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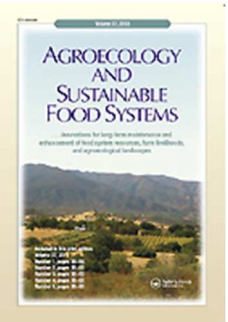

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Abstract

Based on urgent needs for food security compounded by a changing climate which impacts and is impacted by agricultural land-use and food distribution practices, we explore the processes of action in implementing agroecological food systems. We identified the following characteristics for an agroecological food system: 1. Minimizing use of external inputs, 2. Extent of internal resource recycling, 3. Resilience, 4. Multifunctionality, 5. Building on complexity and incorporating greater systems integration, 6. Contextuality, 7. Equity and, 8. Nourishment. We focus on the city-region food systems context, concluding with practical drivers for realizing more agroecological food systems in city-region contexts. Agroecological food systems are widely diverse, shaped by context and achieved through multi-actor planning in rural, peri-urban and urban areas. Application of agroecological food systems in rural-urban contexts emphasize the necessity of diversification, zoning rural-urban landscapes, planning for seasonality in a food systems context, and producing at scale. Rural-urban food systems are a relevant and challenging entry point that provides opportunities for learning how food systems can be shaped for significant positive change. Social organization, community building, common learning and knowledge creation are crucial for agroecological contextualized food systems, as are the supports from appropriate governing and institutional structures.

Key words: equity, city-region, resource efficiency, resilience, nourishment, governance

Introduction

Current farming and food systems confront and are implicated in multiple challenges and unsustainable changes, including biophysical dimensions such as climate change (Beddington et al. 2011), environmental pollution, escalating losses of biodiversity, and deteriorating ecosystem services (Millenium Ecosystem Assessment 2005; Nellemann et al. 2009; Steffen et al. 2004 and 2015). Social forces and structures as well as unsustainable socio-economic processes also strain present capacities to manage growing population pressure, unplanned urbanization, food and nutrition insecurity, dietary shifts and health disparities associated with poverty, and growing inequality among multiple stakeholders, including women, youth, migratory workers and indigenous peoples (Dorin et al., 2013 (a) and (b); Ruel et al., 2017; Minten et al. 2017; Lang, 2016; Seto and Ramankutty 2016). Both urban and rural actors are impacted in relation to land ownership and land use change issues and drivers underpinning global industrial agriculture and connected food systems. Human activity has approached critical limits over an increasing number of the so-called Planetary Boundaries (PBs), beyond which the functioning of ecosystem services may be substantially altered, increasing the risk of destabilizing life on our planet (Steffen et al. 2015). Agriculture and food systems are both a villain and a victim in approaching or breaching PBs, and this is already impacting the ability to farm and produce food. How can humanity sustainably grow nutritious food and return to a safe operating space within the PBs?

As an alternative to this scenario, a growing number of studies and reports indicate significant potential gains from transitioning towards agroecological agriculture as a way of nourishing current populations sustainably while allowing for future generations to support their livelihoods (IAASTD 2009; UNCTAD/DICT/TED 2013; FAO 2015(a) and (b); IPES-Food 2016; Reganold and Wachter 2016; Cook *et al.* 2016; Burley *et al*. 2015; FAO 2014(a); Ching 2016; AFSA 2016). One core quality of transitioning to agroecological farming systems is the regenerative trend of increased "outputs" per unit "input" for a more efficient agriculture for using and conserving diversity on a long-term basis, through the use and combination of different agricultural techniques in ways which restore and nourish the soil and enhance the local environment, instead of continuously

degrading it. In addition, the diversification strategy makes food producing systems resilient to external shocks and influences, such as floods or droughts using, *e.g.,* approaches built on the principles and science of agroecology (Altieri et al. 2012; De Abreu and Bellon 2013). There is growing evidence that such production systems allow for lower cost and more diverse fruit and vegetable supply (Imbruce 2015). Furthermore, conventional thinking about food is increasingly being challenged, shifting from being regarded only as a commodity toward becoming acknowledged for its nourishment, social and cultural values, the links it creates between people, and its deep connectedness with ecosystems, ecosystem services and natural resources (Alkon and Agyeman 2011).

The current globalised industrial food system exhibits the same drivers which impact and shape farming industries and food production, and underscores the importance of focusing on how food flows into food systems, and which structures and related policies are shaped to support and reinforce current farming as well as food systems (Vorley and Lancon 2016). It is not only conventional and industrial production of animal feed, genetic material or major commodities such as wheat, rice, coffee, sugar, maize, and chicken which are controlled and shipped across continents by large trans-national corporations. Our globalized industrial food systems sometimes also include food which originates from farming systems based on organic farming regulations and principles like the IFOAM principles, calling for more coherent, equitable and holistic food systems, and applying agroecological farming methods. In other words, the intentions behind such farming systems and their contributions to agricultural and environmental sustainability are not always extended to food systems, which generally contribute to out-competing local produce, distorting prices and producing huge amounts of food and other waste. This can be seen as a contradiction and emphasize the importance of thinking of not only organic and agroecological production, but be consequent in thinking the principles into the entire food systems. At the same time, there are many examples of organic farming and food as well as agroecology presenting alternatives to the industrial farming and food systems (Gliessman 2016b), and by increasing and

emphasizing this, we can move towards a food system that falls within the PBs. This calls for profound analyses of how agroecological food systems function, and how they can contribute to coherent, resilient and equitable production and exchange of food, where human and social capitals are built up throughout the food systems, in which resources are cycled rather than transported through, from or to disconnected part of the systems. How can such food systems meet challenges such as losses of complex and system-oriented, context-relevant knowledge about farming and food, and how can they contribute to re-connect consumers and the food that they eat across urban-rural settings in city-region food systems?

