Impacts of farming activities on the environment and agricultural landscape - importance of organic farming

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Agriculture and landscape

- Agriculture – sector with areal scope

- Most common anthropogenic activity

- Natural ecosystems are directly and indirectly changed by agriculture – need of sustainable agricultural systems

- Positive and negative externalities of agriculture
Changes in agricultural landscape

• In last 50 years the changes are faster and more intensive than in any previous historical period.

• Between years 1945 – 2010 higher share of natural landscape was transformed into agricultural landscape, than in 18th and 19th century together.

• Impact of agriculture on environment is increasing.
Changes in agricultural landscape

• Agroecosystems are currently the largest kind of terrestrial biom

• Ca. 35% of continents is covered by agricultural activities
  – 11% - Agricultural land
  – 24% - Areas used for grazing
Agricultural landscape – environmental aspects
Agriculture – environmental aspects

- Landscape – comprise of different areas of environment:
  - Biodiversity
  - Soil
  - Water
  - Air
Biodiversity

- Biodiversity
  - The diversity of species communities of living organisms

- Agrobiodiversity
  - The diversity of species communities of living organisms in agricultural ecosystems
  - The diversity of species communities of living organisms straight connected on agricultural ecosystems
Diversity and problems of agricultural landscape

• Expansion of agricultural land and intensification of agriculture have strong impact on natural and semi-natural habitats (e.g. Wetlands, natural meadows, forests...):

  – Direct change of natural habitats to agricultural habitats

  – Intensification of inputs in agroecosystems
Diversity and problems of agricultural landscape

• Conversion of natural ecosystems into agricultural land still continues and will continue with growing world population

• In last 100 years 850 000 000 ha of natural ecosystems was changed into agricultural (deforestation, drainage of wetlands...)

• Strong negative impact on environment – losses of animal and plant species
Diversity and problems of agricultural landscape

• Losses of semi-natural areas and elements in agricultural landscape
  – In Czech Republic between 1948 – 1990 decrease of scattered natural vegetation in agricultural landscape from 2-3% to 0,5-0,7%
  – In GB loss of 95% of richly diverse meadows, 192 000 km of Hedges

• Loses of natural habitats and whole ecosystems
  – Rain forests in Amazonia
  – Deforestation in south-east Asia
Diversity and problems of agricultural landscape

• Intensive crop varieties are grewed on significant share of agricultural land
  – Positive impact:
    • Increase of production
    • Decreasing of pressure on natural habitats
  
  – Negative impacts:
    • Decrease of biodiversity and agrobiodiversity
    • Reduction of ecosystem services provided by biodiversity
Diversity and problems of agricultural landscape

• World genetic diversity in plant production
  – Only 150 crop species from huge total amount of usable crops is important from economical point of view
  – Only 103 crop species consists 90% of world food production
  – Only 4 crops (rice, wheat, maize and soybeans) provides ca. 70% of caloric consumption of world population
Diversity and problems of agricultural landscape

• Genetic uniformity in crop production increased during 20th century
  – 56 % of acreage of soyabean, 71 % of acreage of maise, 41 % of acreage of wheat is covered by 6 varieties/hybrids
  – Losses in diversity of varieties reach up to 90% during last 150 years
    • E.g. USA – decrease of varieties diversity of apples by 86 % (from original more than 7 000 varieties) and pears by 88 % (from original 2683 varieties)
Diversity and problems of agricultural landscape

• Problems of homogeneous varietes:

  – Higher risk of pest infestations
  – Increase of need of intensive chemical protection
    • negative impact on biodiversity and organisms with positive influence on soil quality, fertility, crop yields, etc.
    • Increasing of costs
    • Decreasing of productivity and efectivity of whole system
Diversity and problems of agricultural landscape

