

Knowledge Assessment and Sharing on Sustainable Agriculture

KASSA

Which future for conservation agriculture?

What we know, and what we need to know

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« Agriculture
raisonnée »

Evergreen
revolution

Viable agriculture

Minimum tillage

Doubly
green
revolution

**Sustainable
agriculture**

No tillage

**Conservation
agriculture**

Direct sowing- Mulch
based – Cover
cropping agriculture

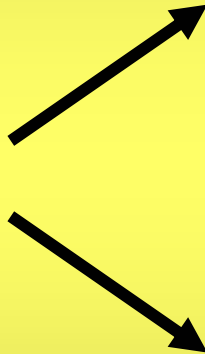
Ecoagriculture

?

Costanza : Ecosystem services (1997)

- 1 Gas regulation
- 2 Climate regulation
- 3 Disturbance regulation
- 4 Water regulation
- 5 Water supply
- 6 Erosion control
- 7 Soil formation
- 8 Nutrient cycling
- 9 Waste treatment
- 10 Pollination
- 11 Biological control
- 12 Habitat / refugia
- 13 Food production
- 14 Raw materials
- 15 Genetic resources
- 16 Recreation
- 17 Cultural

**Ecosystem
functions**



**Ecosystem
products**

**Ecosystem
services**

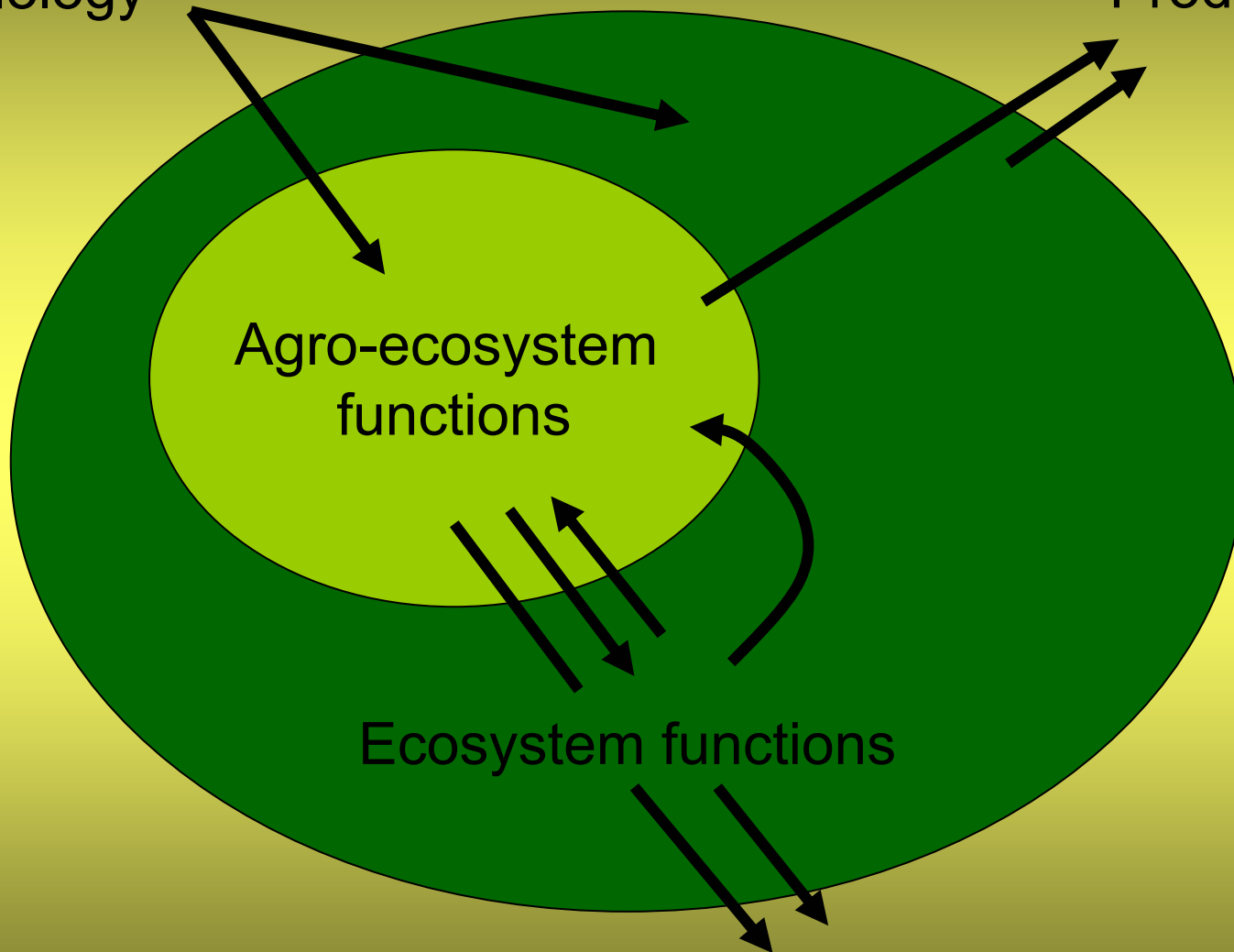
Agricultural
technology

Products

Agro-ecosystem
functions

Ecosystem functions

Services



Examples of relations Technology – Agroecosystem functions – Ecosystem functions – Products – services - externalities

Agricultural technology	Agro ecosystem functions	Ecosystem functions	Ecosystem products	Ecosystem services	Negative Externalities
Mineral and organic fertilization	Soil fertility	Soil chemical and biological kinetics	Biomass	Soil formation Nutrient cycling	Emission of pollutants
Soil tillage (or not)	Soil structure Soil biology and ecology	Water regulation Water supply Water quality Erosion Local climate	Biomass	Soil formation Water supply and regulation Global /local climate change Biodiversity	Erosion Greenh. G. Rain / Drough Floods Biodiv losses
Phytosanitary control	Crop protection	Pathosystem regulation Biodiversity	Biomass	Pollination Biological balance and biodiversity	Imbalances Invasions Biodiv Losses
Irrigation Drainage	Water availability	Water regulation	Biomass	Water availability	Waterlogging Salination

So, (sustainable) conservation agriculture,
(in a wide sense)...

- produces food, fiber, materials (goods)
- and marketable services ,
