Soil and Water Management from an Agroecological Perspective

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Introduction

- **Why focus on Soil & Water Management?**
- **Status of the World's Soil shows 33% of all soils are moderately to highly degraded due to:**
  - **Soil erosion**
  - **Loss of organic matter**
  - **Poor nutrient balance (excess vs deficiencies)**
  - **Salinization and alkalinization**
  - **Contamination,**
  - **Acidification**
  - **Loss of biodiversity**
  - **Sealing and compaction,**
  - **Poor water status**

(Pete et al 2024)

Challenges+: Climate change, pandemic & wars

Introduction

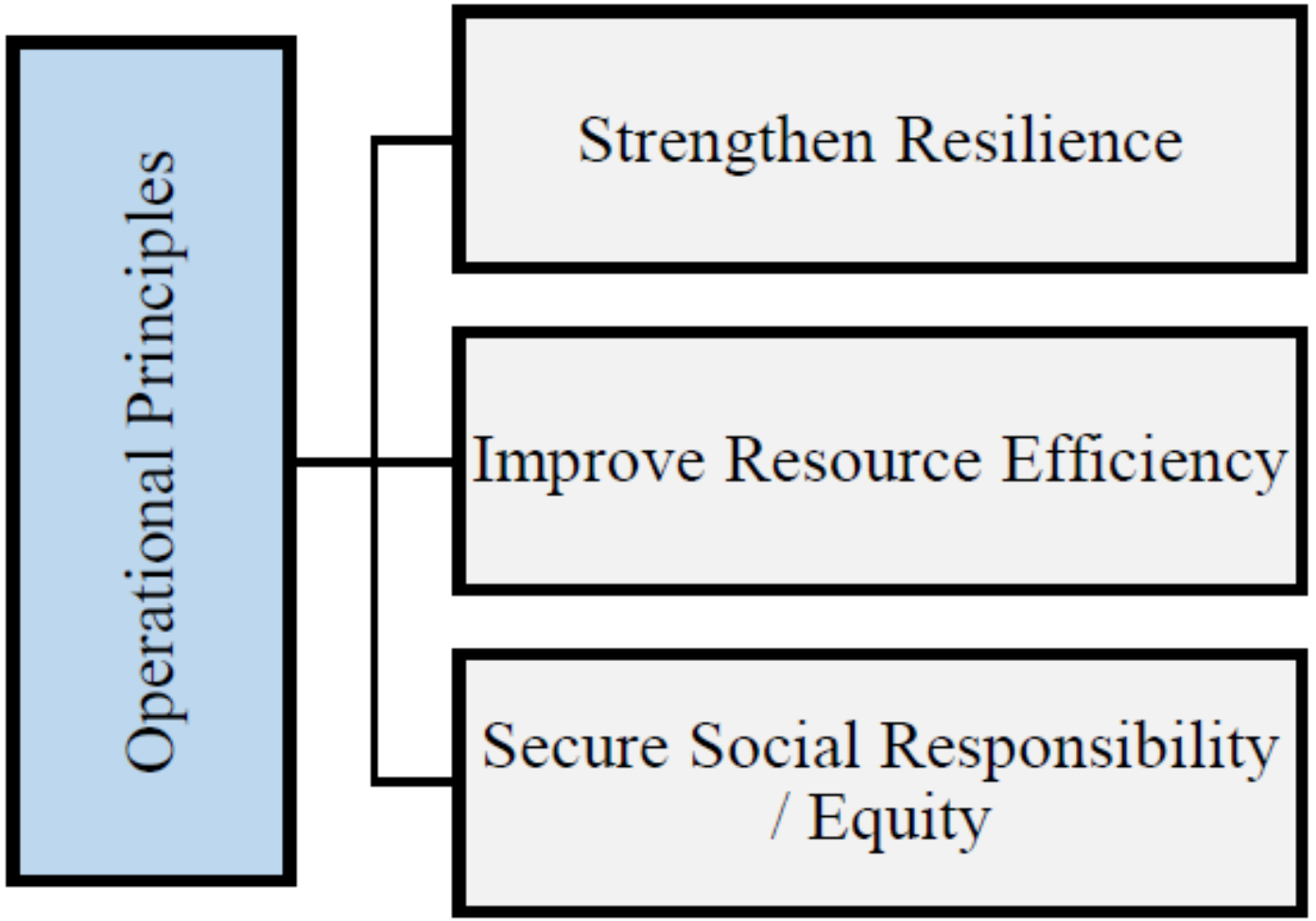
- Sustaining food security, human welfare, environmental safety and ecological and ecosystem services depends on how well we manage soil and water resources
- Approaches to manage soil and water:
  - Soil fertility management
  - Soil and water conservation
  - Conservation agriculture
  - Integrated nutrient management/Integrated soil fertility management
  - Organic farming/Regenerative agriculture
  - Sustainable Agricultural Intensification
  - Agro-ecological approaches

