Collaborative learning for self-driven change in complex situations

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Abstract: 'Real world' systems change when actors (collectively) change their actions. Hence, research that aims at supporting self-driven change requires methodologies that integrate and expand different stakeholders' knowledge and capacities, and leads to action. This can be achieved in a collaborative learning process that involves actors belonging to different activity systems (e.g. doing research, farming, governing) with their different interests, perspectives, access to information and types of knowledge. They jointly seek to find solutions and develop innovations in complex systems in a process of dialogue (questioning, contradiction, debate, understanding), discovery (observation, experimentation, diagnosis, reflection) and application of the new knowledge and practices.

This paper aims to assess collaborative learning methodologies used in research projects dealing with the management and governance of farming and food systems. The assessment is based on a reflection/analysis of case studies presented at the 11th European IFSA symposium, April 2014 Berlin. We examined the case studies focusing on the following aspects: (1) the identification and interaction of stakeholders, (2) the collaborative learning process itself, including shared problem view, knowledge integration and capacity building, and (3) the outcomes of the process in view of the 'real world' problem that was addressed.

The analysis showed that case studies differed in the degree of involvement of multiple stakeholders with diverse interests and knowledge. This points to the necessity to make the stakeholder integration process more explicit to allow for learning from successes and failures of previous projects. A common finding for the collaborative learning process was that trust among the different stakeholders was key to promoting knowledge exchange and mature reflection. The most common outcomes from the collaborative learning process were related to participants' perception of gaining something meaningful, such as new relationships, new knowledge, and or skills. Most importantly, stakeholders' awareness of their role in the process of change was strengthened.

Keywords: collaborative learning, participation, change process, knowledge integration, capacity building

Introduction

Food and farming systems can be considered complex systems because they consist of human, social, technical, physical and natural components all contributing to production and value addition activities using biological organisms. As they form part of the ecosystems of specific locations, they are very diverse and heterogeneous over space and time. Furthermore they are characterized as dynamic systems with many linear but also non-linear interrelations between different components (Folke et al., 2002). As some of the interrelations are circular, the systems respond to events via feedback mechanisms that either stabilise or amplify and reinforce processes within the system. That tends to make their outcome uncertain and unpredictable. Moreover, food and farming systems deeply depend on human management. The management measures are based on

the actors' values and strategic goals, and based on their understanding of how these actions can influence the system and its outcomes (Kaufmann et al., 2013). Food and farming systems are characterized by having multiple actors involved, each with different interests, perceptions, access to information, and types of knowledge. Within the system, these actors mutually depend on each other's actions.

Globally, main problems in farming and food systems include, but are not limited to (i) food insecurity, (ii) resource exploitation, degradation and scarcity such as of water, soil and biodiversity. , (iv) climate variability and change with its' associated extreme weather and disruption of expected patterns (ii) market uncertainty and instability, and (v) health hazards and food contamination. Because of the aforementioned characteristics of complex food and farming systems, finding solutions to such problems involve several challenges. They require more than technological solutions where 'real world' actors are seen as passive recipients of information and new or improved technologies. This is evinced by the failure to translate strategies for improvement or new technologies from formal research to the real world (van Veldhuizen et al., 1997; Critchley and Nyagah, 1999; Leeuwis, 1998).

Hence, research that aims at fostering change in complex systems needs to involve 'real world' actors. This also recognises that in human activity systems, change can only happen if relevant actors change their actions. If the changes needed are beyond the scale of individual control, collective or coordinated actions of multiple actors might be required. Humans might change their actions because of external motivation, such as incentives or new regulations, or because of internal motivation, arising from better understanding gained from a learning process. As stated by Checkland and Poulter (2010), whoever owns a problem should be a co-owner of the process to solve it. As multiple actors are interdependent in food and farming systems, involvement of and collaboration between different actors, each with their own interests, knowledge and capacities, becomes necessary.

Even though learning among interconnected actors, sometimes also referred to as stakeholders, is recognized as a key element to promote solutions to the problems collectively faced (Leeuwis et al., 2002), little is known about how to enhance learning that promotes change in relation to sustainability issues, such as climate change (Tschakert and Dietrich, 2010). To improve approaches that encourage learning processes among multiple stakeholders who share a common problem, Lang et al. (2012) and Cundill et al. (2013) specifically encourage comparative analysis of different case studies.

