

# Sustainability assessment of agro-ecological innovations at territorial and value chain scale

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**Keywords:** sustainability, innovation management, content analysis, transdisciplinary research, agricultural innovation, value chain

## Abstract

With growing awareness of global environmental problems caused by agricultural production, producers and retailers increasingly strive to introduce sustainability led changes at farm level. A propagation of cooperative approaches has led to a diversity of niche developments worldwide with multiple but small-scale effects on sustainable land use. The potential for a broader impact is often inhibited by the failure to appropriate the value creation necessary for a long term establishment in the market. The study reported here was conducted as an intermediate step in developing assessment and management tools for innovations in a smallholder farm environment. Semi-structured interviews were analysed based on network analysis, content analysis and case comparison in order to answer the following questions:

- What environmental, economic or social values are expected from the innovation as a contribution to sustainable land use?
- What is the potential and what are the limits of integrating sustainability assessment into innovation management processes in regard to value chain and territorial approaches?

Ethical issues and diversification in farm structure were found more relevant to the sector oriented approach of poultry production. The regional case differed in highlighting consensual strategies, a strong recognition of future generations, property rights and provision making. Issues of local added value, closed circular systems and capacities for development were found to link both territorial and value chain approaches. The approach is discussed for its potential in making explicit the societal and environmental value creation and for fulfilling aspects of plausibility and applicability by the practitioners involved in the project.

## 1. Introduction

With growing awareness of global environmental problems caused by agricultural production, producers and retailers increasingly strive to introduce sustainability led changes at farm level. From a consumer-oriented perspective, the willingness to pay for sustainable production of food has increased in Europe over the recent years (de-Magistris & Gracia 2016; Vecchio & Annunziata 2015). This development fuels the legitimate expectation that sustainability led changes in agricultural production can contribute to the development of new opportunity recognitions and entrepreneurship by finding new ways of production and creatively developing alternative markets.

Previous studies in ecological economics suggest that competitive advantage in changing environments is determined by employing dynamic and entrepreneurial capabilities rather than by valuable, rare or inimitable resources (Newbert 2007, Alvarez & Busenitz 2001, Porter 1985). An assessment of resources combinations for responsible innovations in small and medium enterprises calls for new business models that source from collaboration in multi-actor networks (Halme & Korpela 2013). A propagation of cooperative approaches in recent years has led to a diversity of agriculture-based niche developments worldwide with multiple but small-scale effects on

sustainable land management (e.g. Little et al. 2010). The potential for a broader impact is often inhibited by the failure to appropriate the value creation necessary for a long term establishment in the market. The development of new products is challenged by not reaching a competitive advantage over conventional management practices.

The overall objective of the study reported here was to assess the potentials and limitations of integrating sustainability assessment into innovation management processes. The question is addressed in the frame of a transdisciplinary project accompanying an ongoing innovation process for two case studies in north-eastern Germany. The first case aims at using surplus biomass for small-scale thermal production in wet grasslands. This will be enabled by a cooperative production strategy by pooling wet grassland farm area in the Biosphere Reserve Spree Woods/Blota in the federal state of Brandenburg. In the second case, smallholder farmers aim to realize the value of traditional quality breeds produced in a mixed poultry production system. This is explored through joint marketing of eggs and meat in Brandenburg and Berlin via Naturland Marketing, a trading farmer association for organic farmers. Semi-structured interviews were analysed based on network analysis, content analysis and case comparison in order to answer the following questions:

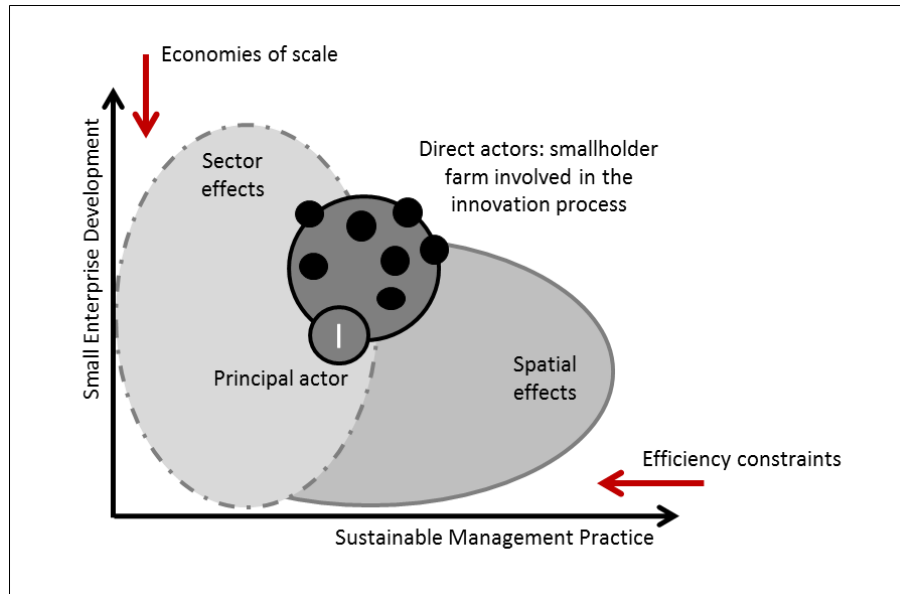
- What environmental, economic or social values are expected from the innovation as a contribution to sustainable land use?
- What is the potential and what are the limits of integrating sustainability assessment into innovation management processes in regard to value chain and territorial approaches?

### 1.1 Agro-ecological innovation

Agro-ecological initiatives born in the organic movement have the aim to extend the use of local resources as an alternative to the mainstream regime of industrialised agriculture (Barbier & Elzen 2012; Wezel et al. 2009). Activities often involve practices that call for low factor inputs per land unit, thereby favouring farm systems in regions with low yield potential or traditional cultivation practices.

The creation of alternative production practices as a new form of agriculture requires a comprehensive approach that differs for example from approaches of transforming conventional to organic farming by depending on multi-level and multi-actor cooperation to a larger extent, e.g. due to missing linkages with supply chains. Similar to processes of radical innovations, value realisation of innovative sustainable land management practices is challenged by quantity effects in implementation (economies of scale) as well as efficiency constraints in production and marketing. In regions, where value chains have adapted more or less completely to agricultural systems that follow the rules of economies of scale, alternative production systems find themselves in a situation where they are “too big to ignore, but too small to survive” (pers. comm. smallholder farmer). Positive impacts at a landscape level (spatial effects) then depend on coordinated and overlapping strategies between actors, e.g. in distribution and marketing. An improved linkage to supply chains (sector effects) depends e.g. on interaction of actors between sectors based on spatial proximity. Furthermore, an achievement of synergies as well as access rights to resources requires interaction between stakeholder groups previously unrelated in production practice. Termed system innovation (Elzen et al. 2004; Geels 2005), these type of innovations were found to encompass technological change by requiring a broad change process including adaptations in farm management, the production system or the business model as well as new combinations of resources allocations. Figure 1 illustrates the analytical framework for the assessment of farms that in order to develop new production processes are faced with constraints that can be partly

explained by theories from small enterprise development (Glover et al. 2016, Porter 1985), and partly with theories from adoption of sustainable management practices (Schot & Geels 2008).



**Fig. 1** Agro-ecological innovation systems influenced by economies of scale and efficiency constraints (own illustration)

### 1.2 Linking impacts at territorial and value chain scale

Traditional environmental impact assessment of production processes on farms generally targets spatial criteria. Units are based on ha of land, and impacts are often measured in emissions or effluents. Agro-ecological indicators for an optimization of integrated farming systems have been developed for example by Bockstaller et al. (1997). These indicators estimate the impact of cultivation practices on the environment, and enable farmers to adapt their cultivation practices to the requirements of an integrated farming system, from one cropping year to the next. Successive tools for assessing environmental, economic and social aspects of sustainable management practices in farming systems have differentiated between sustainability at farm-level and contributions to sustainable development at a regional scale (Ghadban et al. 2013).

Assessments in innovation processes on the other hand are often related to the value chain. Units are generally described per kg of product, such as in life cycle assessments (Lindner et al. 2010), while evaluations additionally put a strong focus on the stakeholders linked to the product (Sieber et al. 2015). An integration of the supply chain perspective and the production site with its natural environment remains a challenge due to trade-offs between the different characteristics of scope (Schader et al. 2014).

