Enhancing resilience of agrifood systems by nutrient and energy economy

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Abstract

An optional session: "How to enhance agrifood resilience? -Operationalising resilience approaches"
Preparation for unknown risks, e.g. market fluctuation, will demand resilience and adaptive capacity of social-ecological systems (SESs). In agrifood systems, especially in developed world, both fertiliser and energy expenses are remarkable while at the same time market variation and extremes in the prices of these inputs have become more common. Integration and connectivity of SESs has been argued to be one of the key elements to enhance resilience of the systems (e.g., Cumming et al. 2005, May et al. 2008). Integrated, recycling farming systems may reduce dependence on external inputs (Edwards et al. 1993) and thus reduce vulnerability to price fluctuation. By recycling nutrients of organic waste and by-products and cascading energy it is possible to compensate fossil inputs (Kahiluoto et al. 2011, Rufino et al. 2009b). However, currently nutrient flows in agrifood systems are relatively open: manure is available, but used inefficiently in the fields, and organic waste of agrifood systems are rarely utilised as recycling fertilisers. Additionally, energy utilisation of organic waste is still minor. Integration of farming systems has been studied especially in developing world where higher resilience to climate change in terms of profitability has been reported among integrated than specialised farms (Niggol Seo 2010). The aim of our study is to analyse the relevance of integration for resilience of dairy systems in higher latitudes. We are operationalising resilience here as a capability of agrifood system to maintain stable nutrient and energy economy, good environmental performance, and income stability when facing market variation and extremes. We are studying whether recycling and independence from inputs in terms of nitrogen (N), phosphorus (P), carbon (C) and energy (e) are key determinants for resilience of a dairy system. Our specific hypotheses are: 1) Resilience of a dairy system is enhanced by high recycling rate of NPC, efficiency and cascading of energy use, and independence of inputs and market price regarding NP and energy, and 2) Integrated farming, e.g. mixed farming at farm or at regional level, enhances resilience. We will analyse dairy systems in Finland and in Leningrad oblast, North-West Russia at farm, farm network and dairy system levels. Studied systems represent a wide range of dairy systems with various NPCe input sources and degrees of recycling and cascading. Quantitative data of inputs (fertilisers, fodder, energy etc.) and outputs (milk, meat etc.) are collected by interviews for five consecutive years. Material and substance flow analysis

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will be applied for data collection and ecological network analysis and link analysis (Rufino et al. 2009a) to analyse the data. Environmental performance will be estimated in terms of nutrient and energy use efficiency. Also qualitative data collected by semi-structured interviews at the different levels of dairy systems are utilised for identifying the experiences of market fluctuations and income stability. Based on the results of the analysis, we will discuss the role of integration in terms of recycling and resource sovereignty for resilience of dairy systems.

**Keywords:** Adaptive capacity, Agriculture, Carbon, Energy, Food security, Network, Nutrient, Resilience