Agricultural University of Tirana
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Research Institute of
Organic Agriculture
Switzerland

Joint Bachelor Course on Organic Agriculture 2014

Lecture 5: Soil ferility and organic fertilizers in organic farming

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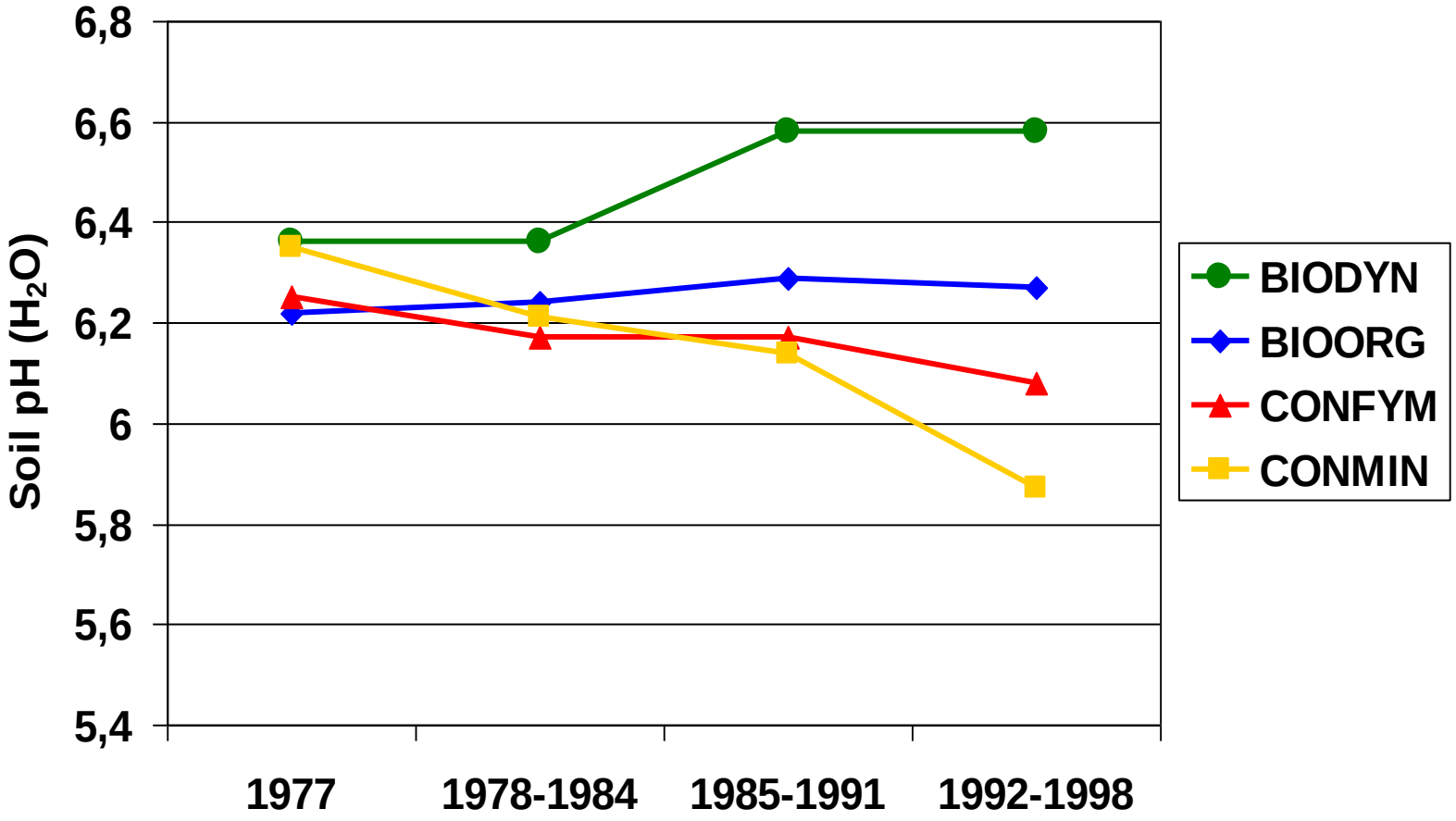
SNF/SCOPES