Introduction

- Agro-ecology a comprehensive approach that integrates:
  - Ecological principles,
  - Socioeconomic,
  - Environmental stewardship

  to improve the resilience and productivity of food systems (Somashekar et al. 2024; Ying and Egermann 2024)
- Agro-ecology - a paradigm shift in agriculture – to help:
  - Combat hunger
  - Adapt to climate trade, and
  - Mitigate environmental degradation (Raj et al 2024)
- Agro-ecology consider the landscape approach – interdependence of farm land and off-farm – socioeconomics for resilience, pest management, nutrient cycling to enhance agri-systems productivity

Introduction



Strengthening the ability to endure shocks and bounce back from shocks

optimize resource use for economic gains, environmental sustainability, and social equity

promoting fairness, accountability, social and ethics in society

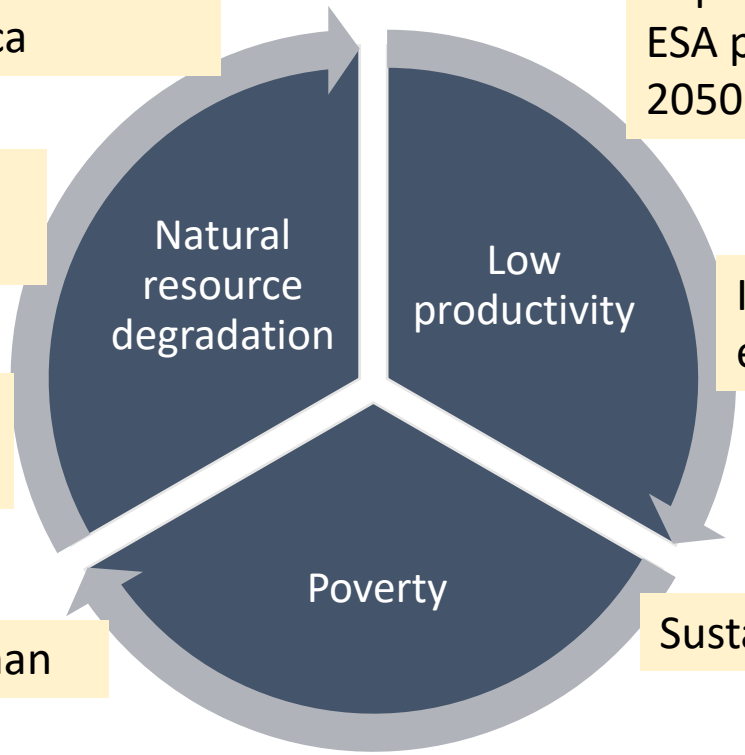
- **Operational Principles of Agroecology (Raj et al 2024)**