In this paper, we aim to provide a review of methodologies that were used in collaborative learning processes. Our assessment is based on an analysis of case studies that focus on methodologies used for collaborative learning and it is structured according to the following steps(1) identification and interaction of stakeholders, (2) collaborative learning process, including knowledge integration, creation and application, and (3) outcomes of the process. Evaluation criteria derived from relevant theories (including Engeström, 1999; Kolb 1984; Mezirow, 2000; and Vygotsky, 1978) are used to assess the methodologies used. To learn from the experiences shared by the authors of the case studies, we highlight successful examples and point to difficulties acknowledged as warranting further methodological improvement.

Collaborative learning to foster self-driven change

Collaboration

Collaboration is a process through which different actors bring their attention to a shared issue in a constructive manner. It is possible that not all of the actors agree or share a common goal. Rather, to be a productive interaction, all of those involved must be willing to engage in a process which might be specifically designed to accommodate diverse viewpoints and perspectives – some of which may be at odds with each other and ontologically irreconcilable. These actors can be abstracted and/or grouped into categories with relevance to a certain topic, region, or issue and collectively referred to as stakeholders. For example, the International Fund for Agricultural Development (IFAD) defines stakeholders as, *"an agency, organisation, group or individual who has a direct or indirect interest in the project/programme, or who affects or is affected positively or negatively by the implementation and outcome of it"* (IFAD, 2002). Although the term 'stakeholder' has its origin in business ethics literature (Freeman, 1984), it is commonly used in development-oriented projects; and more broadly, in projects which seek to address a specific problem. Funding agencies for projects which bridge science with 'real world' application have also adopted this terminology. A colloquial explanation of the term is someone who has a 'stake' in a problem (either directly or indirectly). Literally, a stake is a wooden or metal post such as might be driven into the ground to claim ownership. In this case, it is claiming involvement in an issue, topic, region, or problem.

Identifying stakeholders can benefit from social network analysis. This is specifically recommended by Spielmann (2011:195) for researchers seeking to identify and implement relevant innovations. Although some stakeholders might be selected for participation due to certain criteria such as interest in a particular issue, it can be useful to approach stakeholder analysis iteratively throughout a project period as knowledge of the issues might change (Jepson and Eskerod, 2009; Reed, 2009).The benefits of having diverse stakeholders collaborate when approaching a complex problem is that important aspects of the issue which might have otherwise been unconsidered might emerge through the process of soliciting a wide range of perspectives (Cuppen, 2012; Roloff, 2008). Likewise, this increases the probability that a research project, governance strategy etc. is effective, relevant and implemented. For example, when stakeholders act in different activity systems, their experience will lead them to know certain parts of a process which might not be known by others. Stakeholders with different spheres of influence may have the ability to promote or discourage implementation of a project or idea within, for example, different groups, institutions, or regions. These experiences lead to diverse knowledge which can be relevant and necessary to achieving a goal.

Learning

Learning follows the principle of continuously reducing information or increasing order in the information either by structuring it or recognizing patterns (von Cube, 1967:53). How learning is achieved when aiming to foster self-driven change in complex systems is explained by relevant adult learning theories: experiential learning theory, transformative learning theory and Cultural Historical Activity Theory (CHAT) with its origins in socio-cultural theory. The first two focus on individual learning processes, where knowledge is produced through the transformation of experiences. The third learning theory is based on the assumption that we learn through our interactions and communication with others.

Experiential learning theory characterizes learning as a process of creating knowledge through transformation of experiences, or learning-by-doing. Kolb (1984:38) defines experiential learning as *"the process whereby knowledge is created through transformation of experiences"*. It follows an iterative learning cycle composed of four stages: concrete experiences, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). The concrete experience

forms the basis for observation and reflection; with the experience one has the opportunity to consider what is working or failing (reflective observation), and to think about ways to improve on the next attempt (abstract conceptualization). Since practitioners´ knowledge is usually derived from experience and partially implicit, reflection of their own actions can help to make this knowledge explicit and to share it with other stakeholders. Explicit knowledge can again become implicit if it becomes incorporated into new procedures and 'ways of doing'. Facilitating this process of dynamic transformation of knowledge has been described by Nonaka and Takeuchi (1995) as an important aspect of learning and a source of innovation.

