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# Generating transformative agency among horticultural producers: An activity-theoretical approach to transforming Integrated Pest Management

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ABSTRACT

This study presents a systemic innovation in the context of Integrated Pest Management – IPM. We introduce the Change Laboratory method as a tool for transforming pest management in a community of greenhouse firms that are interdependent through a shared pest. The objective of the study was to see if the Change Laboratory method, based on an activity theoretical and expansive learning approach, is appropriate for promoting the agency among greenhouse growers so that they become transformative agents of their own activity. The study is based on deductive and inductive content analysis of transcribed discourse data from six Change Laboratory sessions. By analyzing how expressions of transformative agency and its different forms of expression unfolded over the sessions, we showed that criticizing was the most important agentive talk that fed the reconceptualization of the current, problematic activity. The analysis of the envisioning expressions of transformative agency indicated a collectively produced reconstruction (re-design) of the object of IPM activity, i.e. a radical change, in activity-theoretical terms, in the activity of whitefly IPM. As a result of the process, the growers began knowledge sharing and collaborative learning in two villages of the study area, using a learning club as the platform. In contrast to traditional views of externally induced change, the agentive actions were performed by the growers themselves instead of external change agents. Being able to identify the discursive transformative agency actions in the talk of farmers can improve the capability of interventionists to support transformative change when implementing IPM through co-innovation. We propose that revealing the object of farmers' and other stakeholders' pest management activity through analysis of transformative agency actions during formative interventions could contribute to better understanding what it takes to implement IPM in 'local conditions'. This study provided us an opportunity to contrast and compare the activity-theory-based approach to facilitated change with other social learning approaches to change, with their specific system concepts, in the domain of natural resource management.



## 1. Introduction

The EU framework directive 128/2009/EC on the sustainable use of pesticides emphasizes that integrated pest management (IPM) shall be used by all crop producers from 2014 onwards (European Union, 2009). This top-down initiative needs to be transformed into a bottom-up co-innovation process through which agricultural producers transform their pest management approaches (e.g. (Wijnands et al., 2014). Co-innovation denotes reconfiguration of relational, institutional and organizational patterns and arrangements, learning processes, and information flows among stakeholders working towards a common purpose (Klerkx and Nettle, 2013; Maniak and Midler, 2008) with the direct involvement of farmers in all stages of the innovation process to ensure relevance, applicability and adoption (Dogliotti et al., 2013; Peshin and Dhawan, 2009).

Recent studies suggest that new types of agency are needed to produce and implement radical co-innovations (Courvisanos, 2007; Geels, 2004; Klerkx et al., 2010a, 2010b). We argue that the implementation of co-innovations requires transformative agency, a future-oriented creative potential for generating intentional change in human activity (Blackler and Regan, 2009; Caldwell, 2005). Transformative agency is the capacity to form and implement intentions that go beyond and transform the accepted routines and given conditions of an activity (Engeström and Sannino, 2013). It is increasingly understood as distributed, dispersed, and decentralized among multiple actors in organizations and communities (Buchanan et al., 2007; Meyer and Jepperson, 2000). It is also distributed in time, taking shape in often lengthy processes of learning, design, and implementation.

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Agency is traditionally understood as the ability to take intentional action and make a difference over a course of events (Giddens, 1984), or the capacity of an individual to initiate and maintain a program of action independently of the constraining power of social structures (Burton and Wilson, 2006; Campbell, 2009). No single actor has sufficient power and resources to pursue his or her innovation goals without taking into account and coordinating with other actors (Aarts et al., 2007; Klerkx and Aarts, 2013; Caldwell, 2005). Recently, therefore, the emphasis of agency for innovation production has shifted from individual to collective and distributed agency (Blackler and Regan, 2009; Buchanan et al, 2007; Caldwell, 2005; Garud and Karnøe, 2003; Lockie, 2004; Pelenc et al, 2013; Whittle et al., 2011). The emergence of transformative agency, a collective process in nature, is a particularly demanding learning challenge in contexts where the practitioners have been socialized into modes of thinking and acting that emphasize individualism and private property, possibly at the expense of collaboration and joint responsibility. In natural resource management, social learning has become a leading concept for fostering innovation and managing change (Blackmore, 2007; Loeber et al., 2007; Pahl-Wostl et al., 2008). Social learning refers to the construction of shared mental models among the individuals involved so that the ensuing change becomes situated within wider social units, whereupon learning occurs through social interactions and processes between actors within a social network (Bos et al., 2013; Reed et al., 2010; Scholz et al., 2013). Horticultural enterpreneur-producers may be expected to exemplify this pattern. As pests do not respect the geographical and legal boundaries between individual producers, successful implementation of IPM requires new levels of collaboration among producers located in the same geographical area and being interdependent through pest movement between firms (Yu and Leung, 2006).

Relatively little is known about how transformative agency emerges and unfolds during the innovation process and whether general patterns in its unfolding can be expected (Haapasaari et al., 2014). In particular, the emergence of transformative agency in a predominantly individualist context is a poorly understood issue. In this paper, we show how a formative intervention method called Change Laboratory (Virkkunen and Newnham, 2013) was used to induce transformation of IPM in horticulture by specifically supporting the transformative agency of greenhouse growers in a facilitated learning process. The intervention method combines bottom-up and top-down approaches and is therefore particularly suitable for turning top-down initiatives into locally focused and motivated innovation processes. Our study applies cultural-historical activity theory (CHAT) to explore two questions: (1) what type of transformative agency actions can be expected to happen when agency increases among actors in facilitated innovation processes? (2) what it takes to make people the owners of their own innovations and the development of their productive activity?