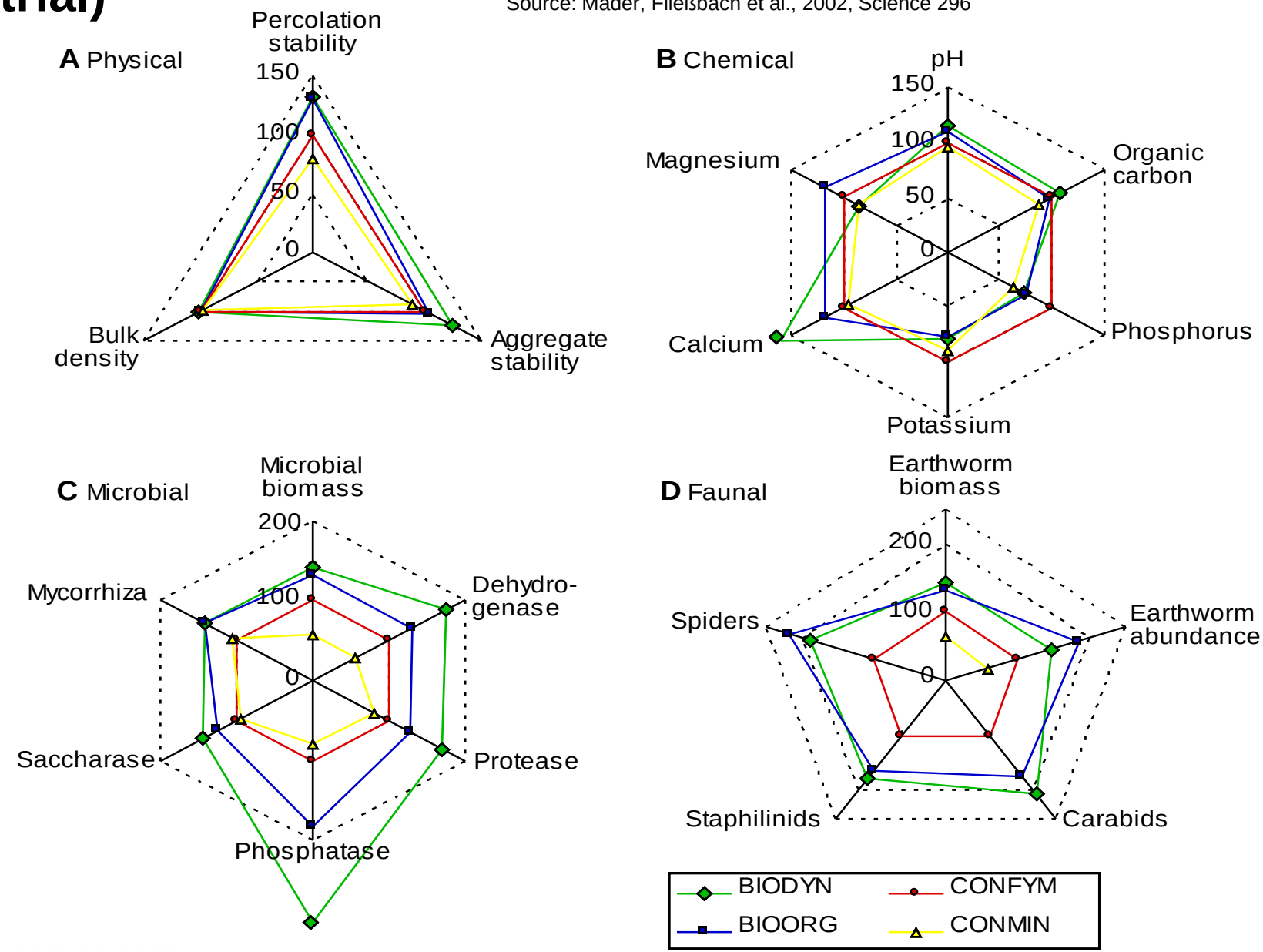
Changings of soil pH depending on agricultural systems