Food systems –challenges & complexity in the EA Region

Has to restore 65% of the degraded lands is in Africa

Capacity to feed the growing ESA population of 1 billion by 2050

Prevent deterioration of fresh water



Increase production without expanding agricultural land

Guarantee provision of ecosystem services

Guarantee wellbeing of human

Sustain gross domestic product (GDP)

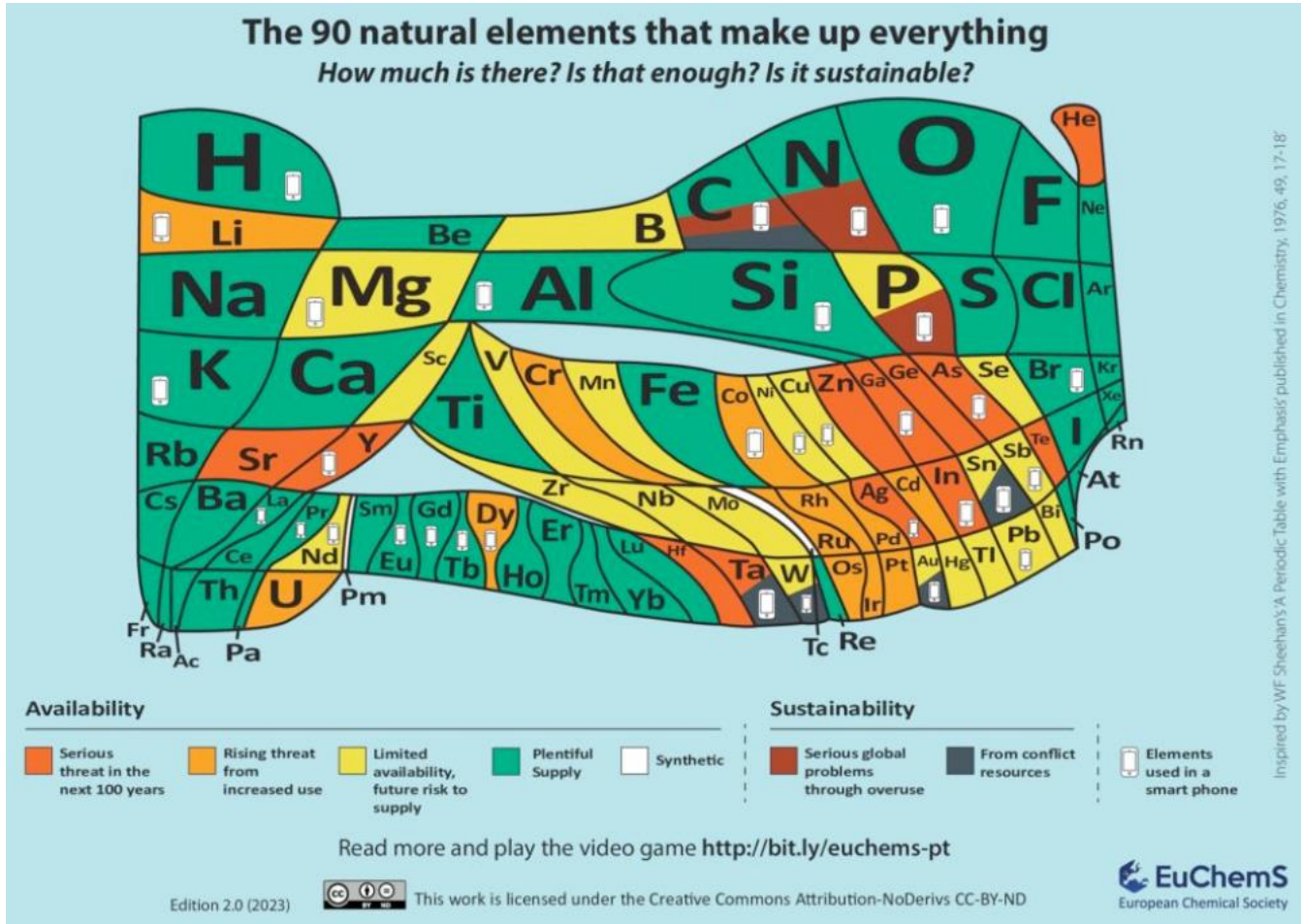
Sustain employment of 60-80% population & descent job