An increasing number of papers and reports link agroecology and food systems (Gliessman 2015; Méndez et al. 2013; Wezel et al. 2016; AFSA 2016; IPES-Food 2016; Fernandez et al. 2013; Guzmán et al. 2013), referring to the fact that agriculture and food systems are intricately linked, and to a large extent driven by the same global (economic) structures. Given the intricate and mutually-reinforcing relations between agriculture, food, and socioeconomic systems, the present article aims to characterize and explore how the concept of agroecology stimulates the conceptualization of agroecological food systems, or perhaps even a more inclusive term like 'socio-agroecological food systems'. Food systems following the principles of agroecology calling for resilience, multifunctionality (Caron et al. 2008), equity and recycling of resources face particular challenges and have significant options for impacting sustainable development in city regions (Dumont et al. 2016; Duru et al. 2015). This needs to be seen in a light where an increasing amount of the global population lives in urban areas, from smaller towns with few thousand inhabitants, to mega-cities of millions of people. Urbanisation has changed diets and nutrition, while food consumption has become detached from food production worldwide (Hawkes et al. 2017). Re-connection taking a systems approach requires major changes in consumption patterns, resource management and social responsibility, if everybody should be nourished in agroecological food systems.

We aim to explore the connections and linkages between the concepts of agroecology and food systems, and focus particularly on how the food system framework can locate and ground the concept of agroecology within a rural-urban landscape setting. This exercise requires us to critically examine the reciprocal flows and the multiple environmental, social and governance related connections needed for an agroecological food system transformation.

The conceptual framework of agroecological food systems

To explore the idea of agroecological food systems and their features and interactions particularly in city-region contexts, we outline the two major key concepts 'food systems' and 'agroecology', first separately and then as a collected concept, and explore the ideas of agroecological food systems in city regions with urban and rural areas.

The concept of food-systems

A food system is a system that involves activities, social and institutional structures and processes related to the production, distribution, exchange and consumption of food (Sobal et al. 1998). Agricultural systems are part of food systems, integrated in ecosystems and constituted socio-ecological systems (FAO 1997; http://www.fao.org/docrep/w0078e/w0078e04.htm#P1642_90314). Over the past few decades, the understanding of food systems has clearly developed as result of the development of a more and more globalized food systems (for review of recent research, see Brinkley 2013). Ericksen (2008) compared some features of 'traditional' versus 'modern' food systems, and addressed the governance of different food systems, with or without support for local production, and Foran and co-authors (2014) point to the existence of different concepts of how food systems are constructed, with examples from so-called developing countries. The structure and governance of the food system clearly influences consumption patterns by providing both producers and non-food-producing consumers with options of availability. The range of social and environmental welfare outcomes stemming from food system activities were also discussed and visualized in Ericksen (2008), and Jennings and co-authors (2015) analysed how planned and well

governed city-region food systems could contribute to different aspects of food security for different groups of citizens, stable incomes, circular economies and resilience at various levels.

Characterizing a food system can follow through its different social aspects, like the type and degree of contact between those who grow and produce food and those who receive and eat the food without participating in the production of it, or who and how many people are involved on the way from the soil to the plate. Where local food systems with short supply chains have potential for involving resource feed-back loops, raise collective awareness among different actors within the food system, and give possibilities for mutual learning (Francis et al. 2016), a larger and decoupled food system lacks the direct interaction and feedback, exchange of experiences and knowledge, or the embeddedness inherent in a localised food system. A decade of research on New York's Chinatown produce economy gives an example of the importance of this connectedness: the studies revealed that 80-plus produce markets offered an incredibly diverse assortment of lower-cost produce because they are connected to a web of nearby, independently-run small farms and wholesalers (Imbruce 2015). The diversity of production is directly related to the proximity of supply and lower cost of healthy food. In a food chain (value chain / long supply chain), a product flows through different steps, where various forms of transformation may occur, and connection and feedback loops between these different steps may not necessarily exist. In such systems, farmers or industrial food producers can risk becoming producers of 'food from nowhere', as expressed by Bové and Dufour (2002), and later unfolded by Campbell (2009), and 'consumers' can become reduced to a non-informed and non-responsible person, only 'consuming food no matter of origin', as a contrast to so-called 'food citizens' defined as a consumer who makes decisions that support a democratic, economically just and environmentally sustainable food system, with a possibility of being actively involved in the food system at different levels (Gliessman 2015; Guzman and Woodgate 2013). The call and practice of re-localizing of food systems is similarly seen as a harbinger of rural-urban reciprocity as consumers and producers are

re-embedded physically and socially in the food system while raising awareness of their respective impacts on one another (Hinrichs 2000).

The concept of agroecology

Agroecology is widely acknowledged both as a science, a practice and a movement (Altieri 2002 and 2009; Altieri *et al*. 2012; Gliessman 2014; Silici 2014; Tittonell 2014; Wezel et al. 2009). Its academic roots go back nearly one hundred years, drawing on (and co-evolving with) the fields of agronomy, horticulture, and ecology. Through the view of agricultural systems as ecosystems, agroecology combines these disciplines and has subsequently incorporated further disciplines of cultural, human and social sciences in a wider systems approach. It has existed as an explicit concept since the 1930s, evolving through the 1970s by increasing awareness of practices, focusing on indigenous knowledge and emerging social movements. These tenets position agroecological paradigms as both an alternative to chemical, mono-cultural or industrial farming, and as a catalyst for conventional agriculture to adopt more sustainable approaches.

Agroecological systems are considered to be built on the principles of natural ecosystems (Gliessman 2015; http://www.agroecology.org/Principles_List.html) and are seen as multi-functional and functionally integrated systems of complementary and dynamic relations between living organisms and their environments. In Table 1, below, some well-explored key characteristics related to agroecology are listed. The functions of natural ecosystems, in terms of energy and nutrient flow, as well as the dynamics of adjusting and being resilient to constantly changing surroundings and regulating populations, clearly are different from an agroecosystem. The latter are altered by and reacting to human dominance, or at a more extreme end, are disconnected or isolated from pre-existing energy and nutrient flows (*i.e.*, glasshouse production, hydroponics or other techniques).