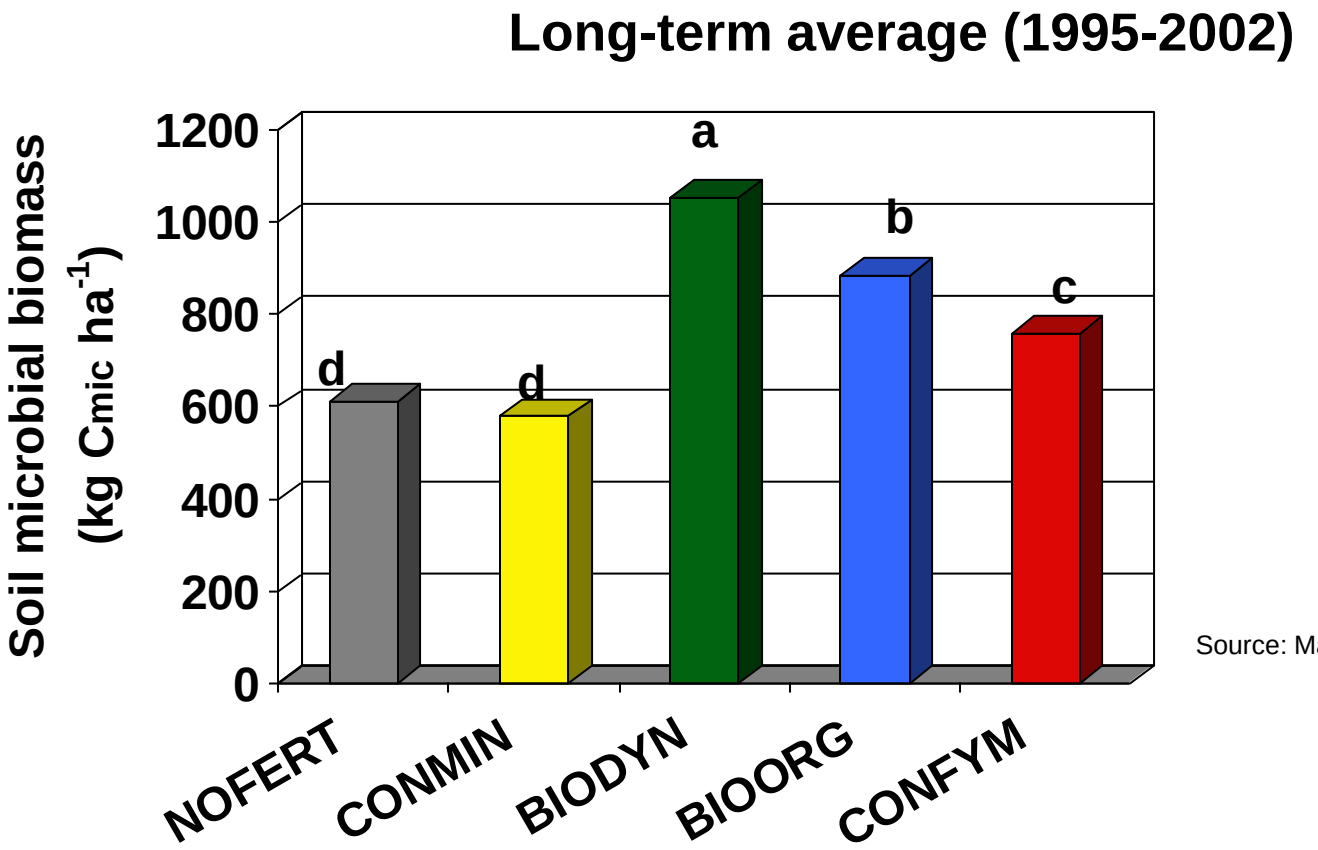
Source: Fließbach et al., 2007, Agr Ecosys Environ, 118