## 2. Method

The study of agriculture based innovations for sustainable land use was conducted in north-eastern Germany in a range of up to 300 km from Berlin. Economic activity declines with distance from Berlin, and the main area is characterised by agriculture, coal mining, renewable energies, and increasingly tourism. Agricultural practice is dominated by large farm enterprises with an average size of 238 ha, which is four times the German average. Grain, field forage and oil seed

make up relevant crops in terms of land use. In light of current price developments, farms on marginal areas face increasing challenges to operate profitably in the long term. The overall development calls for economically viable alternatives based on innovative approaches. Often these are developed in a niche market environment, for example by making use of a demand for local, organic or high-quality products in the urban environment of Berlin.

The integration of two ongoing innovation management processes into a transdisciplinary research project on sustainable land use was the starting point of the analysis. The innovation in both cases was a combination of a product based on a new type of production process that is perceived as sustainable, and an organizational innovation based on a new form of cooperation between actors. In the first case, local farmers aim to explore the use of surplus biomass for small-scale thermal production in wet grasslands by implementing a joint strategy enabled by pooling smallholder farm land. In the second case, smallholder farmers in the poultry sector cooperate with Naturland Marketing, a marketing platform for organic farmers, in order to realize the value of traditional quality breeds based on mixed poultry production systems.

The overall approach is defined by participatory action research, characterized by the joint solution-oriented collaboration between practitioners and researchers (Pelenc et al. 2015; Padilla & Filho 2012; McIntyre 2008). The aim was to facilitate the development of the innovation towards higher market relevance and to achieve long term establishment of the innovation outside its initial niche. The process was being driven by practitioners while the role of the researchers was to reflect, assess and consult during the process of development and adaptation. The study reported here was conducted as an intermediate step in developing tools for an assessment of innovations for sustainable land use.

## 2.1 Case comparison and data collection

In both case studies, sustainable management practices were introduced that can be described in terms of innovative change. Both case studies stand out due to their setting and situation:

- The innovation process is based in the agricultural sector and is in a phase of a conceptual or actual proof-of-concept,
- The sustainable management practice implicates additional costs that require compensation. The break-even threshold was not reached at individual farm level, mainly because additional benefits were not acknowledged by consumers. This component, however, was not clearly defined by the stakeholders at the outset of this study.
- The stakeholders were not aware of benchmark figures, instruments for resources planning or tools for integrated assessments such as RISE (Grenz 2013) or SMART (Schader et al. 2016). A production process “as is” has either phased out or did not exist from the start. In consequence, we found that the actors themselves employed no heuristic instruments for a quantified assessment of resources, outcomes or impacts e.g. based on book-keeping data.

Two main data collection methods were applied in the study, namely key informant interviews and focus group discussions. For each case study we conducted an on-site inspection together with actors involved in the innovation process followed by a transdisciplinary focus group workshop with experts from practice, and a workshop for reflection with researchers from different fields of sustainability science. Open-ended interviews were conducted with people linked to the innovation as well as additional stakeholders from each sectoral and regional surrounding. The interviews were taped and transcribed. Focus group discussions and excursions were documented by protocols and used additionally to understand interactions and relationships between actors. Data

was analysed by content analysis and case comparison to identify the value perceptions of actors linked to the innovation.

## 2.2 Key informant interviews

Semi-structured interviews with open questions were conducted for both case studies. In regard to sustainability value perceptions, a response to questions can differ between open and closed questions. The question: “What do you associate with sustainability?” posed as an open question will often be responded to by an individual interpretation of the concept of sustainability, while a closed question may lead to socially expected responses.

Actors for the interviews were identified by their proximity to the innovation process via network analysis. Actors were categorised at three different levels of cooperation (Table 1):

A **principal actor** was identified who is closely linked to the idea or invention. The principal actor was characterized by the ability to recognize an entrepreneurial opportunity and initiate the process of combining and organizing resources. In both case studies, this person was not a farmer. The exploitation of the entrepreneurial potential, however, was strongly dependent on the commitment of a collective group of farmers who committed to the idea for implementation.

The group of smallholder farmers committed to the innovation process was identified as the group of **direct actors**. The direct actors brought own resources into the innovation process. The relationship to the principal actor is one of mutual dependence and joint ownership of the innovation process. The relationship between the principal actor and the group of direct actors is characterized by negotiation processes mainly aimed at improving the product or the production process.