Over the past decades, many academic agroecologists have increasingly stressed the importance of considering the human and social systems as integrated part of the agroecological system. Building complex systems involves extensive human knowledge, experience and community collaboration.

Blay-Palmer and co-authors (2016) point to the benefits of sharing place-based knowledge and good practices can help in joining forces for transforming food systems at a wider scale. The scale of an agroecological system can be large or small, but the scope of agroecological farming activities is wide; the majority of the population of smaller-scale family farmers are often considered to be applying agroecological farming approaches, and are currently estimated to produce food nourishing 50-70% of the global population and supply up to 80% of the food in Sub-saharan Africa and Asia (FAO 2012(a); Lowder *et al.* 2016). With regard to human livelihood and scale related to agroecological systems, Walter Goldschmidt (1978) found that rural communities with more, smaller farms saw higher human well-being than those with fewer, larger farms in settings of North-American farming in the middle of last century. This has been questioned by modernist scholars, but has also seen numerous studies support its conclusions over time, and it certainly has never been strongly refuted (as observed by Chappell and LaValle 2011). As the example above on research in New York's Chinatown produce economy showed, the diversity of production was found directly related to the proximity of supply and lower cost of healthy food.

Another argument for how the resilience of an agroecosystem includes environmental elements as well as social and institutional elements is raised by Gonzales de Molina (2012) who refers to Holling *et al.* (1998) and Holt-Giménez (2001): '*The resilience of an agroecosystem does not depend solely on its productive arrangements. State institutions, responsible for managing natural and socioeconomic disasters, can create favorable or adverse conditions for the recovery of the productive capacity of an agroecosystem. In this respect, there are institutions that favor the resilience of an agroecosystem more than others. In contrast to private or simply state property, communal forms of ownership, characteristic of traditional rural cultures, result in management approaches that adapt more easily to surprises or changes experienced by ecosystems*'.

This emphasis on institutions and the resilience dimension suggests stronger links between agroecology and fundamental environmental, ethical, political, and governance related questions

and issues about the right and access to land and other natural resources and ecosystem services, such as water, soil, forests, and pollinators. It also underlines the importance of wider disciplinary and practical perspectives, such as landscape agroecology and the process of landscape planning in rural as well as linked rural-urban settings. Wezel and co-authors (2016) emphasize the relevance of working with 'agroecology territories' in a more holistic framework combining sustainable agriculture and food systems as well as addressing biodiversity conservation, as places actively engaging in transition to sustainable farming and food systems.

What qualifies a food system to be an agroecological food system?

> *The agroecosystem concept and the science of agroecology provide a foundation for examining and understanding the interactions and relationships among the diverse components of the food system (Francis et al. 2003).*

How can a food system be characterized as agroecological? There is a clear and undisputable link between how food is produced and how it goes into the food system. Stassart and co-authors (2012) and Levidow et al. (2013) emphasized ways in which agroecological systems could expand to a broader level, suggesting greater valorization of agrobiodiversity and the underlying diversity of knowledge found in both farming and food system, while providing broader perspectives of agroecology both in farming and food systems. Logically, food cannot be claimed to be 'sustainable', even when being produced in a 'sustainable way', if it feeds into and contributes to food systems which are fundamentally unsustainable, *e.g.*, are contradicted by the use of huge amounts of fossil fuels or packaging material, or increase social inequity, or are wasteful of other tangible and intangible resources.

Sustainability has multiple dimensions, and as emphasized by Gliessman (2007, p. 345): '*A sustainable food system is one that recognizes the whole-systems nature of food, feed and fiber production in balancing the multifaceted concerns of environmental soundness, social equity, and economic viability among all sectors of society, across all nations and generations'*. Gliessman (2011) writes, with a background of 15 years of experience with an agroecology course, about the

constraints of earlier framings of agroecology only as a science: '… *they are primarily trying to make an argument that agroecology is basically a science for developing new food production technologies that do a lot of positive things for agriculture, the environment, and for people. This is good, but what they don't seem to acknowledge is that agroecology is also a social movement with a strong grounding in the science of ecology. And when I say strong grounding in ecology, I mean grounded in our understanding of relationships, interactions, co-evolution, and a capacity to change to meet the complex aspects of the sustainability we are trying to achieve in food systems – from local to global'*. Gliessman (2015) mentions five important elements of alternative food system (alternative to the current globalized food system): '*In such a system (1) food production and consumption has a bioregional basis; (2) the food supply chain has a minimum number of links; (3) farmers, consumers, retailers, distributors, and other actors exist in the context of an interdependent community and have the opportunity for establishing real relationships; (4) opportunities exist for the exchange of knowledge and information among all those who participate in the food system; and (5) the benefits and burdens of the alternative food system are shared equally by all participants. These aspects of an alternative food system are closely interrelated. (Gliessman, 2015, p. 323).*

The linkages between agroecology and food sovereignty receive wide acknowledgement and detailed explanation by agroecological and food sovereignty movements (Altieri and Nicholls 2012; Perfecto *et al*. 2009; Holt-Giménez and Altieri 2013; Anderson et al. 2015; Vandermeer et al. 2009), viewing agroecology as a major catalyst for enabling the realisation of the agrarian reform called for by the food sovereignty movements. These movements focus upon principles of low-input use, resilience, sustainability as well as its prioritisation of smallholders or peasant farmers (De Abreau and Bellon 2013; Thiemann 2015; Perfecto et al. 2009; van der Ploeg 2013). Food sovereignty and agroecology are also strongly united through their agency for and common defense of what are claimed as the common inheritances of humanity in terms of natural resources. Altieri and Nicholls (2012) demonstrate how different dimensions of sovereignty including food, energy

and technological sovereignties are all critical to agroecology and contribute to its resiliency. Table one suggest how linkages between key features of agroecology on a wider scale can be thought into important functions and structures of entire food systems.