Soil properties in agricultural systems (DOK long term trial)

Source: Mäder, Fließbach et al., 2002, Science 296



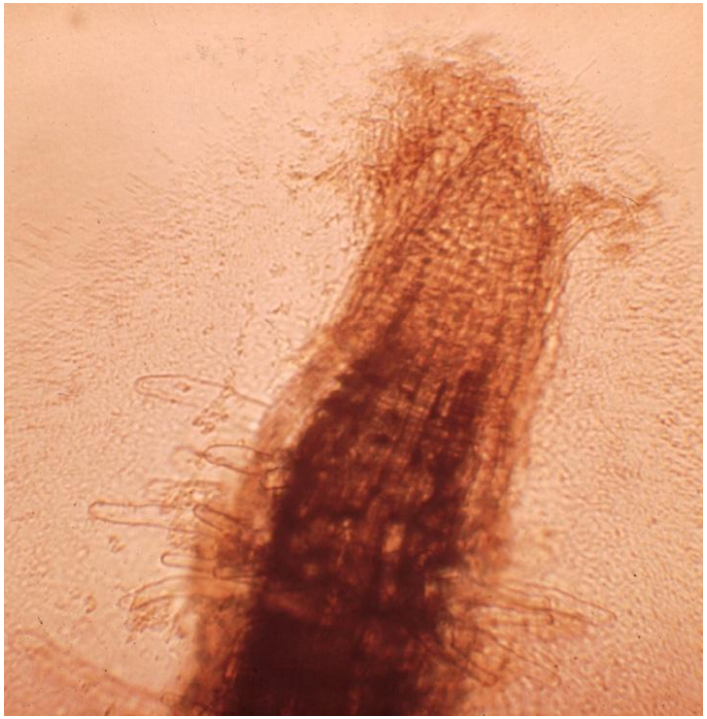
DOK: soil microbial biomass



Source: Maeder, FiBL, 2012

calculated for 0-20cm at average density of 1.4 g cm^{-3}

Rhizosphere



Contact zone between roots and soil

- Abundance of bacteria around root tip

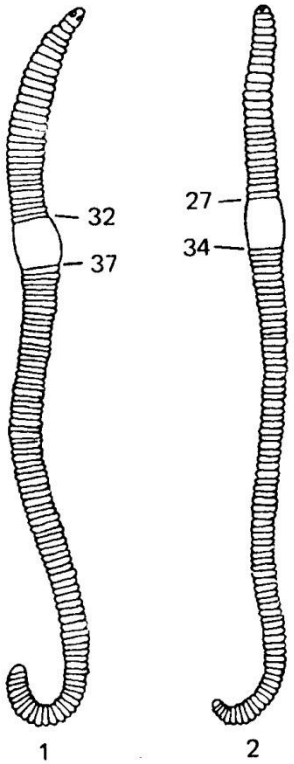
Zone around roots rich on:

- Organic matter released from the roots, which is abundant food for soil biota Soil micro-organisms

Roots exude mucigel

- Mixture of organic compounds
- Nutrition and energy for MO

Earthworms



1. Lumbricus terrestris
2. Allobophora caliginosa

- Important soil fertility indicator
  - Soil acidity tolerance until pH< 5
- Processing plant residues
- Forming water stable soil aggregates
- Incorporate OM in soil
- Enrich topsoil with nutrients and humus
- Cultivating soil by creating channels
  - Facilitating drainage
  - Allow roots explore grow deeper, along nutrient occurrence

Source : Brady, The nature and properties of soils. 1974

Compost

green	brown
Fresh (straw) manure	Straw
Rotted manures	Cornstalks
Grass clippings and Green leaves	Dried leaves
Lawn & garden weeds	Sawdust, wood, paper
Food wastes	Hardwood bark
Fruit wastes	Softwood bark
Alfalfa hay	Peat moss
Clover herbage	Branches
Urine (cattle or sheep)	Rice hulls
Blood meal	Newspaper
Coffee grounds	Pine Needles

http://www.norganics.com/applications/cnratio.pdf
http://www.homecompostingmadeeasy.com/carbonnitrogenratio.html

