Commons-based plant breeding and seed production as a social innovation to enhance resilience in the agricultural sector

Lea Kliem & Stefanie Sievers-Glotzbach

Introduction

Building resilience has been proposed in science and international policy as a future priority for food systems to meet challenges like climate change. There is little systematic research on the role of the seed sector for socio-ecological resilience in plant cultivation systems. The ongoing privatization and concentration with breeding efforts is directed to create small number of high-yielding varieties. As an alternative, (new) organizational approaches in the seed sector build upon common ownership and collective management in plant breeding and seed production, including participation of smallholder farmers in variety development and management. Such a commons-orientation appears to be a promising approach to improve food system resilience.

Theoretical Background

- We conceptualize resilience as emergent properties that contribute to the stability and adaptability of social-ecological systems in case of perturbations. These properties include
  - (i) the amount of disturbance a system can absorb and remain within a domain of attraction
  - (ii) the capacity for learning and adaptation and
  - (iii) the degree to which the system is capable of self-organizing (Carpenter et al., 2001, p. 766).
- In recent years Indicator-based frameworks have been developed to attempt to assess resilience. Some of these frameworks have specifically focused on agroecosystems (e.g. Altieri et al., 2015; Cabell & Oelofse, 2012; Wiréhn et al., 2015).

Research Goals

- To conceptually and empirically analyze how a commons-orientation in plant breeding and seed production promotes or impedes resilience of crop systems in comparison to private property-based structures.
- Address two knowledge gaps of
  - (i) how the seed sector influences resilience of agricultural systems in general
  - (ii) how commons-structures in the seed sector affect resilience of crop systems in specific.

Methods

- Building on Cabell and Oelofse (2012) this paper applies an indicator-based framework to assess the contribution of two types of governance systems of seed production (conventional and commons-based) to the resilience of crop systems. For this, we reviewed, adopted and complemented Cabell and Oelofse's set of 13 indicators.
- Text-based document analysis of 50 publications of conventional and 50 publications of commons-based seed companies and initiatives. All analyzed documents are self-portrayals of the corresponding companies.

(a) Documents of conventional seed companies

(b) Documents of commons-based seed initiatives

Discussion

The conventional seed sector has advantages in terms of production efficiency under controlled conditions as well as financial viability. However, this investigation reveals that commons-structures in the seed sector improve the resilience of crop systems (system-to-be-governed) and the resilience of plant breeding and seed production structures (governance system).
Core aspects of the commons-based seed sector positively affecting agro-ecological resilience are its polycentric organizational structure, the breeding of varieties with reproducible seeds, the rejection of intellectual property rights and the sharing of both practical breeding knowledge and variety information. Principles of organic breeding further contribute to improving agro-ecological resilience, as commons-structures are only implemented in the organic seed sector to date.

Results

MEASURING AGRO-ECOLOGICAL RESILIENCE OF THE SYSTEM-TO-BE-GOVERNED		
Indicator	**Conventional Seed Sector**	**Commons-Based Seed Sector**
Socially self-organized	• Social self-organization not given • Needs of farmers and further actors along the value chain are integrated through stakeholder management	• Vegetable growers form own structures for breeding, seed multiplication and marketing • High degree of coordination and cooperation along value chain
Ecologically self-regulated	• Focus on hybrid varieties • "Integrated solution": (GM) seeds with fitting pesticides	• Breeding of naturally reproducible varieties • Core breeding goals are robustness/ resistance without chemical inputs • Focus on adaptability to changing environmental conditions
Functional and response diversity	• Low genetic diversity through breeding for monogenetic resistances • Concentration on few crop species; crowding out of regionally adapted through generalist high-yielding varieties • Agrobiodiversity at the landscape level reduced through "integrated solution"	• High genetic diversity through breeding of open pollinated varieties • Focus on preserving and enhancing agrobiodiversity at crop species level • Fostering functional diversity of cultural landscapes
Optimally redundant	• Reduction in redundancy of seed supply channels through market concentration and tight legislation on variety approval and intellectual property rights	• On-farm conservation of varieties at different locations • Development of redundancy of different breeding methods
Coupled with local natural capital	• Breeding of varieties that are adapted to specific climates • Core breeding goal is increased resource efficiency in terms of pesticides, nitrogen, water, energy and land use	• Breeding of varieties adopted to specific regions and agro-ecological conditions • On-farm breeding under organic conditions
Appropriately connected: Globally autonomous and locally interdependent	• Selling combination of (GM) seeds with fitting pesticides and machinery • Application of patents on plant genes and variety protection on new varieties • Increasing concentration in the global seed sector, merger with pesticide producers	• Breeding of self-reproducing varieties (reduced reliance of hybrid varieties) • No variety protection/ open-source-system • Breeding of varieties for locally available nutrient inputs • Local connectedness of breeders and farmers e.g. in participatory breeding

MEASURING AGRO-ECOLOGICAL RESILIENCE OF THE GOVERNANCE SYTEM		
Indicator	**Conventional Seed Sector**	**Commons-Based Seed Sector**
Builds human capital & Reflective and shared learning	• Employee qualification, stakeholder communication and partnerships with private and public research institutions • Extensive training programs for farmers	• Regular exchange between breeders and farmers within and between organizations • Knowledge on breeding history of new varieties is shared publicly • Practical training for commercial and hobby gardeners free of charge
Honors legacy	• Future is seen in biotechnological breeding techniques • Traditional practical knowledge of farmers is not appreciated	• Seed banks for collection and in situ maintenance of conservation varieties • Usage of traditional varieties and landraces • Application and further development of traditional breeding techniques
Polycentric, decentralized governance structures	• Increasing market concentration opposes polycentric structures • Organization of multinational seed companies into decentral facilities and research centers worldwide (but one governance body)	• Polycentric organizational structure of breeding organizations • Multiple, decentral breeding projects with own decision-making competences • Decentral networks of seed producers and variety preservers
Ensuring resource access and broadening participation	• Intellectual property rights (variety protection, patents on genetic material and breeding technologies) limit access to seeds and genetic material for both farmers and breeders • Resource access is interpreted in terms of access to knowledge and credit	• Securing access to varieties through waiving of private property rights for varieties and breeding of varieties with reproducible seeds • Own (transparent) organic breeding sector increases choice for farmers • Participatory breeding approaches
Exposed to disturbance	• Breeding occurs mostly under controlled environmental conditions (lab) • Future is seen in biotechnical breeding methods, specifically gene editing	• In situ breeding in organic-agriculture selection environment • Exposure to site-specific disturbances • Holistic breeding approach
Reasonably profitable	• Hybrid and GM seeds have significantly higher price than farm-saved seeds, but also higher yields • Market concentration led to price increases for seeds; financialization of seed sector leads to volatile prices and hampers food security	• No data on impact on economic situation of farmers • Insecurity of long-term financing of commons based, organic breeding sector (but diverse sources of financing) • General lack of financial resources for organic breeding

References

Altieri, M. A., Nicholls, C. I., Henao, A., & Lana, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. Agronomy for Sustainable Development, 35(3), 869–890. https://doi.org/10.1007/s13593-015-0285-2

Cabell, J. F., & Oelofse, M. (2012). An Indicator Framework for Assessing Agroecosystem Resilience. Ecology and Society, 17(1). https://doi.org/10.5751/ES-04666-170118

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? Ecosystems, 4(8), 765–781.

Wiréhn, L., Danielsson, Å., & Neset, T.-S. S. (2015). Assessment of composite index methods for agricultural vulnerability to climate change. Journal of Environmental Management, 156, 70–80. https://doi.org/10.1016/j.jenvman.2015.03.020