[Table one near here]

Multifunctionality and resilience are highlighted by numerous agroecological scholars and address agroecological systems' capacities and aims (Wilson, 2007). These scholars assess system properties such as ability to absorb shocks, and other inherent capacities to undergo relevant transformations, transitions, and processes of stabilization under changing and new conditions through feedback loops and iterative development processes (Altieri and Nicholls 2012; Gliessman 2015). Resilience is a relevant key concept which potentially informs the design and maintenance of an agroecological food system, which can build upon local structures of markets, linking reciprocal flows e.g. between urban and rural landscapes, preserving food cultures and nourishment, and opening new possibilities for processing, storing, and retailing. In an agroecological farming system 'health' is crucial at all levels of the system. This holistic understanding of health and the importance of maintaining a high immunity level is also relevant for food systems, where the juxtaposition of feed-back loops, like immune system response, are imagined to help regulating the resource flows and stimulate the social connectedness in the food system, and emphasizing the nourishment aspect of the food which is produced, exchanged and eaten in the food system.

Nourishment is an important characteristic, not only of food itself, produced under circumstances which nourish the soil and environment, but also in a food system which aim at composing our entire diets as a 'sustainable diet', as defined by FAO: '*those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources'* (FAO 2012:

http://www.fao.org/docrep/016/i3004e/i3004e.pdf). In addition to the established four aspects of food security (World Food Summit 1996; FAO 1996), and in connection with the institutional framework and governance of food, the Ryerson University Centre for Studies in Food Security (2016) adds a fifth dimension of food security, namely 'agency,' which multiple examples and cases point to as the most crucial critical factor for all aspects of food security (see also Chappell and LaValle 2011; Chappell 2017; and Rocha et al. 2012), and which highlight equity as an important pillar of agroecological food systems. This also links to 'nourishment' as a concept which goes far beyond 'providing passive populations with calories', focusing instead on peoples' ability, access and right to grow, exchange, and eat healthy, nutritious food which is meaningful to them, in a fair and equitable way (as e.g. described in AFSA 2016).

Particular challenges and opportunities for agroecological food systems in city-region contexts

> *Potentials in the agriculture and food systems that link urban and rural areas need to be maximized as a normal part of a balanced development process. (FAO 2014(c))*

City Region Food Systems (CRFS) is referred to as a cutting-edge concept (Blay-Palmer et al. 2015; FAO 2014(d)). In this article, we understand a city-region context for food systems as a landscape which includes rural, urban and peri-urban areas, the two latter varying from few thousand persons (smaller towns) to many million people (mega-cities), which of course will call for widely different place-based and context relevant solutions.

The increasing and partly unplanned urbanization has led to significant changes in diets, consumption patterns and food trade (Proctor and Berdegué 2016; Vorley and Lancon 2016), and in many urban areas, food markets are detached from local or domestic food production. In addition, huge amounts of so-called waste are produced, both in terms of food waste from processing and ensuring availability of a wide range of food at all times for eaters, as well as waste based on non-renewable resources (e.g. packaging material). The fact that we talk about 'waste'

underlines the detachment from food production and farming, soil management, animal keeping and resource cycles which was not present just 100 years ago (Vitiello and Brinkley 2014; Brinkley and Vitiello 2014

These issues are addressed by the first two points in Table one, which are strongly interlinked and enforces minimal external inputs and recycling of resources (Altieri 1995 and 2002; Altieri et al. 2012; Gliessman 2015) and biomass (Altieri and Toledo 2005; Altieri and Nicholls 2012). In a city-region context, this clearly calls for a reorganization of resource cycles and avoidance of losses of energy, water, and nutrients in a combined rural-urban landscape. Where the linkages between rural and urban areas in some cases are facilitated by local governance systems in terms of markets linking e.g. smallholder farmers with urban markets (e.g. Berdegué et al. 2014), creation of full resource cycles including e.g. compost material from cities to the soil and the rural areas, seem to be rarely addressed. Such cycles could involve human food waste being converted into animal feed and compost, energy in terms of biofuels produced from what normally would be considered as organic waste, minimization of plastic and packaging, and systems involving human urine and feces being composted and/or recycled in safe and responsible ways. Indeed, such agro-waste-recycling systems enabled Paris to rely on its local foodshed for over 1000 years (Atkins 2007; Barles 2007; Billen et al. 2009; Billen 2011).

The system boundaries in a city-region food system cannot be clearly defined, and a 'completely closed food system' would be unlikely, even a contextualized food system, shaped and iteratively co-created by multiple involved actors, and based on recycling and closed loops principles. Most likely, based on already existing examples of local food systems aiming at sustainability including environmental, social, economic and institutional levels (referring to the four-dimensional sustainability concept as described by Spangenberg and Valentin (2000), Spangenberg (2004) and FAO (2012 (b)), an agroecological food system in a city-region context will consist of a complex web of smaller food systems, e.g. involving CSAs, urban and peri-urban farming and a number of different supply chains and levels of organization, which interact and overlap internally as well as

with surrounding landscapes and food systems. Most likely, products from other geographic and climatic zones, e.g. coffee and spices, will be involved, and inclusion of surrounding marine or other landscape elements can blur apparently clear systems boundaries. Furthermore, vulnerability to local shocks raises the general idea of crisis-preparedness and will always call for a certain ability of all food systems to step in and assist others, in case of failing harvests or natural disasters, and make wider connections between food systems desirable. Trade and transport between different food systems can be organized in ways which are equitable and environmentally not burdening, and can supplement local food systems rather than displace local produce. These aspects need to be considered if taking the aims and characteristics of agroecological food systems serious.