Compost materials

Green and brown components for building up compost heaps

Approaches to soil fertilization

Conventional

- Provide required nutrients to each crop in a soluble form that plants can use immediately (high input)

Organic

- Provide required nutrients by decomposition of organic matter and natural chemical breakdown of these materials putting the nutrients into forms that are available to crops.
- No chemical nitrogen fertilizers
- No molluscicides
- Manure should be mixed in the soil
- Grass-clover mixtures are common in organic rotations

DOK experiment

Organic		Conventional (Integrated)	
BIODYN bio-dynamic	**BIOORG bio-organic**	**CONFYM conventional**	**CONMIN mineral**
Composted FYM and Slurry	**Rotted FYM and slurry rockdust**	**Mixed FYM and slurry NPK**	**Mineral NPK**
Mechanical weed control Indirect disease control Biocontrol for pests		*Herbicides (thresholds) Fungicides (thresholds)*	
Diodynamic preparations	Copper-sulphate	Insecticides (thresholds) Plant growth regulators	

Source: Maeder, FiBL, 2012

Organic fertilizers – benefits

- Physical
  - Soil stability (soil aggregates, erosion)
  - Increase soil porosity (aeration)
  - Improves water holding capacity

- Bio-chemical
  - Cation exchange capacity (CEC)
    - Nutrient availability
    - Provide nutrients (macro and micro elements)
  - Stimulate micro flora and fauna
  - Protects plants from disease

Source: http://www.chesterfieldfarmsorganic.com/15-2/

Organic fertilizers

Fotos: Fliessbach Nov. 2002

Soil structure: bio-dynamic with composted

Soil structure: conventional without manure

Source: Maeder, FiBL, 2012

Farm Yard Manure FYM

- Animal excrements, urine and bedding materials (straw)
- Varying quantities, decomposition stages, livestock diets cause range of nutrient composition in FYM
- Impacting conditions
  - Type and age of animals
  - Type of forage and food
    - Concentrated food: more excrements (P-rich)
    - Juicy forages: more urine (N and K-rich)
  - Bedding material
    - Enriched with nutrients
    - High usage per livestock unit per day