The third group was termed **indirect actors**. This group was linked to the invention by loose ties in the sense that there was no engagement in the innovation process with own capital resources. Interaction with this group of actors, however, was seen as vital for success in the respective sector and region. Moreover, this group can be positively or negatively impacted by implementation, for example as a final beneficiary of improved regional assets for tourism or better quality products. The direct and indirect actors felt committed to the innovation process on the basis of regional proximity in case study 1, and sector proximity in case study 2.

**Table 1** Description of actor relationships in the case studies

	Principal actor	Direct actors	Indirect actors
<b>Case study 1: Small scale thermal energy production</b>	UNESCO Biosphere Reserve Spree Woods, State Office for Environment	10 smallholder farmers with joint land ownership of 1000 ha in the Spree Woods/Błota	Tourism Nature conservation Hunters and fishermen
<b>Case study 2: Mixed poultry production</b>	Naturland Marketing GmbH	8 farmers with total poultry production of 3000 hens produced and marketed in cooperation with Naturland	Processors (meat) Extension services Breeders Marketing organisations

## 2.3 Content analysis

Content analysis was applied to all transcribed interviews in order to understand the objectives associated with sustainable development by the actors involved in the innovation process. The concept was based on the understanding that value perceptions have an effect on resource allocations and decision making for example in ecosystem services assessments (MEA 2005), and thus should be recognised in innovation management, particularly when it comes to economic

analysis. It was also used in order to reduce complexity by identifying the relevant objectives that linked the innovation process to concepts of sustainability.

Aligned with the overall participatory approach in the project, the content analysis was applied as an empirical method for qualitative and inductive research (Elo & Kingäs 2007). Whole sentences were coded, based on attributes of value perception and indicated by words such as “relevant”, “important”, “prior”, “it is about”, “essential”, “crucial”). The open codings were grouped under higher order headings according to similarity. 15 interviews were analysed for Case Study 1 and 13 interviews for Case Study 2.

In a first step, 46 sub-criteria were identified and classified into 15 generic criteria used to explain the sustainability aspects of the innovation. The criteria were cross-checked against the three pillar approach of social, economic and environmental criteria. In a second step, three main categories were retrieved from further abstraction of sustainability objectives that ran across social, environmental and economic criteria.

### **3. Results**

The principal, direct and indirect actors involved in the innovation process had a clear idea of the values expected from the innovation in regard to sustainable development. The criteria formulated in each case study differed in minor points at the level of sub-criteria, while at the levels of higher abstraction all criteria were considered relevant by the actors in both case studies. An attribution of criteria to social, economic and environmental aspects showed that the range of criteria equally covered all three dimensions of sustainable development (Table 2). In the following, the main differences between case studies are described, and an example is presented for each of the three main objectives identified, namely local added value, closed circular systems and capacities for development. Details of the content analysis are presented in Table 3.

#### **3.1 Expectations of the stakeholders in regard to sustainability**

The component of remuneration and compensation in financial terms was termed a natural objective of the innovation process by almost all interviewed actors. One main concern was the difficulty to reach long-term market establishment in spite of the self-imposed constraint by committing to small-scale production.

The interviewed actors were fully aware of the fact that eggs, meat and biomass held little potential for a unique selling proposition as long as the additional benefit of the production system was not made explicit. The main product asset articulated in case study 1 was to achieve local effects by offering the extra service of “keeping the landscape open” in order to preserve a cultural landscape with a distinct esthetic value and biodiversity. This was considered relevant for the local communities in the region of the biosphere reserve, and furthermore, a requirement for the survival of the region as a tourist destination. In case study 2, the main product asset was seen in “ethical production” that involved raising equal numbers of male and female chicken in order to avoid premature slaughter, improved animal welfare such as small herds held in free-range husbandry as well as a general support of smallholder farming systems.

Criteria of diversification in farm structure were considered more relevant by case study 2, next to ethical issues. The actors took pride in achieving non-standardised production processes, in the sense that every farm was encouraged to pan out how the requirements of the production process would fit best to the local circumstances of the farm. Therefore, the notion of developing alternative approaches, “other” or “better” than existing organic or conventional farming practices were considered basic criteria of sustainability.