Mendéz and co-authors (2013) discussed transformative agroecology and stated that agroecology is explicitly committed to a more just and sustainable future by reshaping power relations from farm to table. In our contextualization of agroecological food systems, we see the need to explore how the food system can be connected in whole cycles, that is, from table to farm as well. As mentioned above, Gliessman (2011, 2015 and 2016(a)) discusses what 'our food system' would look like, if transformed so that it follows the basic thinking of agroecology. This is envisioned as the unfolding across five potential levels of transformation, where the first three address agroecosystem changes, and levels four and five target formation of more local and global food systems, respectively. Level four targets the local level food systems and creation of the above-mentioned 'food citizenship', where food is grounded in a direct relationship between eaters and growers. Level 5, however, targets a wider change: '… *build a new global food system, based on equity, participation, democracy, and justice, that is not only sustainable, but helps restore and protects earth's life support systems upon which we all depend' (*Gliessman 2016 (a), p. 188). This vision for integrating webs of different food systems – whilst emphasizing the importance of fairness throughout the systems – become of high relevance in complex and multifunctional city-region food systems.

How does an agroecological city-region food system challenge food production, exchange and consumption?

There is much evidence of severe negative longterm environmental and social effects of our current globalized food system, e.g. the feed and livestock production as one example (Vorley and Lancon 2016). The ideas of agroecological food systems present alternatives to this, among others by contributing to local economic and resource circulation and inclusive, equitable food systems. Such systems should maybe better be described as 'socio-agroecological food systems', emphasizing the closely woven social, agroecological, and ecological interactions, *e.g.* in terms of networks involving both farmers and non-farmers and between actors in the regions, no matter whether we talk ecological or political zones. Greater recognition is being given to the need for building sustainable and resilient urban food ecosystems (The Chicago Council on Global Affairs 2013; Farming Matters 2015). In Figure one below, we have attempted to illustrate how key concepts of agroecology can stimulate the food systems thinking in a city-region food system context.

[Figure one here]

Minimising use of external inputs and increasing internal recirculation of resources

As highlighted above, the focus on food systems in the discussion about agroecology demands a far more comprehensive and holistic systems approach than *e.g.* the simple 'value chain' or 'supply chain', long prominent in food systems development discourse. Agroecological systems are based on minimal external inputs and increased recycling of resources. Food in a 'chain' traces the steps on the way from production to consumption, with potential for complete detachment of relationships between the steps, and often sees eaters as 'end-users' who are called 'consumers'. In the current detached system, feed can come from a different continent, and the products can go to a third continent, enabling animal production and consumption literally 'without limits', as it is the case for example in current Danish pig production, where the feed comes from South America, pigs are raised in Denmark, and the pork is exported to Asia. The systems approach gets lost in this

regime, eliminating the potential for feedback signals to improve resilience and adaptive capacity, both regarding resource flows, and consumption patterns. The question of animal products can reveal the limitations of this chain perspective: if stressing the systems approach, animal feed needs to come from within 'the system', which is also where animal products will circulate. If a systems approach is taken – as is necessary in an agroecological system – production is limited by the need to produce food for people situated within and maintaining landscapes – and closer proximity between animals and crops improves the potential and efficiency for nutrient cycling. A 'full agroecological food system' may also have short supply chains, based on recycling and circulation, which will connect 'the two ends of the chain' and actors within the food system.

Following the emphasis above to constantly align and adjust food production with food consumption, the mere production of food can be seen as a big challenge. Depending on the magnitude of the urban areas, the agroecological food producing systems will have clear challenges in producing enough diverse food. Compared to many current urban food consumption patterns, the consumption patterns of agroecological food systems have to change, towards local (and therefore also season-related) food, and animal products of an amount which can actually be supported by each agroecological food system. How can the consumption patterns and the capacity of the food producing rural and urban farms be aligned and adjusted to each other, mutually and iteratively?

This will require processes of negotiation, adjustments and development of common understandings, shared knowledge and collective action to ensure that everybody at all times will have access to healthy nutritious food.

Resilience, integration, complexity and multifunctionality

One aspect which is rarely explored is how such strongly interwoven food systems can contribute positively and benefit the overall landscape and biodiversity (Bommarco et al. 2013; Caron et al. 2014; Kremen and Miles 2012), such as e.g. the findings of Chappell et al. (2016), where increased ant biodiversity may have been linked to positive changes in local food security in Belo Horizonte, Brazil. Another aspect that is rarely explored in detail is how urban-rural food systems will require

certain features of the food producing systems, which involve the rural areas. How will it change the consumption patterns?

Seasonality can present constraints on the 'boundedness' of a food system, as can the desire for convenience in contemporary diets. Depending on growing conditions, rain patterns and seasons, it can be a huge challenge to produce diverse food all year round for a population in and around urban areas and the rural areas connected to it. These requirements emphasise the qualities which are highlighted in the agroecological food systems: resilience and multifunctionality in well-integrated and complex system. A development towards more diverse, integrated production can lead to a much more diverse all-year round production, as is for example seen in agro-forestry and food forest systems. The combination of rural farming and urban farming, where rural farming to larger extent produce stable food, roots, animal products and e.g. fruit and urban farming focuses on fresh vegetables, leafy food, spices, nuts and fruit, can form examples of ways of extending the traditional growing seasons.

Innovative processing possibilities, e.g. solar powered freezing facilities, can offer other opportunities for bridging the 'production cycles' with the 'consumption cycle' in urban-rural areas. Furthermore, the diversity of systems – both within systems and within a web of systems of urban and rural farming – will contribute to resilience and nourishment based on balanced diets all year round.