On-farm fertilization

livestock

manure and compost

Nutritional cycle on farms

forage crops

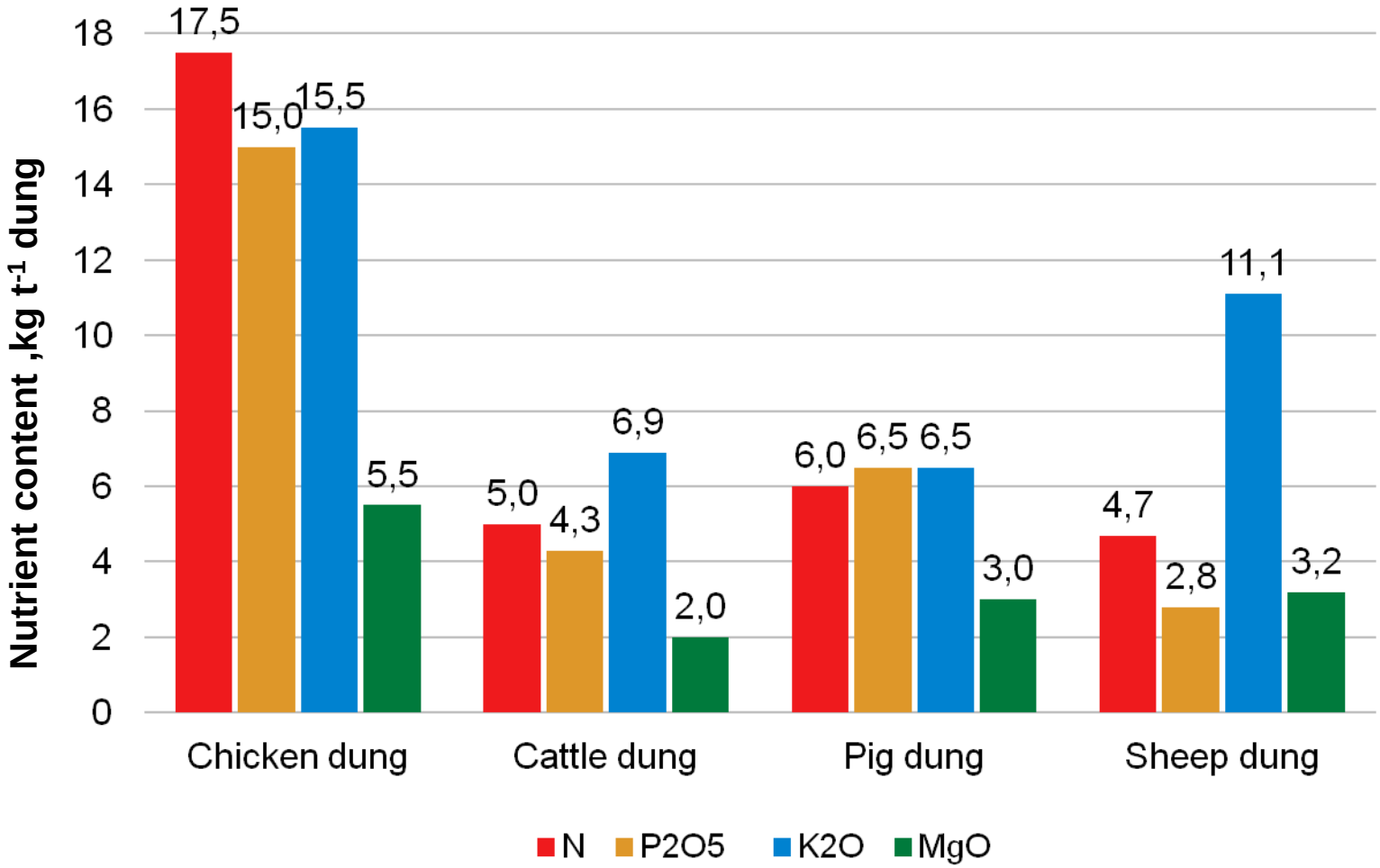
mineral elements

soil

On-farm fertilization

- On-farm fertilizer supply in organic agriculture possible
- Fertilizing schedule and outline
  - Sufficient and optimal nutrient use of manure resources
- Priority to manure resources
  - Crops, costly to grow and harvest
    - Cash crops (vegetable), field crops, roughage
  - For livestock production
    - fodder crops
  - Fruit crops and vineyards

Nutrient content of FYM



Source: Dr Popp presentation, IPNI project fertilizer recommendations, 2013

Manure composting

Advantages

- Cost-efficient application
  - Less volume and mass
  - Directly applicable
- Uniform application
- Org. N and P availability
- Reduced/no NH_3-loss
- More Humus
- Increased CEC
- Reduced viable weed seeds
- Reduces pathogens
- No suppress of seed germination

Disadvantages

- Loss of nitrogen as NH_3
- Additional costs/input
  - Time, labor, machinery, land, constructions (e.g. impermeable ground)
- No starter fertilizer effect