Another more recent learning theory is the transformative learning theory. Mezirow (1991; 2000) describes learning as a reflective process that enables an individual's perceptions to be altered. It centres on how to encourage learning so that an individual's relevance system is transformed through critical reflection. Knowledge can be defined as information that individuals have internalised and that on the whole forms their relevance systems with which they then further assess new information (Probst et al.1997). A change in the relevance system occurs after an individual faces a problem where past experiences offer no immediate solutions, also called *disorienting dilemma*. According to Mezirow (2000), there are two ways by which individuals learn: instrumental and communicative. Instrumental learning refers to improving a task-oriented problem, while communicative learning is related to the understanding of the meaning of what is communicated.

It was Lev Vygotsky who first stated that we learn through our interactions and communications with others. His notion of zones of proximal development (ZPD) has implications for collaborative approaches. According to Vygotsky, the ZPD is the distance between the actual and potential learning of an individual, where the actual is determined by his or her independent problem-solving capacity, whereas the potential is determined by the individual's problem-solving capacity under guidance or in collaboration with peers (Vygotsky, 1978:86). Hence, collaboration with others enables interacting in this way to go beyond their current learning capacity. The Cultural Historical Activity Theory (CHAT) explains how a group of people with different experiences and perspectives that are working in an object-oriented activity system, jointly develop new knowledge or tools to address their problems (Engeström, 1987; Engeström, 1999).

Collaborative Learning

A Collaborative Learning approach is conceptualized as a sequence of three processes, including: *dialogue*, *discovery* and *application of new knowledge*. During the process of *dialogue* (Phase A), information from different actors with different perspectives, hence different relevance systems, is synthesized. By questioning, clarifying contradictions and debating, a broader understanding is achieved. This is a process of *knowledge integration*. The process of *discovery* is intended to resolve knowledge conflicts and to fill knowledge gaps (Phase B). It consists of (1) testing ideas in order to gain experience, with or without conducting a trial experiment, (2) analysing new information by questioning what worked and what didn't, and (3) drawing conclusions regarding what might need to be done differently. This process is characterized by *creating new knowledge* through each of the stages. When working in collaboration, participants become able to create new knowledge that goes beyond what either of them would have achieved individually. *Applying the new knowledge* is the basis leading to individual or collective actions where new practices are consolidated into a more broadly recognized social activity (Phase C). To engage in a process of continuous learning, this process should be documented.

Collaborative learning processes foster two levels of learning outcomes. One of which is related to what participants, including researchers, can learn from the collaborative process itself, and the second of which is the actual content of the process. Outcomes from the content of the collaborative learning process are related to (1) a change in the relevance system (2) enhanced problem-solving capacity, and (3) increased action possibilities. Outcomes associated with the collabora-

tive learning process entail enhancement of (1) social capital[57] by enhancing trust, strengthening horizontal and vertical networks, and increased collaboration; (2) human capital mostly in the form of capacity building; and (3) agency.

Methods

This article is based on an analysis of 14 case studies designed to foster change in complex situations. Although each of these case studies has different perspectives and varied objectives, all focused on learning processes involving different stakeholders. Case studies were selected from submissions to the 11th European IFSA symposium, April 2014 in Berlin for workshop 1.7 on, 'Collaborative learning to solve problems and develop innovations in complex systems: focus on methodologies'.

These case studies include research projects in Asia, Africa, Oceania, Central and South America, and Europe. Complex issues addressed range from sustainability of regional agro-ecological systems including farmer innovations and water management policy and practice to rural development more broadly. A few specific examples include sustainable rubber cultivation in southwestern China (Aenis and Wang), dairy farmer wintering practices in Southern New Zealand (Dalley et. al.), and water management in the Northeastern fenlands of Germany (Kröger et.al.). Some projects are in the early stages of project formation such as Tardivo et. al. who use conceptual maps from different stakeholders as a tool for analyzing perspectives relevant for a regional agricultural action plan in a lavender and wheat growing region of Southern France. Others include multiple projects in many countries within their structure have been on-going for many years such as Waters-Bayer et al. Annex 1 gives a full list of the case studies.