Contextuality, Equity and Nourishment for Health Resilience

The challenges highlighted above – production at scale, producing diversity and producing food all year round - will of course vary widely depending on the context. Clearly, tropical areas differ from temporate areas, dry areas differ from very wet areas and the length of growing seasons vary widely. Vandermeer and Perfecto (2013) emphasise the necessity of using traditional and local knowledge in combination with the knowledge and insight of 'modern ecological knowledge', to develop agroecological knowledge which is both deep and broad at the same time, allowing for learning across sites, as well as developing each site. In large part of Europe and North America,

current farming practices have focused on very few types of productions with only one yearly harvest of e.g. grain. Many exciting initiatives could serve as examples of urban food strategies involving local food producing systems (Sonnino 2016), and emerging agroecological food systems, viewing rural-urban landscapes as interconnected, and connecting actors through exchange of food and resources (Chappell 2017; FAO 2014(a), Hummel *et al*. 2015; Rocha *et al.* 2012; RUAF 2015; Forster and Getz Escudero 2014 (a) and (b); Dubbeling 2013; Cohen and Ilieva 2015). The visions and practical organisation shown in these examples, bridge rather than contrast 'rural' and 'urban', which opens opportunities for sustainable, agroecological food systems across the rural urban continuum (Forster and Getz Escudero 2014(b)), which again highlight the importance of contexturality, where smaller towns provide completely different options and challenges than larger cities, seen as contexts for city-region food systems.

'Equity' is a cornerstone in relation to systems research and agroecology (Nair 2014; FAO 2014 (a)), and relates to justice in terms of 'equitable access to resources' in relation to farming, seed, water, and land, for current and future generations. Many initiatives on justice in the food chain also address equity, e.g. 'technology justice' building on access, local innovation and sustainable use of technologies (IIED Technology Justice Policy Briefing 3, 2015). The term highlights social aspects and includes original populations and peoples' rights to land, water and natural resources. It also encompasses the genetic inheritance of humanity, and equal rights to make a living and survive on this planet. It also raises issues of gender equality, acknowledging both women and men's rights to dignified futures and livelihood as well as food. It recognizes that women often are responsible for family food, agro-biodiversity and knowledge transfer between generations regarding many agricultural and food practices.

Where agroecological farming systems use methods to nurture the soil and the ecosystems while producing healthy nourishing food, the agroecological food systems takes the very same principles up to the level of the way in which we compose our entire diets and process, sell, buy and exchange food within the food systems. The concept of nourishment includes nutritional and cultural aspects

of food and food consumption, and links to ideas of 'sustainable diets', as defined by FAO: 'those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources' (FAO 2012 (a)). Furthermore, focusing on nourishment also emphasize the concept of health, which in a more holistic framing can be seen through the lenses of resilience (Döring *et al*. 2015), linking our diets closely to the farming and the food systems. The different understandings of resilience do not only cover social, economic, institutional, and environmental transformation processes of land and food, but also of public health and the health at all levels from soil, plants, animals to humans and ecosystems.

Governance and planning of a city-region food system

Whether rural areas can benefit from urbanization and can be closely linked to food systems in rural-urban areas depend much on national and international policies on subsidies, land use, trade and agriculture. Nelson and co-authors (2009) emphasized the importance of governments actively promoting and supporting the development of sustainable food systems, although they also notice that in the case of Cuba, this was done primarily for ensuring food for the current generation of humans, rather than for ideological or moral reasons (e.g. taking future ecosystems into considerations). Petersen and co-authors (2013) demonstrate a process of increased agroecological governance of the food system in the case of Brazil, strongly influenced by the struggles of rural social movements, helped to gradually form more inclusive and direct rural-urban connections in the food system.

Vorley and Lancon (2016) call for a shift from 'agricultural policies' to more integrated 'food policies' involving both agriculture and food in increasingly urbanized areas, and Proctor and Berdegué (2016) emphasise the need to deconstruct the rural-urban dichotomy as the first step of creating equitable inclusive rural-urban food systems. The Kenyan Greenbelt Movement (Mathaai

2004) is another example on how land, cities, ecosystems, human livelihoods and equity issues were combined in efforts for better food security and sovereignty. Agroecological food systems are about more than rural responses to urban consumption. They are multi-faceted and encompass economic, environmental, social and institutional aspects, requiring deliberation and negotiation within a multi-actor perspective (Nelson et al. 2009; Poux et al. 2016). This is fundamentally different from the current globalized food system that takes little account of the diverse range of perspectives and needs among multiple actors in the production, processing, and exchange of food. Bellamy and Ioris (2017) discuss the imbalanced subsidy system e.g. through EU, to farming and research, where the majority of support goes to industrial farming systems. However, many initiatives are taken on governance levels to stimulate domestic food production and local value chains, e.g. Nigeria's policy to stimulate domestic production of major commodities, and ban of rice import in 2012 (Vorley and Lancon 2016). A considerable effort is required regarding the governance of each agroecological city-region food system to facilitate social interaction and institutional arrangements that can constantly support the processes of recycling and exchange between different levels and elements of the system. Jennings and co-authors (2015) provided a visualization of the concentric city food provenance zones to illustrate how the idea of a 'region' might pertain to a political or an ecological region, and to describe how different zones might contribute to a city's food supply in varying proportions. The importance of planning for change and transition into coherent and efficiently working city region food systems is emphasised through innovations in infrastructure and governance, like for example illustrated in Figure one above. Different options for governance of city-region food systems are pointed to by Da Silva and Fan (2017), who mention the necessity to coordinate policies for rural and urban areas, promote social protection in rural and urban areas and support inclusive and efficient value chains between rural-urban areas. These highlight the importance of bringing stakeholders, researchers, politicians and practitioners together, and draw emphasis on the importance of facilitating legal frameworks for these city region food systems (Dubbeling 2013). The city-region food systems need to be organized and supported through governance, among others to allow farmers to plan their strategies

and form collaboration efforts (Filippini et al. 2016), which necessarily must be place-based and complex. Governance is also required in relation to the pricing policy, and external factors surrounding food production are not considered in the current pricing system (Bebbington et al. 2001; FAO 2014b). Another aspect is the protection of farmers, who are often overseen or reduced to outgrowers or industrial workers on their own land – which is maybe even taken from them – and the governance system around agroecological food systems need to ensure that the potentials of diverse farms and human as well as social knowledge are fully utilized and valued, and being described in research efforts taking the agroecological principles into account (Hatt et al. 2016). In current food systems, small scale producers are particularly often marginalised and have no possibilities to participate to attain a fairer share or distribution of the income, risks and benefits in these structures of prevailing markets, policies and related institutions (UN 2010).

