Call: Accelerating farming systems transition –agroecology living labs and research infrastructures

Theme 1: Determining and assessing the benefits and trade-offs of agroecology and identifying best practices.

Title: Nanotechnology-enhanced agroecological practices for sustainable food systems: performance assessment and policy recommendations

This research project explores the intersection of agroecology and advanced nanotechnology to enhance the sustainability and resilience of food systems. By leveraging innovative materials and methods, the study aims to quantify the environmental, economic, and social impacts of agroecological practices while addressing their trade-offs. Through a transdisciplinary approach, the project will assess the role of nanomaterials in improving soil health, crop productivity, and environmental protection. The research further examines value chain transformation, identifying business models and policy frameworks to accelerate the agroecological transition.

Agroecology has emerged as a transformative approach to sustainable agriculture, emphasizing ecological principles, biodiversity, and local knowledge. While agroecology offers numerous benefits, such as reducing environmental impacts and enhancing ecosystem services, its broader adoption faces challenges, including economic trade-offs, productivity concerns, and insufficient policy support. Integrating cutting-edge technologies like nanotechnology into agroecological practices presents a promising avenue to overcome these barriers. Nanomaterials, with their unique properties, can revolutionize agroecology by enhancing nutrient delivery, improving pest control, and mitigating environmental degradation. However, understanding the benefits, risks, and scalability of such innovations remains crucial. This project addresses these gaps by combining advanced chemistry, nanomaterials research, and agroecological expertise to provide actionable insights for stakeholders.

Main Goal: To evaluate and enhance the performance of agroecological systems by integrating nanotechnology, assessing their benefits and trade-offs, and proposing value chain transformations and policy frameworks to support the agroecological transition.

Specific Goals:

1. **Develop Innovative Nanotechnology-Enhanced Agroecological Solutions:**
    - Design and test nanomaterials (e.g., nano-fertilizers, nano-pesticides, and soil amendments) tailored for agroecological applications.
    - Evaluate the environmental safety and ecological compatibility of nanomaterials.
2. **Assess the Performance of Agroecological Practices:**
    - Quantify the environmental, social, and economic impacts of agroecological systems enhanced with nanotechnology.

- Identify and document trade-offs associated with nanotechnology integration, including potential ecological risks.

3. **Transform Value Chains for Agroecology:**
    - Analyze the role of nanotechnology in creating efficient and sustainable value chains.
    - Develop innovative business models to support the commercialization of nanotechnology-enhanced agroecological products.
4. **Develop Policy Recommendations:**
    - Collaborate with policymakers to design frameworks that promote the adoption of nanotechnology in agroecology.
    - Provide guidelines for risk assessment, regulatory compliance, and public engagement.
5. **Foster International Collaboration and Knowledge Sharing:**
    - Facilitate knowledge exchange and capacity building through workshops, training, and joint publications.

Detailed Plan:

1. **Phase 1: Nanomaterial Development and Testing**
    - Develop prototypes of nano-fertilizers and soil amendments.
    - Conduct laboratory and field trials to assess efficacy and environmental impact.
2. **Phase 2: Performance Assessment**
    - Implement agroecological practices enhanced with nanotechnology across diverse geographical and climatic conditions.
    - Collect and analyze data on crop yields, soil health, biodiversity, and greenhouse gas emissions.
3. **Phase 3: Value Chain Analysis**
    - Map current agroecological value chains and identify bottlenecks.
    - Propose strategies for integrating nanotechnology into sustainable business models.
4. **Phase 4: Policy Development**
    - Engage with policymakers, industry stakeholders, and farmers to co-develop policy recommendations.
    - Organize stakeholder workshops to disseminate findings and gather feedback.

5. **Phase 5: Dissemination and Capacity Building**
    - Publish results in peer-reviewed journals and present findings at international conferences.
    - Develop training programs for farmers and extension workers on nanotechnology-enhanced agroecology.

Expected Outcomes:

1. Novel nanomaterials and methodologies tailored for agroecological systems.
2. Comprehensive assessment of the benefits, trade-offs, and risks of integrating nanotechnology into agroecology.
3. Innovative value chain models that leverage nanotechnology to enhance sustainability and profitability.
4. Policy recommendations that support the agroecological transition, ensuring environmental safety and societal acceptance.
5. Strengthened international collaboration and capacity for sustainable agriculture research and innovation.

Impact: The project will contribute to the global transition toward sustainable agriculture by demonstrating the potential of nanotechnology to enhance agroecological practices. It will provide evidence-based recommendations for policymakers, create new opportunities for businesses, and empower farmers with innovative tools and knowledge. By addressing environmental, economic, and social dimensions, the research aligns with the goals of the funding call and advances the science and practice of agroecology.