

Sustainable nutrient management: exploring transformation pathways across intervention levels

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1. Introduction

Intensive agriculture relies on nutrient resources (e.g. N, P), which are limited or can cause environmental issues like eutrophication. Various agricultural practices offer alternative nutrient sources and management approaches, but their implementation is often limited to specific intervention levels (e.g. farm, region). Our study examines barriers to starting a transformation process and actors and factors that form potential transformation pathways across these levels.

2. Methods

Literature review (24 publications)

Scopus review (Apr 2023) criteria:

- nutrient management
- intensive farming as starting point
- describing transformation/transition

Following analysis criteria

- barriers and challenges of transformational change
- key actors or factors across intervention levels

We connected identified factors with their related actors to the targets of the rapidity of transformation, political feasibility and social acceptance.

3. Results

Barriers for transformation

Barriers to starting a transformation are described in three categories: social, structural and economic (Fig. 1). The social barriers have the largest variety, though economic ones are mentioned most frequently. Both show that parts of the underlying problems appear to be structural.

Shaping transformation pathways

We identified eight influencing factors for transformation pathways that impact social acceptance, political feasibility and the rapidity of pathways (Fig. 2). They are allocated to intervention levels discussed in the publications, mostly smaller scales up to ecosystems. The diversity of involved actors varies, depending on the factor.

Challenges during transformation processes

During the transformation process, challenges appeared on economic and agronomic issues (Fig. 3). The economic challenges are rooted in the structures of current systems, whereas the agronomic one is technical.

4. Conclusion

Barriers and challenges:

All publications had to deal with initial barriers during the transformation process. Most of them are connected to current structural factors, as they are well established for intensive farming rather than alternatives. To overcome the barriers, we suggest getting familiar with and describing them for a more holistic approach to the transformation pathways. The challenges during the process suggest focusing more on economic factors as they remained from the barriers.

Designing transformation pathways:

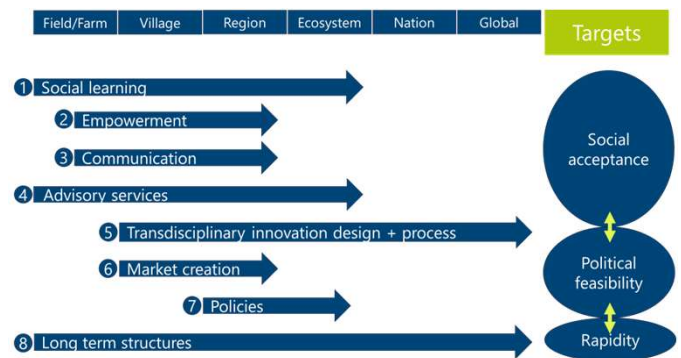
We recommend considering the identified factors and actors for reaching the targets of rapidity, political feasibility and social acceptance when dealing with pathways. Social barriers were overcome through implementing the factors and did not remain as challenges during the transformation. As publications mostly range on smaller scales, the factors are drawn on these levels but potentially could go beyond.

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Figure 1: The variety of barriers hindering entry into the transformation processes. Social factors are highlighted in dark blue, economic in light blue and the influence of intensive farming systems (mainly as structures) in green.



Involved actors:

1. Social learning: farmers (with/-out experience in sustainable nutrient practices), advisors, communities, transdisciplinary researchers
2. Empowerment: of actors such as farmers, advisors and cooperatives in forming and influencing sustainable nutrient management development
3. Communication: availability of communication partner (esp. for farmers) contact person can be an advisor, cooperative, or other farmers
4. Advisory service: official advisor and promotion of service
5. Transdisciplinary innovation design + process: Multi-actor co-creation of innovations (incl. farmers, advisors and other actors depending on need)
6. Market creation: e.g. (state) institutions as first purchasers, special farmers markets
7. Policies: actors involved in transformation process and relevant politicians
8. Build up long term structures: All actors need to be involved in implementing long term structures that keep the transformation going

Figure 2: Factors and related actors mentioned in publications to improve the transformation pathways across the intervention levels field/farm, village, region, ecosystem, nation and global, indicated by the range of the arrows. Factors are grouped as targets (social acceptance, political feasibility and rapidity) serving transformation processes. The numbers indicate actors and, for some factors, actions impacting the factors.

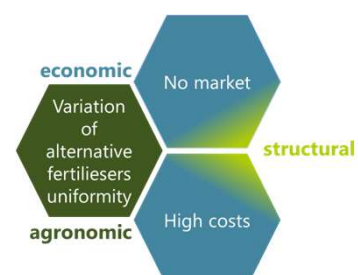


Figure 3: Challenges perceived by publications during the transformation processes. Dark green indicates agronomic, light blue economic challenges, and light green indicates the influence of established intensive farming systems.