- Reduction of field „accompanying“ flora
- 100 spieces of non-curtual plant species in agroecosystems = space for up to 1200 species of fauna representants
- Liquidation of field „accompanying“ flora (typical for intensive farming systems) leads to strong decrease of biodiversity
- Intensive usage of insectids against pests have negative impact also on other species
Diversity and problems of agricultural landscape

• Alternatives for intensive agriculture

  – Systems protecting landscape, biodiversity and agrobiodiversity, with smaller demands on external inputs

  – Sustainable farming systems

  – Organic farming
Protection of landscape and environment in agriculture

- Organic farmers are usually active in environment and landscape protection
- Protection of environment is one of main goals of organic farming
- Balance between farming and protection of environment
  - Coexistence of ecosystems and agroecosystems
- Usage of preventive methods in production, support of biodiversity
Positive impacts of biodiversity on farming systems

• Plant protection

• Preventive and cheap tool for protection against weeds

• Semi-natural elements in agricultural landscape helps with reduction of pests
Positive impacts of biodiversity on farming systems

Parasitation of *Pieris napi* by *Cotesia rubecula*

<table>
<thead>
<tr>
<th>Distance from landscape element</th>
<th>Parasitation (%)</th>
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<tbody>
<tr>
<td>0-5 m</td>
<td>65%</td>
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<tr>
<td>10 m</td>
<td>57%</td>
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<tr>
<td>100 m</td>
<td>5%</td>
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</table>
Soil
• Intensive farming is unsustainable
• Strong intensification leads to degradation of soils
  – 38 % of agricultural soils was damaged by agricultural activities between 1945 – 1990 and this trend continues
  – Main damages of soils are caused by erosion
  – In Czech Republic ca. 40 % of agricultural land is affected by erosion
  – In Europe ca. 33 000 000 ha is damaged by soil concretion
  – In Czech Republic ca. 45 % of agricultural land is affected by concretion
Agriculture and soil

- Keeping erosion on acceptable level – goal of sustainable agriculture

- 1 t soil/ha is created per year

- Loss of 1-4 t of soil/ha – normative in Czech Republic

- Real loss in intensive agricultural systems up to 40 t of soil/ha
Positive changes within organic farming

• Soil protection in organic farming:
  
  – Diversification of crop rotations
  – Usage of cover crops and intercropping
  – Smaller land blocks
  – Creation of landscape elements
    • Influence against water and wind erosion
    • Effect against wind erosion 17x the height of landscape element
    • Other positive aspects (biodiversity, landscape quality...)

Influence against water and wind erosion
Positive changes within organic farming

- Soil organic matter (up to 30% higher organic carbon content)
- Increased soil biological activity (by 30-100 %), biomass decomposition indicator
- Higher total edaphon biomass (by 50-80 %)
- Higher saprophytic fungi abundance, higher root colonization by mycorrhiza
- More efficient use of acceptable resources by soil microorganisms
- Improved physical and chemical soil properties, soil structure
- Improved hydroscopicity and erosion threat reduction
Water
Agriculture and water

• Influence of agriculture on water regime is enormous

• In many countries the water is used in agriculture faster, than it can be restored from natural sources

• Ca. 66 % of water used by people is used in agriculture

• Intensive farming causes water pollution mainly by usage of pesticides and mineral fertilizers
Positive changes within organic farming

• Respecting of local condition affects the crop selection and decrease the need of irrigation

• Organic farmers fertilize the soil in such way so not to pollute groundwater (usage of manure and liquid manure)

• Green manure also used and legumes are properly incorporated into the crop rotation – reduction of the leaching of nitrogen into groundwater

• Due to wider crop rotations the soil structure in organic farming provide better infiltration.
Positive changes within organic farming

• In 40 scientific publication comparing nitrate leaching or a leaching potential analysed by [Haas, Berg, Köpke, 2002]

  – twenty eight stated lower values within the organic farming system

  – nine issued comparable data

  – only in three cases, the nitrate leaching respectively its potential were higher within organic farming than in conventional one
Air quality
Agriculture and air quality