Soil-Water-Agroecology Nexus

- The need of mitigating multiple soil health threats (Somashekar et al. 2024)
- Nutrient re-cycling – composting technology, Biological N fixation, Agroforestry
- Improve water and nutrient use efficiency – high biomass/yield per unit nutrient applied
- 4R -Right nutrient source at the Right rate, Right time and Right place

Soil-Water-Agroecology Nexus

- Recycling technology
- Essential nutrients (N, P, K, Zn, Mg, B, Mn) recycling is needed due to:
  - Limited natural deposits (limited availability)
  - Competing needs for essential plant and human nutrients
  - Energy intensive Haber-Borsch to fix N_2



Soil-Water-Agroecology Nexus

- Soil and environment – Waste management
- Agricultural and food waste management and recycling – to increase nutrients and soil organic matter in agricultural soils
- Clean up environment – remove waste dumping sites, odor and contamination
- Protect water bodies from – eutrophication and toxic mental pollutants

Agroecology and Sustainable Intensification Strategies

- The duo are additional strategies to address the global issue of increasing food production while lowering environmental impacts (Raj et al 2024)
- Multi-disciplinary approach is essential
- Accurate soil health information is essential for appropriate SWM using agro-ecology principles: validated tool/methods

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Agronomy Journal

SPECIAL ISSUE: MACHINE LEARNING IN AGRICULTURE

Validating SoilDoc kit for site-specific fertilizer recommendations for maize production in Tanzania

Nyambilila A. Amuri[1] | Johnson M. R. Semoka[1] | Ray Weil[2] | Mhamadi Mzimbiri[3] | Lydia Gatere[4] | Cheryl Palm[4,5] | Pedro Sanchez[4,6]

Plant Health Progress ◆ 2018 ◆ 19:56–63 https://doi.org/10.1094/PHP-08-17-0044-RS

Research

Farmer-Focused Tools to Improve Soil Health Monitoring on Smallholder Farms in the Morogoro Region of Tanzania

Anna L. Testen, Department of Plant Pathology, The Ohio State University, OARDC, Wooster, 44691; **Delphina P. Mamiro** and **Jackson Nahson,** Department of Crop Science and Horticulture, Sokoine University of Agriculture, Morogoro, Tanzania; **Nyambilila A. Amuri,** Department of Soil and Geological Sciences, Sokoine University of Agriculture; **Steven W. Culman,** School of Environment and Natural Resources, The Ohio State University, OARDC, Wooster, 44691; and **Sally A. Miller,**† Department of Plant Pathology, The Ohio State University, OARDC. Wooster. OH 44691

Soil water management & Agroecology

frontiers | Frontiers in Agronomy

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Farming systems and soil fertility management practices in smallholdings on the southern slopes of Mount Kilimanjaro, Tanzania

Lydia Mhoro[1,2*], Akida Ignas Meya[1], Nyambilila Abdallah Amuri[2], Patrick Alois Ndakidemi[1], Kelvin Marck Mtei[1] and Karoli Nicholas Njau[3]

- **What works best on what conditions/situation:**
- **Fertility status: lowland zones had low nitrogen (0.14%), organic carbon (OC) (1.22%)**
- **Both zones: had low extractable phosphorus (P) (8.3 to 9.3 mg P/ha)**
- **Major challenges: shortage of manure and high cost of inorganic fertilizers.**

Agroecology and Sustainable Intensification Strategies

- ISFM mineral fertilizers + organic materials enriched with nutrients
  - Improve yield
  - Nutrient efficiency

frontiers | Frontiers in Soil Science

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Rice straw incorporation and Azolla application improves agronomic nitrogen-use-efficiency and rice grain yields in paddy fields