We conducted a content analysis of the information provided in the case studies to determine whether and how the evaluation criteria were achieved when using different methods or approaches. We further compiled the strong points and weaknesses as given by the authors when reflecting on the methodology. Selected case studies were coded using computer-assisted Qualitative Data Analysis software in family R (Huang, 2012). We used the coding to construct tables to further synthesis.

Assessment of collaborative learning methodologies

The assessment of the methodologies used among these 14 case studies, is based on three aspects used to establish a collaborative learning approach. The first aspect deals with building the collaborative team and framing the problem. The second aspect is related to the collaborative learning process itself, and the phases of knowledge integration, creation and application. In the third aspect the outcomes from the process and from the content are outlined. A summary table, which relates methods used and assessment criteria, appears at the end of each section.

Stakeholders' identification and interactions

The majority of case studies analyzed stated that active involvement of different stakeholders is one of the bases for success. Stakeholder representation was achieved using different methods such as network analysis, iterative stakeholder analysis, concept maps, interviews, and establishing dialogue (Table 1). Key for enhancing participation in most of the projects was an agreement on the goals and approach, as well as a clarification of the role of each of the stakeholders in the process (Table 1). Participation was even driven from a local initiative (e.g. Ryschawy et al. and Chantré et al.), or participants were invited by researchers and peers (e.g. Dalley et. al.).

Main challenges were departure of key staff and participant drop-off. Losing actors resulted in a loss of momentum. The main cause of participant drop-off was research fatigue. Research pro-

[57] The conceptualization for social and human capital are based on Pretty and Ward (2001) and Pelling and High (2005).

jects avoided research fatigue by monitoring project progress, maintaining relationships and enhancing communication. Giving all participants the opportunity to express themselves and valuing their participation was also seen as key in enhancing participation and avoiding research fatigue. Experienced facilitators used methods to help mitigate power imbalances of academic knowledge during group meetings and discussions.

Table 1: Methods to establish collaboration and select stakeholders

Collaboration	Method	Leads to/achievement (how)	Assessment criteria
Stakeholder representation	Network analysis (1,5) Stakeholder analysis (1,4,8) Interviews (2,3,6,10) Snowball sampling (9)	Identification of institutions and actors (1,3,4,5) Insight into participant's background and wishes (4,9)	Multiple types of stakeholders included Diversity of interests represented
Stakeholder participation and roles	Participants selected by: research team (1,5,7,9,12), peers (5,6) and invited to participate as volunteers (5,6,9,10) Local initiative (7,10)	Pre-established selection criteria for participation (4,5,12), e.g. willingness to learn, good communicators, honest, committed, skills such as record keeping (5)	Establishment of the collaboration
	Individual communication (5,7,9) General meeting (4,5,6,12)	Definition of a common agenda that includes objectives, structure of the approach, roles and responsibilities (4,5,6,9)	Clear benefits, roles and responsibilities
	Communication platform (4,5,6,12)	Regular meetings (face to face or via video conference)	Communication
	Process supported by (professional) facilitators (2,8,9,11,12,13)	Giving all participants the opportunity to express themselves and valuing the participation (7,9) Researchers were seen as participants (not experts) in groups discussions (7,9,10)	Power differences balanced

The numbers in brackets refer to the research project where the example was extracted (see list of case studies in Annex 1)

Methodologies for the collaborative learning process

Finding solutions and developing innovations in complex systems was aimed at through a process of dialogue, discovery and in some cases application of new knowledge. A commonality between case studies was the use of visual tools and methods to have a visual representation of the system, its interactions, problems and contradictions. Visual representations enhance mature discussion and reflection among different actors. For instance, to bring together multiple perspectives and come to a common problem understanding, Tardivo et al. used cognitive maps and Schäfer et al. used constellation analysis; to analyze information d^^uring the process of knowledge creation, Ryschawy et al. used visual assessments of individual farm trajectories to understand major changes and to co-construct visions for desirable futures, McKee et al. used a schematic representation with symbols to reveal relationships between envisioned options (

Constructing knowledge through a process of discovery was characterized by iterative activities in which actors compared practices or management strategies, collectively shared information (with or without conducting experiments or trials) analyzed it and interpreted it. A commonality between case studies was the collective assessment and evaluation of one's own and others' practices, innovations or ideas. On-going discussions were facilitated allowing sufficient time for debate. The collaborative learning process in several research projects ended here; hence participants had not yet applied the new knowledge, or this was not documented. Some case studies

proceed with the application of new knowledge in the form of collective or individual actions to scale up. Some of the case studies are in the preliminary phases of longer-term research projects and others are in the process of formulating institutionalization strategies to support collaborative learning in agriculture after many years of working together.