Agroecological food systems can be essential features contributing to the practical and theoretical realization of initiatives linked to the so-called Milan Urban Food Policy Pact, which was launched in October 2015 and signed by 117 mayors from all over the world (http://www.foodpolicymilano.org/urban-food-policy-pact/; Forster *et al.* 2015). The commitment builds as a response to the increasing food demand from cities, which by now host over half the global population, and is shaped in recognition of global challenges including climate change, human health problems, disconnections in the food value chains and lack of access to healthy food: '*… to … work to develop sustainable food systems that are inclusive, resilient, safe, and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimize waste and conserve biodiversity while adapting to and mitigating impacts of climate change'*. Furthermore, this Pact gives attention to the significance of landscape level planning entailing ecosystems and farming systems within and around the cities and it identifies participatory strategies to realize their holistic goals: '*…apply an ecosystem approach to guide holistic and integrated land use planning and management in collaboration with both urban and rural authorities and other natural resource managers by combining landscape features, for*

example with risk-minimizing strategies to enhance opportunities for agroecological production, conservation of biodiversity and farmland, climate change adaptation, tourism, leisure and other ecosystem services'.

The collaboration behind the Milan Pact represented a wide cross section of city leaders, anticipating food system pressures likely to accompany the trend of rapid urbanization in many areas around the world, while also providing a relevant framework for utilizing and shaping sustainable living environments and food systems in the hundreds of shrinking cities worldwide (Hermann et al., 2016). The vision, strategies and practical applications of work to incorporate agroecological food systems provide ample entry for potential solutions in many types of situations all dealing with states of transformation in rural, urban and rural-urban areas.

Conclusion

We reviewed the literature on agroecology in a food systems context and identified the following eight key characteristics: 1. Involving minimal external inputs, 2. Resource recycling, 3. Resilience, 4. Multifunctionality, 5. Building on complexity and integration, 6. Contextualisation, 7. Equity and, 8. Nourishment. We focused particularly on city-region food systems and the particular challenges and opportunities of agroecological food systems in such settings. Agroecological food systems are widely diverse, shaped by context and achieved through multi-actor planning in rural, peri-urban and urban areas. They call for a fundamentally different vision of food systems that runs counter to the current large and globalized food systems that are based on specialization, industrialization, and comparative advantages assessed through narrow economic modelling. The deep mutual embeddedness of farming and food systems emphasizes that 'agroecological food' is not only food which is produced using agroecological agricultural methods, but also food going into a system which is built on the basis of agroecological principles, and where resources are part of full cycles, that is, also going from where food is eaten to where food is grown. The latter receives generally much less attention than the flow from food production and into the systems where food is shared, traded, eaten and valued as food. Likewise, the environmental and landscape

related benefits from city-region food systems have been sparsely explored. A radical shift in thinking is particularly necessary in relation to 'rural producers' and 'urban receivers'. More comprehensive and holistic food system communities are foreseen where 'rural producers' clearly also are knowledgeable consumers, and 'urban receivers' are involved actors, developing more balanced food systems with, for example, less waste of food and resources, more balanced diets, and recirculation strategies. Application of agroecological food systems in rural-urban contexts emphasize the necessity of diversification, zoning rural-urban landscapes, planning for seasonality in a food systems context, and producing at scale. Rural-urban food systems are a relevant and challenging entry point that provides opportunities for learning how food systems can be shaped for significant positive change. Social organization, community building, common learning and knowledge creation are crucial for agroecological contextualized food systems, as are the supports from appropriate governing and institutional structures.

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Agroecology principles…	**… in a food systems context**
(1) Resource recycling and minimizing losses	Recycling and minimizing losses of biomass and natural resources in terms of food, water and compost between the different levels of a food system, including minimizing losses of genetic resources. In a city-region food system this implies common awareness and organization of rural-urban cycles.
(2) Minimal external inputs	Use of local resources which enhance the environment: energy, human skills, capacities, and which are in accordance with the natural and social environment in a food system, hence 'internal inputs'.
(3) Contextualised	Farming and food systems are developed in each context with and by the actors, who carry and constantly co-create relevant knowledge. The consciousness of the context may be emphasized in the agroecological city-region food system, where several 'non-natural elements' are involved in the landscapes. In CRFSs the importance of this is captured in the concept of 'place-based food'.
(4) Resilience	Adaptive capacity, health and immunity in the food system at all levels (social and environmental; individuals and populations), in terms of ability to absorb shocks and disturbances, over seasons and in times and conditions of change and challenges. This involves feed-back loops of production and need for diverse food over seasons. Diversification and diverse genetic resources can enhance resilience.
(5) Multifunctionality	The system has ability and capacity to carry out multiple different functions, often involving multiple actors and giving many different

	roles to each system element, as well as to the links between them.
(6) Complexity and integration	Enhancing interaction and synergies in social-ecological systems, building on sensible resource efficiency at all levels of the food systems, to meet the challenges of *e.g.* seasonality, storage and production at scale.
(7) Equitable	Emphasising multi-actor involvement, the necessity of clever use of human resources and mutuality within the system, valuing different capacities and knowledge types and no exploitation, as well as acting in ways which nourish and allow future generations to develop and flourish.
(8) Nourishing	Use of non-destructive inputs and resources which nourish soil, the environment, plants, animals, humans, landscapes and ecosystems at all levels of the food and ecosystem, supporting healthy diets in resource clever food systems, and understanding health as resilience.

