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
Agriculture and landscape

• Cultural landscape

  – Landscape formed by nature factors and by anthropogenic activities

  – Increasing intensity of usage of natural resources affects the entire land area

  – Increasing share of cultural landscape
Agriculture and landscape

• Factors contributing to changes in landscape
  • Agriculture – one of oldest and most important anthropogenic activities
  • Forestry and wood industry
  • Fishery (ponds)
  • Food production
  • Industry
  • Energetics
  • Transport
  • Mining and quarrying
Agriculture and landscape

• The most significant anthropogenic changes in the landscape:
  • Vegetation character
  • Structure, layout and architectural features of rural settlements and homesteads
  • Specific buildings
  • Formation of infrastructure
  • Land parceling
  • Changes in water regime
  • Changes in soil quality
  • Micro and mezoclimatic changes
Agriculture and landscape

• Landscape is changed in each historical period
  – Creation of specific landscape matrix
• Landscape matrix - specific arrangement of land use (fields, vineyards, orchards, forests, ponds, lakes, settlements...)
• In time the arrangement of land use is changed
  – Changes in landscape look
  – Specific landscape elements can be preserved (mapping of landscape history)
Evaluation of landscape

- Landscape evaluation summarizes a wide scale of different professional views

- Subjective and objective components of evaluation
  - Objective components (share of grasslands, number of specific landscape elements) can be calculated and proven by statistical methods
  - Subjective components (harmony, landscape value) depend on evaluator

- Subjective and objective components of evaluation have identical value and importance
Perception of landscape

- Landscape is perceived by humans in last ca. 600 years only
- Middle ages – landscape is place, region (physical reality)
- 15. century – landscape is unimportant background
- 16. century – landscape is „picture“
- 17. century – landscape is complex unit (beginning of scientifical perception of landscape)
- 20. century – landscape is system
Perception of landscape

Cave paintings ca. 3000 b.c.

Mosaic floor in Rome 4. - 5. century

Evangeliar of Oto III of Reichenau ca.10. century
Perception of landscape

St. Jerome by Master Theodoric – ca. 1365

Leonardo da Vinci - Mona Lisa 1503-06
Perception of landscape

Rembrandt Van Rijn – Landscape with stone bridge  ca. 1638

Claude Monet, wild poppies, 19-20. century

Karel Kupka – Landscape, presence
Perception of landscape

Annunciation
1308-1311 Duccio Di Buoninsegna

1350 – Anonym
Perception of landscape

1398 – Melichor Broederlam

1435 – Rogier Van Den Weyden
Perception of landscape

1472-1475 - Leonardo Da Vinci

1489-1490 – Sandro Botticelli

1520-1530 – Andrea Del Sarto
Perception of landscape

• Readability of landscape
  – Where I am?
  – When I am here?
  – How long we are here?

• Readability on different level – different indicators (from biodiversity species – to land use)

• The more information you can read from the landscape, the better quality landscape have
Doplnit pár fotek k "Čitelnosti"
Changes in landscape and historical development
Agriculture and landscape

• One of the oldest anthropogenic activities

• In Europe landscape is changed by agricultural activities almost 8000 years

• Strong impact on landscape character and functions

• With growing population and increasing demands on production, impact of agriculture is increasing
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
Changes in agricultural landscape
Changes in agricultural landscape

• Largest agricultural bioms:
  – South-east and south Asia
  – South America
  – Eurasia and North America
  – Surroundings of large lakes in Africa
Changes in agricultural landscape in Europe

• The first significant turning point in the Middle Ages (13th-14th centuries)

  – Formation of new settlements
  – Deforestation of landscape
  – Formation of new fields and pastures
  – Secondarily non-forested landscape gains the higher share than the forested landscape
Changes in agricultural landscape in Europe

• Changes in agricultural systems
  – Intensification of agriculture in surroundings of cities and settlements
  – Increasing share of pastures
  – First „crop rotations“
  – Cattle and sheep breeding
Changes in agricultural landscape in Europe

• 15th – 17th century – peak of deforestation
  – Changes in biodiversity – expansion of species connected on deforested mosaic landscape

• 19th century – progress and changes in most of anthropogenic activities – impact on biodiversity and agrobiodiversity:
  – Industrial revolution
  – Changes in production technologies
  – Growing of new crops (potatoes, sugar beet, clover)
Changes in agricultural landscape in Europe

• 19th century – changes in population density in landscape
• Beggining of migration from agricultural landscape into towns
  – Disappearance of network of small fields and pastures
  – Decreasing of biodiversity (species connected on agricultural mosaic)
  – Biggest impact on invertebrates
Changes in agricultural landscape in middle Europe

• Major changes in the mid-twentieth century (after WWII)
  – Agricultural landscape is influenced by new geopolitical arrangement
  – Strongest impact on post-communist eastern bloc countries
Agriculture and landscape in Czech Republic

• Agriculture before 1948
  – Standart smaller private farms similar like farms in Austria, Germany, Poland, etc.
  – „Connection“ of farmers on their own land
  – Relative good condition of landscape
  – Tradition of family farms
  – Local agriculture production for local customers
Agriculture and landscape in Czech Republic

• Agriculture in years 1948-1989

  – Nationalization of farms

  – End of tradition of local farmers families

  – Breaking of the linking between peoples and agricultural landscape
Agriculture and landscape in Czech Republic

• Agriculture in years 1948-1989
  – Birth of large cooperative farms

  – Changes in production
    • Centralization of production (AP/PP)
    • Application of identical crop rotations for almost whole country
    • Only small differences in structure of production between places with very different conditions
Agriculture and landscape in Czech Republic