Contrary to this, consensual decision making was articulated only by case study 1, due to a strong sense of accountability for land development. This was underlined by a strong recognition of land ownership in the present generation as well as for future generations in terms of farm succession and community stability. The notion of preservation of farm structures and land as it were considered elementary criteria of sustainability that were not mentioned by case study 2.

**Table 2** Social, economic and environmental criteria for sustainable agro-ecological innovation

Criteria	Sub-Criteria	Social	Economic	Environmental
Economic efficiency	a) full cost recovery of costs and inputs, b) achievement of net profit, c) achievement of a competitive market position.		x	
Product demand	a) acknowledgement of product criteria, b) purchase of the product, c) willingness to pay a surcharge, d) regular purchase.		x	
Integrated production	Best practice in terms of a) farming practice, b) resources efficiency.	x	x	x
Employment	Production and marketing generate a) new sources of income, b) new options for employment.	x		x
Growth	Production and marketing a) implemented according to expectation, b) improved via horizontal linkages, c) improved via vertical linkages, d) transferred to the next generation (future ability).		x	
Continuity	Quality and quantity of production is a) stable and permanent, b) assured against risks, c) secured by ownership and property rights, d) contributing to the environment and livelihood of the region.	x	x	x
Regionality	Production and marketing rely on a) integration of local actors, b) integration of local resources, c) generation of local benefits.	x	x	x
Cooperation	Production and marketing lead to a) communication and interaction with actors along the value chain, b) joint activities with other actors for mutual benefit, c) merging of activities between actors along the value chain, d) collaborative decision making.	x		
Circular material flow	Production and marketing support a) recycling of resources and materials, b) closed cycle of goods and products, c) diversification of assets and risks.	x	x	x
Quality	Production and marketing meet the requirements of the consumer in regard to a) taste and esthetic perception, b) state of condition and shelf life, c) general standards defined by market and trade, d) criteria extra to common standards.	x	x	
Diversification	Production and marketing are based on a) non-standardised farm size and structure, b) non-standardised production processes, c) diverse and inclusive staff structure, d) alternative approaches in product handling, e) improvement of existing approaches in product handling.	x	x	
Independence	Production and marketing approaches can be decided and implemented independent of actors along the value chain.	x		
Biodiversity	Production and marketing do not negatively impact the conservation of a) species, b) genetic resources, c) habitats.			x
Climate	Production and marketing comply with best practice in climate relevant emissions.			x
Ethical aspects	Production and marketing comply with a) ethical production standards, b) reduction of waste, non-renewable resources and surplus produce, c) reduction of input resources beyond the necessary (e.g. large packaging).			x

### 3.2 Local added value

Local added value was defined as feedback effects expected from the implementation of the innovation in the immediate surroundings, implying financial, social and environmental benefits. "Local" was understood in reference to the unit of observation. The direct actors mainly referred

to the farm in a village environment, or the village in the district environment, while indirect actors and principal actors referred to the district, the region or the federal state.

Benefits included financial returns for people working in adjacent sectors considered sensitive or worth protecting in the region, such as tourism in case study 1, and food processing in rural agricultural regions in case study 2. The expectation was that the implementation of the agro-ecological production processes would achieve additional income sources and indirectly contribute to the survival of small scale farmers, but also producers and processors.

### **3.3 Closed circular systems**

The notion of closed circular systems was defined in a broader context encompassing a balanced nutrient flow in order to include an efficient use of natural resources with no surplus or unutilized waste production and recycling of materials. Furthermore, closed cycles were also understood in social terms in the sense of well-functioning networks for cooperation within the sector or region.

The aspect of closed cycles was often linked to regional anchorage, but was also extended to the meaning of exploiting the full value chain by coupling elements needed for production and marketing independent of distance. For example, in the case of mixed poultry production, the smallholder farmers had calculated that for approximately every 180 eggs produced, one stock chicken was raised. The reduction of surplus production in this case included the objective of a balanced supply and demand for example by good customer relations. In case study 1, the exploitation of previously underused biomass was considered the major element for closing perceived gaps in the functioning of local social structures and local monetary flow.