Table 1. Key words and concepts of agroecology. In this table, we explore how these key words and concepts can become meaningful in different types and settings of food systems.

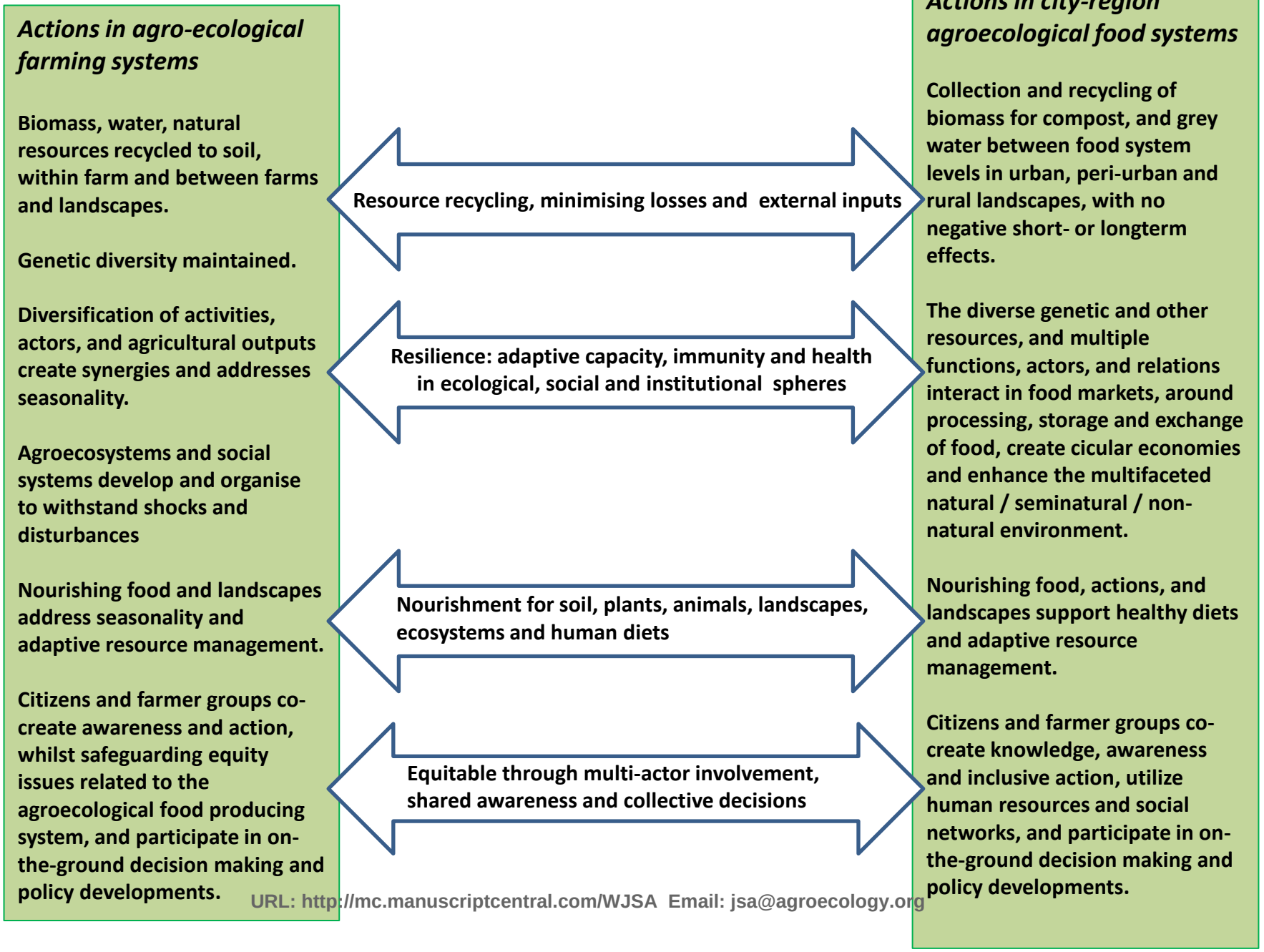
Actions in agro-ecological farming systems
Biomass, water, natural resources recycled to soil, within farm and between farms and landscapes.
Genetic diversity maintained.
Diversification of activities, actors, and agricultural outputs create synergies and addresses seasonality.
Agroecosystems and social systems develop and organise to withstand shocks and disturbances
Nourishing food and landscapes address seasonality and adaptive resource management.
Citizens and farmer groups co-create awareness and action, whilst safeguarding equity issues related to the agroecological food producing system, and participate in on-the-ground decision making and policy developments.
Resource recycling, minimising losses and external inputs
Resilience: adaptive capacity, immunity and health in ecological, social and institutional spheres
Nourishment for soil, plants, animals, landscapes, ecosystems and human diets
Equitable through multi-actor involvement, shared awareness and collective decisions
Actions in city-region agroecological food systems
Collection and recycling of biomass for compost, and grey water between food system levels in urban, peri-urban and rural landscapes, with no negative short- or longterm effects.
The diverse genetic and other resources, and multiple functions, actors, and relations interact in food markets, around processing, storage and exchange of food, create cicular economies and enhance the multifaceted natural / seminatural / non-natural environment.
Nourishing food, actions, and landscapes support healthy diets and adaptive resource management.
Citizens and farmer groups co-create knowledge, awareness and inclusive action, utilize human resources and social networks, and participate in on-the-ground decision making and policy developments.

Figure 1. Characteristics of agro-ecological systems related to actions and how these characteristics can be spelled out and become visible in agricultural as well as in food systems, with particular emphasis on agroecological food systems in rural-urban landscapes.