Said H. Marzouk[1,2*], Johnson M. Semoka[2], Nyambilila A. Amuri[2] and Hamisi J. Tindwa[2]

[1]Ministry of Education and Vocational Training, Zanzibar, Tanzania, [2]Department of Soil and Geological Sciences, Sokoine University of Agriculture, Morogoro, Tanzania

- **Combination of Azolla, rice straw +100 kg N ha^{-1} + 30 kg P ha^{-1} + 30 kg K ha^{-1} + 20 kg S ha^{-1} = higher rice grain yield fo 3.3 to 5.3 t/ha, nitrogen uptake and agronomic efficiency of N than control with 0.79 to 0.83 t/ha in the control, in Kilombero valley, Tanzania**

Soil water management & Agroecology

- **Resident microbial strains potential candidates for bio-fertilizers.**
- **Are we there?**

Original scientific paper
DOI: /10.5513/JCEA01/25.1.4063
Journal of Central European Agriculture, 2024, 25(1), p.243-254

Multifunctional plant growth promoting potential of *Burkholderia vietnamiensis*-OP984178 and *B. ambifaria*-OP984173 isolated from rhizosphere soils, Tanzania

Grace MPINDA, Nyambilila AMURI, Hamisi TINDWA (✉)

Department of Soil and Geological Sciences, College of Agriculture, Sokoine University of Agriculture, P.O. Box 3008, Chuo Kikuu, Morogoro Tanzania

Two strains, *B. vietnamiensis*-OP984178 and *B. ambifaria*-OP984173: showed the ability to release soluble phosphorus from insoluble/slow release tricalcium phosphate, ferric phosphate, and hard Minjingu rock phosphate powder; produce indole acetic acid (plant growth promoting hormone) up to 23.45 µg/ml and 24.24 µg/ml, respectively; showed antifungal efficiencies of 31.48% and 24.81%, respectively, vs *Fusarium proliferatum*-MZ497514 on potato dextrose agar

Soil water management & Agroecology

- Agroforestry-integrate native trees:
- Do we have enough of native tree for agroforestry?
- Are plans to conserve native trees for agroforestry in place?

Silva Fennica vol. 57 no. 3 article id 23009
Category: research article
https://doi.org/10.14214/sf.23009
SILVA FENNICA
http://www.silvafennica.fi
ISSN-L 0037-5330 | ISSN 2242-4075 (Online)
The Finnish Society of Forest Science

Abubakari H. Munna[1], Nyambilila A. Amuri[1], Proches Hieronimo[2] and Dino A. Woiso[3]

Modelling ecological niches of *Sclerocarya birrea* subspecies in Tanzania under the current and future climates

Munna A.H., Amuri N.A., Hieronimo P., Woiso D.A. (2023). Modelling ecological niches of *Sclerocarya birrea* subspecies in Tanzania under the current and future climates. Silva Fennica vol. 57 no. 3 article id 23009. 24 p. https://doi.org/10.14214/sf.23009