### **3.4 Capacities for development**

Although conscious of the constraints of small-scale production, a strong expectation of growth potentials was communicated in the interviews. Capacities for development were defined as a potential to develop the innovation along horizontal lines, such as replicating the production process in other regions by including more smallholder farmers into the programme, but also along vertical linkages, for example by the ability to address marketing structures outside the organic sector. Actors in both case studies referred to capacities based on diversification and decentralization, but also communication and knowledge transfer.



**Table 3** Main objectives associated with the agro-ecological innovation as perceived by the actors involved in the innovation process

Main objectives	Small scale thermal production (Case study 1)	Mixed poultry production (Case study 2)	Criteria
<b>Local added value</b>	<p>The key formula was not organic farming, but „grown here, produced here, processed here, and exploited by the local people (SP1).</p> <p>In consequence, financial returns will flow back to the producers and into the region via tourism. (SP2).</p> <p>It can contribute to the diversification of income sources. (SP3).</p> <p>It can generate financial returns that should be available for those who work in those farm areas. (SP6).</p> <p>The use of biomass requires technical resources; logistical questions need to be addressed. I need partners with land, entrepreneurs with financial backup who have the capacity to join in. The kind of information we need is: we have sold so much honey, and we have won ten new bee keepers. They will survive because of these activities. (SP17)</p> <p>And then the value chain is set. Not for mass production, but in the sense of an honest regional product. (SP22).</p>	<p>What we see as a basic element is the potential for the region: buying feed in Germany, breeding of animals in the region. That eggs will be marketed in the region. As well as the meat. (EC1).</p> <p>We say, organic farming is sustainable, so what do we do on top? The regional location of slaughter and marketing are on top. (EC3).</p> <p>The principles of Naturland define organic farming as „a contribution to the conservation of the natural resources and livelihood. This includes biodiversity, climate conservation and animal welfare“. For smallholder farmers it pays off to set up mixed poultry production as an additional income source. This is relevant in order to convince the farmers that mixed poultry is not only more work, but pays off financially. (EC4).</p> <p>When we start a project like this, it is all about the creation of jobs, continuity and keeping people employed, starting from the work in the stall, the care for the animals down to the packing of eggs. (EC16).</p>	<p>Economic efficiency</p> <p>Employment</p> <p>Regionality</p> <p>Independence</p> <p>Biodiversity</p> <p>Climate</p>
<b>Closed circular systems</b>	<p>Practically joining circular systems. To be able to say: “we have this area with surplus biomass, but we can save costs by exploiting the energy in situ by coupling cycles“. The local benefit will increase manifold when we achieve a coupling of local cycles. It means we can generate value and keep jobs in the region. (SP1)</p> <p>From the narrow perspective of nature conservation only two things are relevant: 1) taking out plant nutrient matter, 2) making sure, the meadows have enough moisture. What happens with the biomass is next to irrelevant. (SP4).</p> <p>And that is it, overall, that we come to the point where we have closed regional cycles that may be able to continue to other levels. Then we will have a true innovation, specific for this location. (SP17).</p>	<p>I would define sustainable land use as linkage with all adjacent elements. Socially, this is the village, the surrounding, the region. Environmentally, I see the in- and output in agriculture, and in terms of marketing, it is a closed value chain in the near region. (EC1).</p> <p>We need closed cycles in organic farming. If we now had someone innovative in processing, someone who uses surplus meat in food processing, we'd be even better set. (EC2).</p> <p>All chicks are raised. Wonderful. (EC3).</p> <p>For every 180 eggs one chicken must be eaten. The information is that this project will survive only, when the meat is eaten. The customers need to have this information. (EC7).</p> <p>I liked the idea. We wanted to keep poultry. And we also needed the manure. The circular system is very important. So we thought, this is a good thing, so we set up this type of poultry production. (EC14).</p>	<p>Product demand</p> <p>Integrated production</p> <p>Circular material flow</p> <p>Ethical aspects</p>
<b>Capacities for development</b>	<p>We could make it bigger and broader. The destination of this innovation is more than just the Spree Woods. The aspect of decentralization is the actual approach where I see the potential innovation. (SP1).</p> <p>Where we slowly and carefully have to see to the formation of other small networks. The Biosphere Reserve must become one of several performers. (SP2).</p>	<p>I think it is relevant to look at marketing structures outside of organic trade. Our idea is to get out of the niche. (EC1).</p> <p>In my opinion, this produce will always be a niche for few smallholders. But I imagine that it can be transferred to other regions. (EC3).</p> <p>We implement what we think is the right idea. We get experience and try to grow. We would like to come to the point where we can say we have a project that can be communicated broadly, so that we win more farmers who set up more mixed poultry production sites. (EC14).</p>	<p>Growth</p> <p>Continuity</p> <p>Cooperation</p> <p>Quality</p> <p>Diversification</p>

Interviews were coded SPx for Spree Woods/Blota, and ECx for Naturland Marketing.

