The application of **ecological concepts and principles** to the **design and management** of **sustainable farming systems**"

Understanding (Science)

Practice (Technology)

Object

Limited to a subset of farming systems (i.e., not the unsustainable ones)

Goal and Motivation

What is sustainability?

How does sustainability vary?

What makes a farming system sustainable?

Is sustainability always attainable?

- ◎ The science of agroecology, which is defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems, provides a framework to assess the complexity of agroecosystems (Altieri, 1995).

Table 1. Ecological processes to optimize in agroecosystems

- Strengthen the immune system (proper functioning of natural pest control).
- Decrease toxicity through elimination of agrochemicals.
- Optimize metabolic function (organic matter decomposition and nutrient cycling).
- Balance regulatory systems (nutrient cycles, water balance, energy flow, population regulation, etc.).
- Enhance conservation and regeneration of soil-water resources and biodiversity.
- Increase and sustain long-term productivity.

Table 2. Mechanisms to improve agroecosystems immunity

- Increase of plant species and genetic diversity in time and space.
- Enhancement of functional biodiversity (natural enemies, antagonists, etc.).
- Enhancement of soil organic matter and biological ability.
- Elimination of toxic inputs and residues.

Ekologi Pertanian

- ◎ Ekologi = ilmu yg mempelajari hubungan antar makhluk hidup, dan hubungan antar makhluk hidup dengan lingkungannya.
- ◎ Ekologi Pertanian = ilmu yang mempelajari sistem pertanian dengan menggunakan kaidah-kaidah ekologi.
- ◎ Tujuan ekologi pertanian adalah : mempelajari sistem pertanian dengan menggunakan kaidah-kaidah ekologi sehingga penerapan teknologi pertanian tidak merusak lingkungan.
- ◎ Mengapa hal itu perlu dilakukan?

Perkembangan Pertanian dari jaman kuno - sekarang

◎ Pertanian kuno (purba) :

- ▶ mengambil hasil pertanian tanpa menanam
- ▶ menanam di lahan sempit secara sederhana
- ▶ pertanian ladang berpindah (*shifting cultivation*)
- ▶ berpindah tempat baru jika hasil tanaman sudah turun
- ▶ kembali ke tempat semula setelah 7-10 putaran
- ▶ teknologi masih sederhana
- ▶ hasil untuk keluarga (subsisten)

◎ Pertanian tradisional :

- ▶ pertanian dengan sistem menetap
- ▶ pengolahan tanah dengan tenaga manusia/hewan,
- ▶ bibit menggunakan jenis lokal,
- ▶ pemupukan dengan pupuk organik,
- ▶ pengairan sistem tadah hujan,
- ▶ pengendalian hama penyakit secara manual
- ▶ rasa padi enak
- ▶ hasil panen yg baik dipilih untuk bibit
- ▶ Hasil padi rendah
- ▶ Umur tanaman lama (± 6 bulan)
- ▶ Bibit lokal rentan serangan hama/penyakit



◎ **Pertanian modern (revolusi hijau) :**

- pengolahan tanah secara mekanik (mesin) → sewa
- bibit unggul hasil persilangan buatan
- bibit selalu beli, dan butuh unsur hara tinggi
- penggunaan pupuk an organik (buatan pabrik)
- tanah sawah kekurangan bahan organik
- pencemaran tanah, air dan udara



- pengairan sistem irigasi
- pengendalian hama/ penyakit secara rutin pakai pestisida buatan
- penggunaan hormon tumbuh
- makhluk hidup bukan sasaran mati
- ledakan hama sekunder
- polusi pestisida ke tanah dan air



◎ **Pertanian sehat (sustainable agriculture):**

- menggunakan prinsip-prinsip ekologis
- penurunan penggunaan pupuk buatan dan memberikan pupuk organik
- penggunaan pestisida organik
- pengendalian HPT secara terpadu



Ecological principles

1. Enhance recycling of biomass and optimizing nutrient availability and balancing nutrient flow.
2. Securing favorable soil conditions for plant growth, particularly by managing organic matter and enhancing soil biotic activity.
3. Minimizing losses due to flows of solar radiation, air and water by way of microclimate management, water harvesting and soil management through increased soil cover.
4. Species and genetic diversification of the agroecosystem in time and space.
5. Enhance beneficial biological interactions and synergisms among agrobiodiversity components thus resulting in the promotion of key ecological processes and services

Characteristics	Agroecosystem	Natural Ecosystem
Productivity	High	Low
Species diversity	Low (monoculture)— can use crop rotation and intercropping to stabilize more	High
Genetic diversity within species	Low	High
Plant life-cycles present	Few	All, more perennial
Competition	Negative	Tolerable (ecological niche)
Flowering, plant maturing	Synchronized	Seasonal
Nutrient Cycles	Open	Closed
Permanence	Short	Long
Human Control	High	Low
Ecological Maturity	Early, immature	Mature, climax

Sistem Pertanian Konvensional di Indonesia

- Pertanian Konvensional:
- Maksimal produksi
- Maksimal profit

↓

Tanpa memperhatikan konsekuensi jangka panjang dan dinamika ekologi dari sistem pertanian

Praktek-praktek dasar pertanian konvensional

- 🗑️ Pengolahan tanah intensif (Intensive tillage)
- 🗑️ Monokultur
- 🗑️ Pemupukan anorganik
- 🗑️ Penggunaan pestisida kimia sintetik
- 🗑️ Manipulasi genetik (genetic manipulation)

Why Conventional Agriculture Is Not Sustainable ?

- 🗑️ Soil Degradation
- 🗑️ Waste and Overuse of Water
- 🗑️ Pollution of the Environment
- 🗑️ Dependence on External Inputs
- 🗑️ Loss of Genetic Diversity
- 🗑️ Loss of Local Control over Agric. Production

Toward Sustainability

- ⦿ Sustainability is achieved through alternative agriculture practices informed by indepth knowledge of the ecological processes occurring in farm fields



AGROECOLOGY

Sistem pertanian seperti apa yang dibutuhkan?



Soal:

- ⦿ 1. Jelaskan tentang sistem pertanian konvensional
- ⦿ 2. Jelaskan mengapa sistem pertanian konvensional tidak sustainable dan bagaimana solusinya

Tugas untuk mahasiswa:

- ⦿ Mencari kasus kebutuhan Sistem Produksi Pangan yang berkelanjutan.
- ⦿ Mencari kasus kerusakan lingkungan pertanian dalam kaitan dengan sistem pertanian konvensional