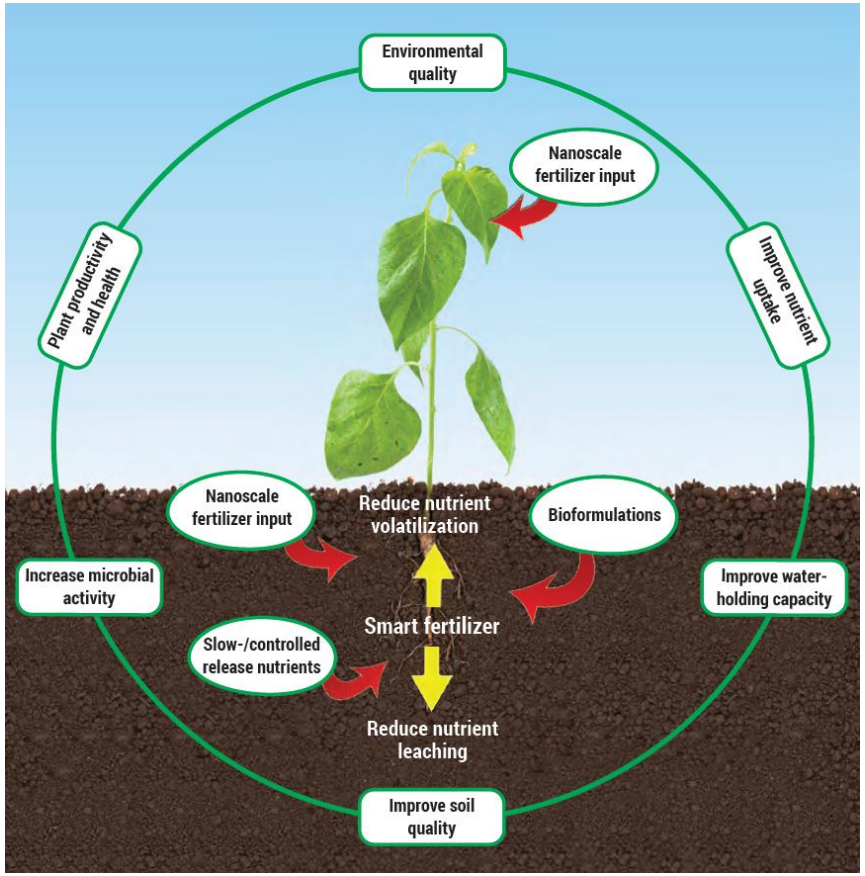
- **Ecological niches of subsp. *caffra*, *multifoliata*, and *birrea* currently occupy 184 814 km2, 139 918 km2, and 28 446 km2 of Tanzania's land, respectively, and 32-51% are under protected areas.**
- **The niche will contract by 0.4–44% due to climate changeCurrently, 31–51% of ecological niches network.**

Research agenda: SWM-Agroecology

- Calls for packaging available best management practices to limit or mitigate agri-systems challenges
- Research and innovations to develop new products and services for nutrient management, soil conservation and water management
- Biofertilizer – isolation, characterization and formulation for efficient use
- Externalities – other places wastes cannot be fertilizer/amendment in another place