• Agriculture in years 1948-1989

• Activities of large cooperative farms
  – Consolidation of fields (demonstration of end of private owners)
  – Plough away of the balks
  – Removing of windbreaks (alleys, small forests, etc.)
  – Building of stables and agricultural buildings with very large capacities
Agriculture and landscape in Czech Republic

• Problems of large cooperative farms
  – Decreasing of biodiversity of field ecosystems
  – Erosion (water, wind...)
  – Pests (missing natural predators)
  – Plant diseases (easy expansion in big fields)
Agriculture and landscape in Czech Republic

• Problems of large cooperative farms
  – Lower yields (problems with pests and diseases)
  – Higher costs for fertilization and pesticides (compensation of lower yields)
  – Degradation of soil and water (use of abnormal amounts of pesticides and fertilizers)
  – Socio-economical problems (motivation of workers, lost connection with agriculture land)
• Problems of large cooperative farms
  – Centralization of loading by livestock units
  – Diseases of animals
  – Higher costs for animal health
Agriculture and landscape in Czech Republic

• Agriculture after 1989
  – Restitution of farms to original owners
    • Agriculture land
    • Animals
    • Buildings
    • Mechanozation
    • Monetary compensations
  – Some farms and parts of agriculture land stays in cooperative farms
• Agriculture after 1989

  – Change of legal nature of farms

  – Decentralization of farming

  – Renovation of traditional family farms (newly created connection on land)
Agriculture and landscape in Czech Republic
Agriculture and landscape in Czech Republic
Agriculture and landscape in Czech Republic
Agricultural landscape – environmental aspects
Agriculture – environmental aspects

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

• Goals of current industrial agriculture:
  – Maximal production on area unit
  – Standardisation of agricultural systems and methods of application of mineral fertilizers and pesticides

• Similar goals have seed producers and agrochemical companies
Diversity and problems of agricultural landscape

• Strong intensification of world agricultural productivity and production in last ca. 50 years
• Expansion of agricultural land
• Intensification of soil cultivation
• Implementation of large scale monocultures

• = negative impact on diversity
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
Dát fotky z Bornea
Diversity and problems of agricultural landscape

• Problems of intensive agricultural systems

  – Strong dependence on external inputs
  – Increasing of inputs = higher consumption of energies and materials
  – Consumption of not renewable resources
  – Decreasing of genetic diversity of cultural crops
  – Negative influence on small-scale farming
Diversity and problems of agricultural landscape

- Decrease of number of agricultural farms due to intensification
  - Food production is strongly influenced by demand of world market, which is controlled by few companies (groups)
  - Lower competitiveness of smaller (family) farms
  - Increasing incomes for distributors, salers, decreasing of incomes for farmers = dependence of farmers
  - Import and export from and into third world countries
  - Deformation of local agricultural systems and structure of agriculture by globalisation of agricultural market
Diversity and problems of agricultural landscape

• Intensification have negative impact also inside of agricultural system

  – Genetic variability of crops
  – Decreasing number of traditional crop species
  – Genetic variability of livestock
  – Reduction of numbers of traditional local breeds
Diversity and problems of agricultural landscape

• Intensive crop varieties are growed 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>
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<tr>
<th>Distance</th>
<th>Parasitization Rate (parazitace na m2)</th>
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<tr>
<td>Přímo přiléhající</td>
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<tr>
<td>Vzdálené 10 m</td>
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<td>Žádný pestrý úhor v okolí</td>
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</table>
Soil
Agriculture and 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
Agriculture and soil

Podmínky:
délka svahu 160 m, 8% sklon, 
hnědozem, 
odnos ornice (t/ha/rok)

Jetel červený
Obiloviny
Cukrovka
Silážní kukuřice
Agriculture and soil
Agriculture and soil
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...)
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)

Hlavní zdroje emisí v EU

Podíl na celkových emisích [%]

- Energetika: 27,8%
Main anthropogenic emissions – EU
(Svendsen 2011)

Hlavní zdroje emisí v EU

Podíl na celkových emisiích [%]

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<tr>
<th>Category</th>
<th>Percentage</th>
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<tr>
<td>Transport</td>
<td>19.5%</td>
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<td>Průmysl</td>
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<td>Zemědělství</td>
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(Svendsen 2011)
Hlavní zdroje emisí v EU

- **Energetika**: 27,8%
- **Transport**: 19,5%
- **Průmysl**: 12,7%
- **Zemědělství**: 0,0%
Main anthropogenic emissions – EU
(Svendsen 2011)

Hlavní zdroje emisí v EU

Podíl na celkových emisích [%]

- Energetika: 27,8%
- Transport: 19,5%
- Průmysl: 12,7%
- Zemědělství: 9,2%
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-farm 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

• \((\text{CO}_2\text{e} = 1x \text{CO}_2 + 23x \text{CH}_4 + 298x \text{N}_2\text{O})\)
CO₂e emissions from farm phase

CO₂e - emissions from agriculture - potatoes CZ

- seedling
- agrotechnical operation
- pesticides
- fertilizers
- field emissions

Conventionally vs. organically grown potatoes in CZ.
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
CO$_{2e}$ emissions from farm and post-farm phase

Regionality and CO$_{2e}$ emissions
Emissions from transport

kg CO₂e/kg

česká italská novozélandská

JABLKA
Impacts of organic production

- Organic products are usually more expensive than conventional.

- Product price – main selection criterion for most of the consumers.

- Selling price vs. Real value of products.
### Impacts of organic production

- Real price of products

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<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