## 4. Discussion

Innovations, according to the actors involved in the innovation process, are considered sustainable when they a) achieve local beneficiary effects for as many people as possible, b) contribute to closed cycles in production and marketing, and c) improve the capacity for horizontal and vertical development. The combined effect is perceived as an additional asset extra to local, organic or conventional smallholder production by the actors.

All three main objectives for an agro-ecological innovation illustrate the relevance of local anchorage. For agrifood systems, localized production systems have been analysed based on the systemic nature of relationships maintained by actors who jointly shape a territory through cooperation and joint products (Torré & Wallet 2013). Spatial differentiation, cooperation and bottom-up development are linked with this approach. The results from this study add elements of regional autarky. In the case studies this becomes evident by the actors expectation to exceed the regular requirements for common organic agricultural production, e.g. of Naturland Marketing (Naturland 2015) and to gain independence from mainstream sector relationships.

### 4.1 Making explicit societal and environmental value creation

In both cases, the innovative approach for agro-ecological production exceeds the regular requirements for organic agricultural production. Thus, the production is affected by a self-restriction to produce low quantities and therefore consciously refuse to use economies of scale. Consumers, however, are mainly unaware of these extra efforts for sustainable land use. At the same time, the actors cannot benchmark their activities against common requirements such as a product label or standard based on common farm statistics. An assessment of sustainability objectives during the innovation process can support the actors in articulating the benefits of the agro-ecological innovation, particularly at the level of the principal actor who takes the role of the entrepreneur. An entrepreneur is characterized by typically facing high ambiguity and uncertainty in the pursuit of a new venture. Decision making is largely built on individual heuristics and beliefs, while factual-based logic may be either too overwhelming or not available where an innovation is created (Alvarez & Busenitz 2001). While the particular benefits of the agro-ecological innovation were not clearly defined at the outset of the study, the actors could harmonize their target and product criteria during the course of the study. The result was perceived as a basis for advancing marketing measures, customer relationships as well as communication between actors.

### 4.2 Plausibility and applicability of the approach

Local added value, closed circular systems and capacities for development are found to link both territorial and value chain approaches. The innovation is considered successful by the actors when the additional product assets are achieved and financed by revenues. One specific of the innovations analysed here is the dependency of success on the willingness of a group of farmers who commits to implementing the innovation in joint cooperation. Case study 1 requires a minimum number of farmers to achieve the aim of open landscape conservation. In case study 2, a critical amount of eggs and meat is indispensable to target the market.

All three main objectives have a clear resonance with value chain assessments for example in supporting linkages with other actors along the value chain, upgrading returns from production and generating financial flows that become an integral part of the region and sector involved (e.g. Graef et al. 2014; Kaplinsky & Morris 2001). The application of the criteria is strongly actor-oriented. This can be a detriment when it comes to an assessment of site-related environmental impacts. While the criteria showed a comprehensive approach in addressing the sustainable and efficient practices needed for transformation towards sustainable development, environmental criteria were selected to a lesser extent by the actors.

## 5. Conclusion

The study was conducted as an intermediate step in developing assessment tools for sustainable agro-ecological innovations in a smallholder farm environment. The integration of sustainability assessment in innovation management was found useful particularly by the principal actors, namely the biosphere reserve management and Naturland Marketing. The benefit is seen in the clarification of objectives in management, and in communication with direct and indirect actors. The criteria were grouped along three main objectives that encompass both value chain and territorial approaches as well as social, economic and environmental values. The results indicate possible development pathways for an assessment tool that supports the actors in innovation management with the aim of improving capabilities for long-term market establishment and sustainable land management, e.g. via life-cycle assessment or balancing methods. The tool, however, must implicitly ensure equal consideration of environmental impacts next to social and economic impacts, as these were considered to a lower extent by the interviewed actors.

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