- trying to reduce / eliminate negative externalities (environment impact),
- and maximize the provision of (positive) services (public goods).

Back to the question...

What do we know?
What do we need to know?
(in terms of generic knowledge)

- What we know

- What we need to know

Soil fertility

- Biomass **mulches** /residues (where it is possible) contribute to **C accumulation**, and to **activation of biological trophic nets** in the soil, leading to mineral supply
- Use of **legumes** crops provides N to the system
- Use of **P** microbial symbiosis
- **Very few knowledge on soil biology and potential capacities** (fungus, termites, worms, arthropods, bacteria...)
- **Symbiosis**

Soil fertility

- Soils have diverse capacities in P, K and micronutrient supply
- Nutrient cycling
- **Pedogenesis** future capacities
- Explore plants pumping capacities...
- and optimization of plant efficient use of minerals
- Optimization of cycling, and reduction of losses

Soil fertility

- Role of living **covers**
 - to reduce erosion,
 - for water storage,
 - N provision,
 - to reduce weeds,
 - as pasture
 - ...
- Role of trees in **agroforestry** cropping systems
- Explore living covers for diversification
- Explore introduction in rotations
- Explore tree possibilities (legume trees, rotations,...)

Soil fertility – waste management

- Urban waste and agro industry waste are not optimally used
- Explore **compost production optimization** for highly biological peri-urban agriculture (generalization in large regions of Asia)
- Dangers of metal accumulation in soils
- Explore bioremediation

Soil structure

- Living or dead covers improve soil structure (moisture, aggregates, presence of biodegrading fauna...)
- Optimization and rapidity of **soil structure rehabilitation** (recovering - remediation) in relation with mineral and biological status

Weed control

- Role of cover crops and mulches
- Role of crop rotations
- Role of allelopathia
- More **experimentation** of diverse solutions in terms of cover crops and rotations
- **Understand biological mechanisms** (genomics) and explore possibilities of molecule synthesis and transgenesis?