Manure application

EU restrictions on manure application

Council Regulation (EC) № 834/2007

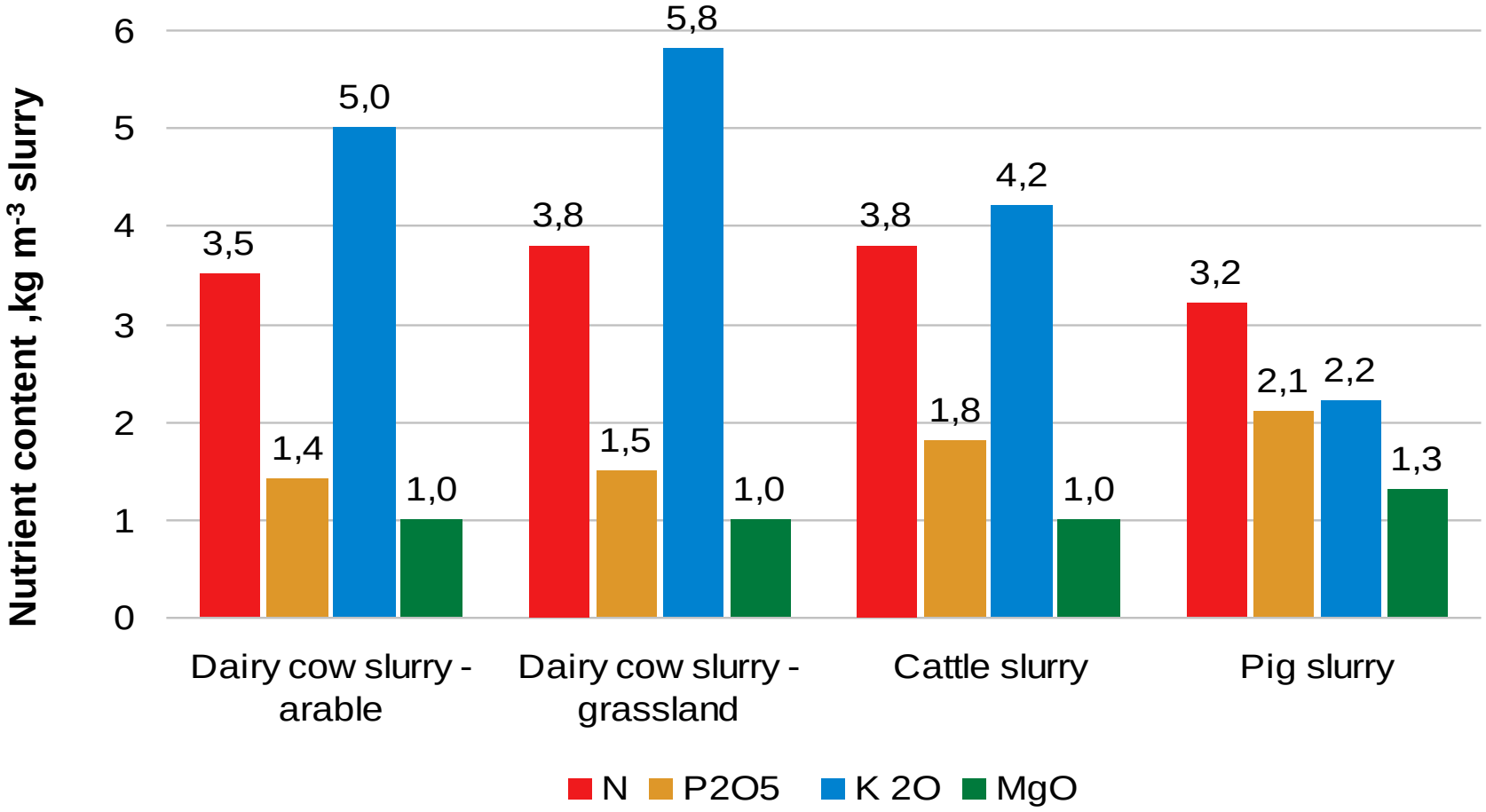
- Manure quantity limited to nutrient equivalent of produced manure
  - by max. 2.5 to 3 grazing livestock units per hectare
- N quantity per hectare from manure
  - ≤ 170 kg/ha for field crops
  - ≤ 210 kg/ha for pastures
- Organic Aim
  - Use of own livestock manure

Manure application

- Time
  - Autumn before deep tillage
  - Early spring before deeper tillage (the most suitable)
  - Application before deep tillage allows manure to be located in deeper soil layers where there is more moisture during summer
    - Continuing mineralization of organic matter