Because of the often rigid structure of research project funding, most of the projects reported common challenges for the collaborative learning process. The first difficulty was to create a joint definition of a problem, where researchers and practitioners together decided upon the need to organize the process, and how to ensure that a project's goals, tasks and activities depart from a common reference point. Some project leaders overcame this concern by framing the project according to previously known stakeholders' concerns or by including steps during the initiation of the project specifically geared towards creating a common understanding of the problem or, in cases of controversy, by clearly representing multiple perspectives, options and possibilities for understanding a problem. Other difficulties identified were to achieve that diverse actors agree upon a common agenda, and to integrate needed flexibility in the project framework for responding adequately to feedback from participants.

Outcomes from the collaborative learning process

Outcomes from the collaborative learning processes are related to (1) the process itself, or (2) the content of the process. Not all outcomes, such as strengthened networks, can be directly measured and so must be assessed through the use of proxies (Table 3). A prevailing success factor reported in the case studies analyzed was that trust among actors promoted knowledge exchange and mature reflections. Among the case studies, collaborative learning strengthened vertical and horizontal networks and enhanced the ability of multiple actors to address a common problem. For example, programs which aim to strengthen networks and capacity for local innovation and rural development in multiple countries are discussed by Waters-Bayer et. al. and by Hofmann-Souki et al. Capacity building was evinced by increased organizational management capacities of participants, and improvements made to the process after feedback. These case studies demonstrate institutionalization processes linked to supporting collaborative learning. Others support collaborative learning in new projects (Nicetic and van de Fliert, Dalley et al.) or among stakeholders (McKee et al., and Chantré et al.)

Reported outcomes with regard to the `real world´ problem addressed are related to: (1) a change in the relevance system, (2) enhanced problem-solving capacity, and (3) increased actions possibilities.

Table 2: Methods for dialogue, discovery and application of new knowledge in relation to assessment criteria. The numbers in brackets refer to the research project where the example was extracted

Collaborative learning process	Method	Example	Assessment criteria
Process of *dialogue:* Integrating knowledge	Literature review (3,5) Surveys (2,5,7) and interviews (1,2,3,4,5,7,10)	Farmers and stakeholders give access to their knowledge (1,2,3,4,7) Identify criteria farmers use to assess the success of their systems or the challenges faced by their systems (3,5)	Diverse inputs or knowledge types
		Identify past and present farming practices, farmers strategies and objectives (2,4,5,6,7,12)	Multiple perspectives on the complex problem
	Collective meeting with multiple actors (3,4,7,8,12), focus group discussion (8,9), workshops (2,3,4,5,8) Communication tools, e.g. brainstorming (2), visual assessment (7) Participatory mapping (2) Reframing (9) Constellation analysis (3) Cognitive maps (1)	Discussion to enable improvement of interpretations (2,3,4,7) Identify relations in different perceptions, competing interest or problems (3) Broader insight into local priorities (2,3,4, 5,6,7,12) Mapping main farming management strategies (2)	Perspectives exchanged and modified
		Shared problem perception (3,5,9,12), and directions for sustainable solutions (9) Identify relevant innovation (7) or solutions to test (2,9)	Shared understanding develops
Process of *discovery:* Constructing knowledge	Co-inquiry (10), participatory trial development (12) Modeling and (on-farm) simulation (2,7,10,14)	Testing of new/improved strategies in production systems (6,12) Co-construction, simulation and evaluation of scenarios/models with real actors in real farms/situations (2,7,10)	Gain experience by testing new ideas
	Field days/visits (5,6,12), innovation fairs (6) Monitoring farming practices / strategies (5,10,12)	Meeting with different actor to monitor progress (10,12)	Observation
	Group discussions (2,4,5,6,7,8,9,12) Co-opting (5) Participatory assessment of farming practices / strategies (12) Visual tools (9)	Discussion of experiments/innovations (6,12) Comparing practices and management strategies between farmers (5,6) Schematic exercise to stress relations (9)	Analyze information and identify cause-effect relations
	Co-construction of scenarios (7,8,9,10,14) Participatory evaluation (5,6,12) Co-developing options for improvement (2,4,5)	Participatory assessment and evaluation of own and others' practices, innovations or ideas (5,6,7,12) Unfold pathways to achieve desired visions (2,9) Recommendations for next season's experiments (12)	Interpret results and draw conclusions
Applying new knowledge	Large scale test (12) Implementation of changes (10)	Test promising systems in larger areas (10,12) Joint innovation activities (6)	Change of practice, shared actions, new action options and activities