Research agenda: SWM-Agroecology

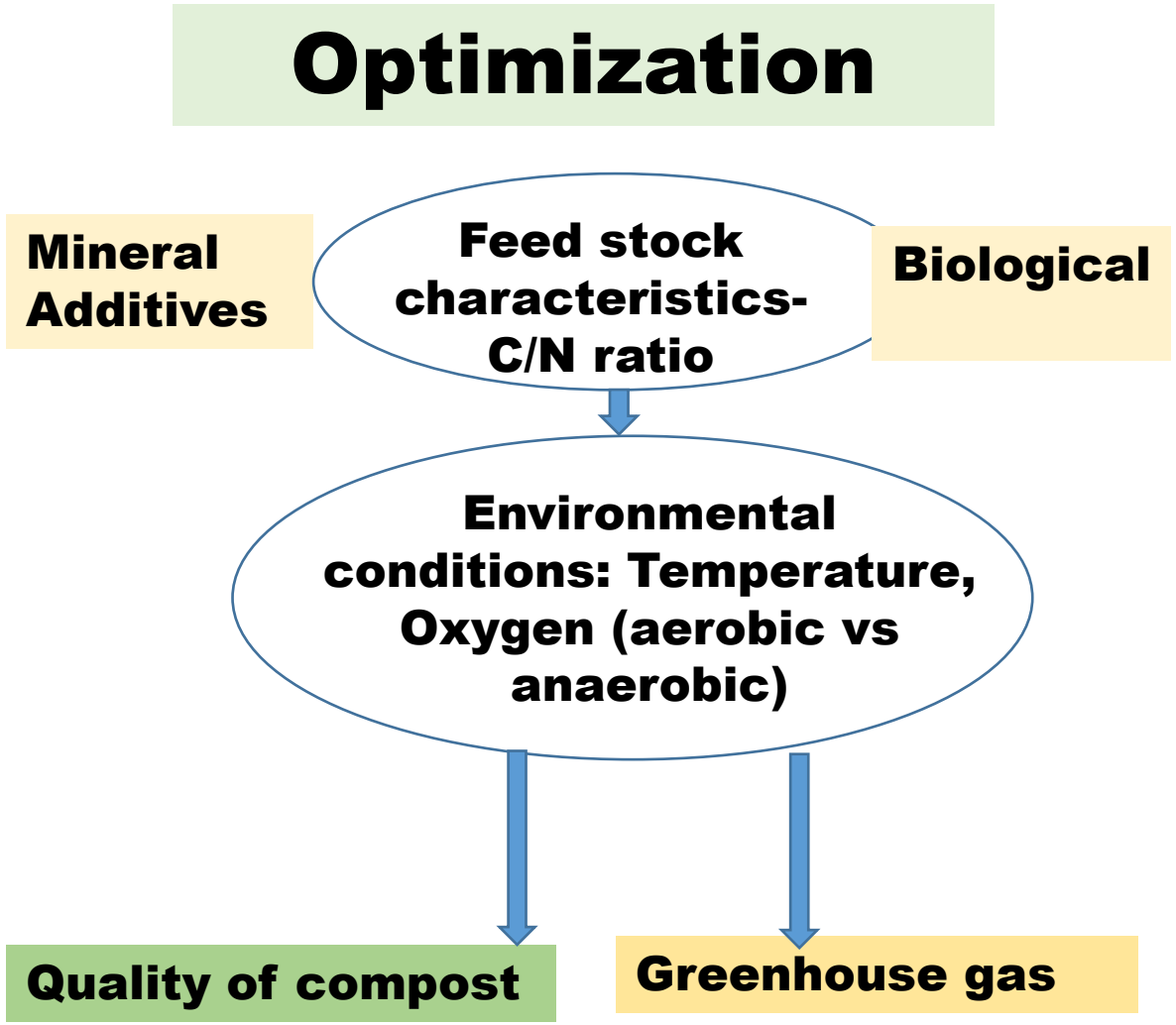
- Nano-technology and soil water management
- These are materials (natural or artificial) of 1 to 100 nanometers
- Can be potentially explored to Improve nutrient efficiency and plant nutrition
- nanoscale fertilizer, additives, coating, controlled release of sustainable fertilizers
- An area of more research (Mikkelsen, 2024; Beige et al 2022)



Potential smart fertilizer effects in the soil-plant system (Calabi-Floody et al. 2017; Mikkelsen 2024)

Research agenda: SWM-Agroecology

- Composting and vermicomposting technologies – recycle + human health + sanitation + safe food
- Organic fertilizers and amendment



SUA Soil & Water Management – Agro-ecology

- Contribution to regional-relevant research and capacity building
  - Regional PhD SWM – ISFM, SWM & Soil Resources
  - PhD Agro-ecology
  - MSc Soil Science and Land Management
  - MSc Agro-ecology - New

Extension and outreach

- Proven best practices to the right environment and socio-economic status

- Action research – co-create solutions with communities – foster adoption

Conclusions

- Soil and Water management is key element of agro-ecology approach to address soil health threats and environmental challenges
- Action research and capacity building at postgraduate level can be strategized to provide agroecological based soil and water management
- Agro-ecological soil and water management must be integrative (include inorganic, organic, biological, socio-economic) and context relevant
- Research on innovative soil and water management in agro-ecological context be explores to sustain agri-food systems functions to provide food, feed, fiber, employment, income and keep the environment safe