- Methods
  - Broadcasting - uniformly broadcasting of manure on soil surface
  - Side dressing/Band placement (suitable for permanent crops)
  - N losses during/after application
    - Primarily: volatilization of NH_3-N
      - Avoid application on hot, dry, windy days
      - Reduced if it rains shortly after application and low air temperature
    - Best: quick incorporation into the soil (max. 12 hours after application)

Nutrient content of slurry of different farm animals



Source: Dr Popp's presentation, IPNI project fertilizer recommendations. 2013

Summary

- Nutrition of plants in organic system depend mainly on natural cycles of nutritional elements

- Soil microorganisms play important role for plant nutrition
  - Living symbiosis with plants (N fixing bacteria and root mycorrhizae). Nutrients' delivery (N, P, K, micronutrient) directly in plant roots
  - Free living soil microorganisms decompose organic matter releasing available forms of nutrients for the plants (ions).

- Organic fertilizers (manure, slurry, composts, green manures) are important source of energy for soil ecosystem and nutrients for microorganisms and growing plants.

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References

- Aggregate Stability
  http://soilquality.org/indicators/aggregate_stability.html
  Last access: 18th April 2014
- Benefits of Mature Compost
  http://www.chesterfieldfarmsorganic.com/15-2
  Last access: 22nd April 2014
- Brady N. (1974) The nature and properties of soils. Macmillan publishing, 639 p.
- Carbon to Nitrogen Ratios of Various Waste Materials
  http://www.norganics.com/applications/cnratio.pdf
  Last access: 22nd April 2014
- Classification of soil water
  http://www.agriinfo.in/?page=topic&superid=4&topicid=279
  Last access: 22nd April 2014
- Direct deposition
  http://www.extension.umn.edu/distribution/cropsystems/components/7401_02.html
  Last access: 8th November 2013
- Erksen S., B. Hansen, K. Schmidt, K. Suhr. (2003) Organic farming. Organic Agricultural College, Denmark, 173 p.
- Fließbach A., H-R. Oberholzer, I. Gunst, P. Mader. (2007) Soil organic matter and biological soil quiality indicators after 21 years of organic and conventional farming, Agr Ecosys Environ, vol. 118, pp. 273-284.

References

- How Compost Happens
  http://commons.wikimedia.org/wiki/File:How_Compost_Happens.gif
  Last access: 22nd April 2014
- P. Maeder, A. Fliessbach, D. Dubois, L Gunst, P. Fried, U. Niggli. (2002) Science, Vol. 296 no. 5573 pp. 1694-1697
- Lampkin N. (1999) Organic farming. Farming Press Miller Freeman House, 715 p.
- Maeder, P. (2012) Soil fertility – results of long term trials. PPP. FiBL SCOPE
- Manure characteristics
  ftp-fc.sc.egov.usda.gov/CA/technical/cnmp/certification/manurecharMWPS.pdf
  Last access: 22nd April 2014
- Popp, T. (2013) Best Management Practices for Sustainable Crop Nutrition in Bulgaria. PPP. IPNI project
- Reganold, J.P., R.I. Papendick and J.F. Parr (1990). Sustainable Agriculture. Scientific American 262, 6:112-120.
- Sarapatka B., J. Urban. (2009) Organic Agriculture, IAEL, 338 pp.
- Soil organisms
  http://www.fao.org/docrep/009/a0100e/a0100e0d.htm
  Last access: 20th March 2014
- The Carbon:Nitrogen Ratio
  www.homecompostingmadeeasy.com/carbonnitrogenratio.html
  Last access: 22nd April 2014

Acknowledgement

This lesson was prepared within the project „Advancing training and teaching of organic agriculture in South-East Europe (Albania, Bosnia and Herzegovina, Kosovo, Bulgaria and Hungary)“ , funded by the Swiss National Science Foundation (SNFS) within the SCOPES program 2009-2012 (project No. IZ74Z0_137328).