A change in the relevance systems among researchers and stakeholders occurred through joint efforts to consolidate a common understanding of the problem which also integrated representations of diverse and sometimes contradictory understandings, as well as processes to find solutions and to develop innovations. In many case studies, the process enhanced the problem-solving of participants, including researchers, as when participants gain a better understanding of the complexity of the systems analysed, and their capacity to assess relevant contextual information is augmented. Increased action possibilities were reported mostly in the form of improved practices, strategies and tools adapted to `real world´ actors' realities (Dalley et al., Water-Bayers et al., McKee et al., Chantré et al., and Nicetic and van de Fliert). For instance, Nicetic and van de Fliert co-develop new soil management practices that include important parameters defined by farmers, such as labor requirements.

Other outcomes reported in the case studies analysed were the co-creation of communication material, and recommendations for extension programs and policy makers (Table 3). One difficulty found in case studies was that participants, including researchers, were worried about achieving particular results (e.g. publications in scientific papers, new methodologies). Some researchers found increased motivation from the satisfaction of seeing some of the results immediately put into action.

Table 3: Learning outcomes from the collaborative learning process

Learning level	**Outcome**	**Example**
From the process	Social capital: (i) enhanced trust	Recognition of others' perspectives and goals, and clarifying roles (2,5,9,13,14), as actors feel valued Participants freely expressed ideas (2,9) Establishing long term relations (9) Cohesive team (5)
	(ii) strengthening networks	Horizontal networks in between farmers e.g. through informal exchange (5,6), innovation fairs (6), and visits (5,6), workshops (4) Vertical networks between different actor in the project, e.g. through a communication platform (2,3,4,5,6,7,9,12), or using other communication technologies (2,5,6)
	(iii) enhanced collaboration	Between researchers and farmers in the experimentation (12), innovation process (6), building models (2) Among farmers in the innovation process (6)
	Human capital: Capacity building	Researchers become facilitators (12) Enhanced organizational management, leadership, planning, manage funds, record keeping (6) among `real world´ actors Local actor document the process (6,11) Participants desire to continue with the approach after project ended (5,6,9,12) Improvements of the process identified: activities modified after feedback and agreement of all participants, e.g. inclusion of new step in PM&E (12), creation of communities of practice to broaden the assessment (5), increased level of complexity in experiment and involvement of actors (6)
	Agency	Higher awareness of participants' and researchers' role in self-driven change (9) Awareness of the importance of a closer collaboration with farmers (4,5,6,12) Self confidence among participants, e.g. farmers interaction with other actors (6,7)

From the content	Change in the relevance system	To asses relevant information (6) Discourses altered (2,3,4,9,12), through the joint effort to find a joint solution to the problem Maturity of discourses (2,3,4,9)
	Enhanced problem-solving capacity	Understand the complexity of the system (1,2,3,4,5), also researchers (3,4,12) Identify and support innovations (6,7) Farmer had access to monitoring information (5,12), and used it as feedback for further knowledge creation (2,12) Identification of out-scaling possibilities and difficulties (12)
	Increased action possibilities	Improved practices, benchmarks and tools adapted to smallholders' realities (5,6,12) Recommendations to extension (5,12), decision support tools (2,3,5), and communication material (4,5,6) Visions or scenarios (2,4,7,8,9,10) that may facilitate changes in policies/ management actions

The numbers on banquets refer to the research project where the example was extracted.