• Due to its large area impact, agriculture belongs to the largest producers of greenhouse gases emissions after industry, mining and transport

• Organic farming produce less greenhouse gas emissions as compared to conventional intensive farming systems
Main anthropogenic emissions – EU
(Svendsen 2011)

Main sources of anthropogenic emissions in EU

<table>
<thead>
<tr>
<th>Category</th>
<th>Share on total anthropogenic emissions (%)</th>
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<tbody>
<tr>
<td>Energetics</td>
<td>28%</td>
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<tr>
<td>Transport</td>
<td>19%</td>
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<tr>
<td>Industry</td>
<td>13%</td>
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<tr>
<td>Agriculture</td>
<td>8%</td>
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Agriculture and greenhouse gases emission - CZ

- Anthropogenic emissions in Czech Republic – energetics, industry, agriculture
- Emissions from agriculture 6.4% (Miňovský et al., 2013)
- Main emissions from animal production (cattle)
- Emissions from plant production are important due to high area impact
Greenhouse gases emissions from agriculture – evaluation methods

• Methods:
  – LCA (Life Cycle Assessment)
  – EF (Ecological Footprint)
  – EA (Emergy Analysis)

• All methods useful for agriculture

• LCA – Life cycle assessment – collection and evaluation of inputs, outputs and possible impacts of production system on environment during life cycle of product
Life cycle assessment (LCA)

• Setting of frame of analysis
  – Important moment of LCA – influence on outputs
  – Pre-farm, farm, post-farem phase

• Functional unit
  – Simply measurable and expressibel
  – Production unit
  – Area unit

• Alocation – Distribution of environmental impacts of one process among the process outputs (products)
LCA – setting of frame
Emissions from plant production in Czech Republic

• Local data from farmers

• Software SIMA PRO

• Setting of production methods and chains
  – Specification of usual methods in organic and conventional farming in Czech Republic

• Modification in ECOINVENT database
  – Modification of partial inputs according to practice in Czech Republic
Emissions from plant production in Czech Republic

- Selected groups of crops
- Emissions from farm phase
- Sub-groups
  - Agrotechnics
  - Fertilizers
  - Pesticides
  - Seeds
  - Field emissions

\[(\text{CO}_2e = 1 \times \text{CO}_2 + 23 \times \text{CH}_4 + 298 \times \text{N}_2\text{O})\]
CO$_{2\text{e}}$ emissions from farm phase

CO$_{2\text{e}}$ - emissions from agriculture CZ

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<thead>
<tr>
<th>Crop</th>
<th>Conventional</th>
<th>Organic</th>
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<tr>
<td>WHEAT</td>
<td>0.50</td>
<td>0.40</td>
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<tr>
<td>RYE</td>
<td>0.30</td>
<td>0.20</td>
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<td>POTATOES</td>
<td>0.10</td>
<td>0.05</td>
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<td>ONION</td>
<td>0.05</td>
<td>0.02</td>
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<td>CARROT</td>
<td>0.02</td>
<td>0.01</td>
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<td>TOMATOES</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
<td>CABBAGE</td>
<td>0.01</td>
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Legend:
- agrotechnical operations
- fertilizers
- pesticides
- seeds
- field emissions
CO$_{2}$e emissions from farm phase
CO$_2$e emissions from farm and post-farm phase

CO$_2$e - emissions from potatoes products - CZ

- Processing
- Trade
- Agriculture

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<td>Potatoes</td>
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<td>Pelled potatoes</td>
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<td>Mashed potatoes</td>
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Impacts of organic production

• Organic products are usually more expensive, than conventional

• Product price – main selection criterium for most of the consumers

• Selling price vs. Real value of products
Impacts of organic production

- Real price of products

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<tr>
<th>Infrastructure</th>
<th>Socio-economical costs</th>
<th>Health costs</th>
<th>Environmental costs</th>
<th>Selling price</th>
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Thank you for attention

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