Pest control

- Sensitivity to **fungus** could be reduced with covers
- Fungus play an important role in biomass first steps of degradation
- Explore role of covers
- **Plant resistance**
- Explore more **mixed varieties**

Pest control

- **Insects** swarmings are controlled using IPM
- Role of covers and mulches in reducing crop fragility and sensitivity to attacks
- Crop rotations
- **Lack of basic knowledge for integrated pest management**

Pest control

- Bacteria
- Virus
- ...
- Invest in IPM; lack of basic knowledge on the biology and ecology (epidemiology) of pests.

Water control (supply)

- Role of covers on water storage and infiltration / flow
- Role of trees and landscape roughness
- **Experimentation** in very diverse situations (soils, slopes, ...)
- Lack of **ecological engineering** knowledge and experimentation in **watershed management**

Water quality control

- Role of covers and landscape roughness in water filtration
- Lack of **experimentation** particularly for recycling waste waters
- Reduce N and P lixiviation and losses / pollutions
- Experimentation / observatories

Mixed cropping - associations

- Role in integrated pest management
- Role in weed management
- Role of biodiversity on biomass productivity (eg prairies)
- Lack of research on **crop compatibility**,
- in plant **breeding** (ripeness homogeneity, size,...)
- on mechanization.

Crop rotations

- Multifunctional role on fertility, soil structure, weed and pest management...
- Widen the number of possibilities
- Explore policy measures for diversification

Plant breeding

- Local varieties adapted to local conditions /
- Standard varieties not adapted to local conditions
- Use marker assisted plant breeding and modern biotech to improve rapidly local adapted varieties in terms of yields.

Local climate regulation

- Role of albedo change resulting from landscape change on local climate: local drought, rain intensity and erosion, ...
- Lack of knowledge on local climate disturbance resulting from landscape change.

Carbon sequestration

- Role of mulches and covers, and agroforestry on C sequestration
- Lack of knowledge on **C balance** in Carbon intensified agro-ecosystems.

Biodiversity contribution (intraspecific)

- Role of intraspecific diversity for
 - Pest management
 - Crop pest resistance
 - Soil recovering (eg worms)
- Very few knowledge
- Research needed

Biodiversity contribution (interspecific)

- Role of interspecific diversity for ecosystem resilience
 - Integrated pest management
 - Mixed cropping
- Experimentation needed in diverse situations

Biodiversity contribution (landscape)

- Role of landscape diversity in
 - Reduction of pest and disease dissemination
 - General ecological resilience
 - Cultural / recreation
- Almost no research

Policy accompaniment

- Existence of agricultural adverse policies (as well as subsidizing)
- Difficulties in transition costs
- Debate on recognition of the public good provision character of agriculture
- Research on policy alternatives
- Studies on alleviation of **transition costs**
- Research on **theoretical and ethical basis of public good provision** economics
- Macro economics and **impact studies**

Policy accompaniment

- Conservation and no tillage agriculture adopted in big farms, Cairns group countries, cereal – soybean production / few cases for family small agriculture (except gangetic plain) and the poor.
- Research on **economic – social – cultural drivers** to use CA as a solution for small and poor agriculture.
- Research on **micro economics** of CA

Policy accompaniment

- Oil price and energy prices increase would be an incentive to CA (reduced costs)
- Consumer requirements and standard evolution (health)
- Studies on consequences on:
 - Biofuel production
 - Wood production?
 - Food prices?
- Studies on the new environmental (and policy) constraints

Policy accompaniment

- Time flexibility and leisure allowed by CA
- Role of CA on human health?
- Studies on new kinds of agriculture (part time, large farms, high productivity...)
- Human health positive externalities to be studied.

General and generic

- Role of complex systems and biodiversity on resilience
- Difficulties to manage complex systems
- How to convince 1,3 billion ag producers to switch?
- Research on **modeling** complex systems
- Research on **management of complex systems**
- **Research on policy** basis: inciting, negotiation, public decision efficiency
- **Training**

Some science priorities

- Functional ecology
- Population ecology
- Genomics (structural, proteomics)
- Economics – policy economic and human sciences
- Complexity sciences
- and inter disciplinaryity