Discussion

This systematic review of case studies revealed opportunities and challenges arising from a collaborative learning process. In all case studies, `real world´ actors with diverse interests, perspectives, access to information and knowledge types were involved in order to foster debate and knowledge exchange. Many of the case studies did, however, not detail how stakeholders were identified. How the collaboration was established varied among the different projects. Some projects were established after a local initiative, while in most, participants were invited by the researchers to participate in the project. They were either invited to speak for themselves, or to represent a group with assumed similar interest and perspectives (see Table 1).

Few case studies were explicit about participant selection criterion. One example is Dalley et al. who explicated the selection criteria for monitor farmers and who structured their upscaling process in a way that participating farmers selected peers to establish a community of practice. Information regarding how a balanced group composition was achieved was also not specified. The case studies of Murgue et al. and Bewsell et al. deliberately maintained stakeholder groups divided to overcome conflict situations. As it can be challenging to bring together actors with different interests, this points to the need to make the process of stakeholders' identification and interaction more explicit. There is further the risk to overlook heterogeneity *within* the different stakeholder groups and hence select 'representatives' that are not necessarily those that should be addressed in light of the problem. Hence, caution needs to be exercised when assuming that a participant from a particular group can stand in for the perspective of the entire group. For this reason, it is important to detail how participants are invited to join a project and reflect why some may want to participate and not others.

The selection of stakeholder in case studies which lead to the implementation of policies, creating or modifying policies, or that might have a restricting impact on individual or collective action possibilities needs to be treated even more carefully, because the power dynamics become more laden. For example, Bewsell et. al. in New Zealand used a participatory process with a deliberation matrix to identify the amount of nutrient runoff that local stakeholders found acceptable for policy implementation. Chantré et. al. were following a specific process set by the European Water Framework Directive for informing agricultural action plans regarding water catchment areas in France. Here the collaborative learning processes can become compromised when negotiation supersedes learning. A key variable was whether or not participation was voluntary and whether one is representing oneself or representing a group. The representative bears the responsibility of

bringing the best outcome for the group which does not always lend itself to the trust needed in collaborative learning processes where openness to the discovery of new ideas is needed.

Knowledge integration through the process of *dialogue* was achieved either by bringing together different perspectives or by encouraging a 'dialogue between different knowledge types'. Transformative learning, or a transformation of participants´ relevance system, was achieved only after this 'dialogue between knowledge types'. To illustrate, Nicetic and van de Fliert encountered that individual discourses of some participants were altered through the joint efforts to find a shared problem. During the process of *discovery*, participants gained experiences by testing new ideas, either in practice (e.g. co-inquiry and experimentation) or in thinking (e.g. scenario analysis). New information gained was augmented by implementing a monitoring system that included the use of various instruments and perspectives different from those regularly used (see Table 2). The new information was then analyzed to understand what was working or failing and in order to work towards consensus on ways to improve it (e.g. pathways to achieve visions or recommendations for next season´s experiments). The cycle was closed by *applying the new knowledge*. This cycle follows Kolb´s learning cycle (1984).

Our analysis suggests that trust building is a key element for collaboration in the learning process, and it is the result of a well structured and facilitated process where actors had sufficient time to integrate their knowledge, get a joint understanding of the problem and to decide about goals, tasks and activities. McKee et al. and Murgue et al. pointed to the importance of designing steps to especially build trust between researchers and participants. Initial clarification of roles and benefits from participating in the project diminishes opportunistic behavior and unrealistic expectations. Building trust was also achieved according to Dalley et al. and Murgue et al. by allowing sufficient time for discussion and debate. Developing a communication system was also attributed as a trust-building mechanism, as stated by Nicetic and van de Fliert, Dalley et al., Water-Bayers et al., and Chavez-Tafur et al. Collaborative learning approaches will additionally benefit from a deeper understanding of trust-building mechanisms..

Despite such efforts, trust between researchers and other stakeholders is not a given. For example, Aenis and Wang describe how a workshop for their research team was organized on the topic of the importance of interacting with non-academic stakeholders. They described how many researchers came to appreciate the value, while still some skeptics remained within the research network. As human interactions can always turn unpredictable and require adaptation and compromise even when all participants go into an interaction with the best of intentions, the likelihood of participants gaining something meaningful from the interaction decreases when the interaction is viewed with distrust or as an obligation to be fulfilled because of external factors such as requirements of a funding organization.

Working in groups can help to build trust through opportunities of expression. Participants in collaborative learning processes strengthened their problem-solving capacities when working in groups, as collaboration with others enables collaborators to increase their capacities (Vygotsky, 1978). For instance, when stakeholders in general, but also highly specialized researchers, get insight into the complexity of the systems they work on, as reported by Dalley et al. Overall, there was a growing awareness of the importance of collaboration in a process of change, as for example was evinced after the implementation of a Participatory Monitoring and Evaluation (PM&E), which enable researchers to conduct field experiments with farmers, not merely on farmers' fields (Nicetic and van de Fliert).

We found that a key outcome from the collaborative learning process itself was that `real world´ actors perceived that they have gained something meaningful from participating in the process, for instance when the goals of the project were aligned with their needs. When this was the case, participants were even likely to continue the endeavor. When participants' benefits are clear from

the beginning, at the end of the project there is a positive feeling of growth, improvement and satisfaction, even when it is not linked to tangible outcomes. For instance, participants in different case studies expressed they have benefitted by increasing their horizontal and/or vertical social networks.

Conclusions

In a collaborative learning process, diverse `real world´ actors come together to create solutions that are beyond individual possibilities. This process includes *dialogue*, *discovery* and *applying the new knowledge*. Main issues to promote collaborative learning among different stakeholders are trust-building mechanisms, allowing time for the process, using varied and iterative visual tools, and planning the approach so that all actors have the opportunity to gain something meaningful. With time, participants' awareness of their roles in the process of creating change is strengthened, while simultaneously, awareness of the importance of collaboration increases. This collaboration between stakeholders, and especially between academics and practitioners and other societal stakeholders improves the ability to respond, adapt and intentionally transform in relation to the complex problems. Specifically with regard to the complex socio-ecological systems of which agriculture is a part, these methods are valuable tools for engagement.

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Annex 1. Selected case studies using a collaborative learning approach

	Case studies
1	Agro-socio systems diagnosis: cognitive maps to formalize stakeholders' knowledge and viewpoints C. Tardivo, S. Delmotte, C. Le Page, and J.M. Barbier
2	Agricultural viability in a water-deficit basin: can participatory modeling and design activities trigger collaboration between water management and agriculture stakeholders? C. Murgue, O. Therond and D. Leenhardt
3	Integration of knowledge in inter- and transdisciplinary research projects: Use of constellation analysis in a project of sustainable land use management M. Kröger, M. Schäfer and J. Rückert-John
4	From information giving to mutual scenario definition: Stakeholder participation towards Sustainable Rubber Cultivation in Xishuangbanna, Southwest China T. Aenis and J. Wang
5	A co-development approach to investigating wintering options on dairy farms in Southern New Zealand D.E. Dalley, J.B. Pinxterhuis, M. Hunter, T. Geddes, and I. Tarbotton
6	Joint learning through facilitation of locally managed innovation funds A. Waters-Bayer, L. van Veldhuizen and C. Wettasinha
7	Evaluating innovative scenarios to enhance mixed crop-livestock farms sustainability: a partnership methodology based on long-term farmers' strategies J. Ryschawy, A. Joannon and A. Gibon
8	Reflections on and lessons from a deliberative process for water management – a New Zealand case study D. Bewsell, B. Small and K. Rijswijk
9	'Shift happens': Co-constructing transition pathways towards the regional sustainability of agriculture in Europe A. McKee, K. Holstead, L.A. Sutherland, T. Pinto-Correia, and H. Guimarães
10	Re-think agricultural practices to improve water quality: two participatory methodologies for collaborative learning E. Chantré, L. Prost, L. Guichard, R. Reau, and J. De Malleray
11	From systematization to learning J. Chavez-Tafur, T. Pinzas and T. Gianella
12	Changing institutional culture: PM&E in transdisciplinary research for development O. Nicetic and E. van de Fliert
13	Establishing transdisciplinary research and learning environments for rural development – a network and process model S. Hofmann-Souki, A. Acevedo Osorio, T. Camacho Bernal, W. Bokelmann, J. Cruz Morales, M. López and M.R. Yumbla
14	Innovative governance and dynamics of cognitive models for agriculture in territorial development. Lessons from a collaborative research program A. Torre and F. Wallet