This article may be seen as a first step to bring together two approaches to system learning and collective agency: the approach to system learning and learning systems in agriculture and natural resources management initiated by Röling and colleagues (Leeuwis and Pyburn, 2002), and the later appliers of this social learning approach (e.g. Pahl-Wostl, 2009), and the CHAT-based theory of expansive learning and methodology of formative interventions, advocated by Engeström and his colleagues (Engeström and Sannino, 2010). The article contributes to the debate on social learning and co-innovation by means of examining the process of collective agency creation within a formative intervention aimed at systemic change. The case of regional IPM is particularly interesting because it is an example of a problem that requires collective construction of a system-level innovation crossing organizational boundaries. In this study, pest management activity, with whiteflies as the focal pest, was the central activity that was analyzed and transformed in the context of greenhouse vegetable production, with greenhouse entrepreneurs as the key subjects.

In the next section, we will present the theoretical and methodological background underpinning the Change Laboratory method (Section 2.1), and introduce the conceptual framework for identifying discursive expressions of transformative agency ( 2.2). We then proceed by describing the setting and the process of the intervention (3.1) and our data and methods (3.2). The results are presented first as an overview (4.1), then as the evolution of specific expressions of transformative agency during the intervention (4.2), and then in terms of distribution of expressions of transformative agency among the participants. Finally, we will discuss our findings (5) and draw conclusions on the value of our research findings to the research on collective agency and social and system learning (6).

## 2. Supporting transformative agency through the Change Laboratory

### *2.1. Change laboratory for supporting transformative agency*

Pelenc et al. (2013, p. 87) point out that "collective agency cannot be imposed; it has to emerge through a learning process based on interactions between people." In this study, we argue that transformative agency requires a specific type of learning, namely expansive learning. It refers to a process in which the object and motive of a human activity are qualitatively transformed in a sustained effort to resolve contradictions in the activity (Engeström and Sannino, 2010).

In CHAT, the theoretical unit of analysis for understanding and explaining human practices is a historically developing activity system (Engeström, 1987; Fig. 1), which is oriented towards the transformation of an object and mediated by culturally artifacts that serve as instruments for a purposeful activity (Gillespie and Zittoun, 2010). When an activity system is taken as the unit of analysis, there is no individual subject without the social context, and no social context without individual subjects (Engeström, 1999a). Although actions are conducted by individuals, these actions make use of artifacts that are originally social and historical. The subjects become agents thanks to the power given by cultural artifacts (Vygotsky, 1987). By way of example, the structure of the sub-activity of pest management within the main activity of tomato production is summarized in Table 1.

Qualitative change and development of an activity take place in expansive cycles driven by contradictions. Contradictions function as sources of development by triggering specific agentive actions of questioning and intentionally breaking away from the constraints of the existing activity (Engeström and Sannino, 2010). An expansive cycle denotes a process to a qualitatively changed activity system with an expanded object. The ideal-typical succession of the learning steps is depicted in Fig. 2, but it must be noted that in practice the process proceeds iteratively (Engeström et al., 2013).

Change Laboratory interventions are aimed at purposefully facilitating expansive learning and transformative agency (Virkkunen and Newnham, 2013). Throughout the intervention, participants are

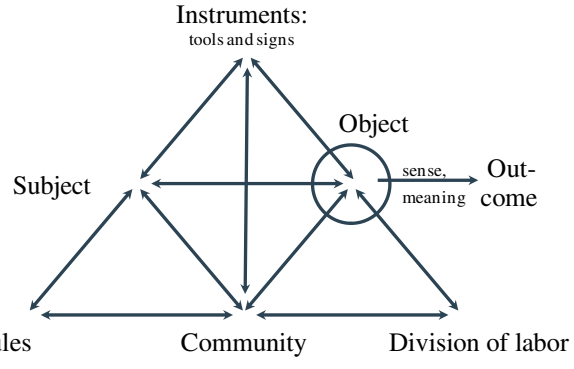


**Fig. 1.** A general model of an activity system with its six main functional elements, featuring the relationships between object-oriented activity, actors (subject) and the community of which they are a part, and the mediating elements (tools, rules and division of labor) between the key elements (Engeström, 1987).

**Table 1**
Functional elements of the sub-activity of pest management in tomato production (the main activity), with explanations and examples given from the current study.

| Functional element | General explanation | Specific contents in the case analyzed |
|---|---|---|
| Object | The common, collective purpose and societal motive for an activity, the 'ultimate reason' behind various practices of involved individuals, groups, or organizations; the conception of the object depends on the position and perspective of the given specific subject | Tomato production (main activity); whiteflies (object of sub-activity of pest management) |
| Subject | The actor engaged in the activity whose perspective is adopted (Engeström, 1987) | Greenhouse entrepreneur (grower) |
| Instruments | Tools and signs that the subject uses to deal with the object of the activity; Tools are resources used primarily to act upon the world, signs are resources used primarily to act upon oneself or others | Spray machine, sticky traps for monitoring pests; bio control agents, data base for storing monitoring results, the concept of pest management |
| Rules | Formal and informal conventions, guidelines, contracts, laws and other societal norms that regulate the activity | Regulations of pesticide use; schedules of controlling and relaxing the control of whiteflies according to the economic interests of individual farms |
| Community | The set of all actors involved in an activity oriented at a common object | Other growers in the region who influence the subject's production activity through their decisions and actions; horticultural advisors, crop protection researchers, packing houses that compensate contract growers for their bio control expenses, plant protection authorities, horticultural suppliers, institutions offering horticultural education (all these influence pest management of greenhouse firms either directly or indirectly). |
| Division of labor | The division of tasks, power and benefits among the members of the community involved in an activity focused on a common object | Each greenhouse enterpreneur is the owner of his/her greenhouse company and responsible for its production of tomatoes; knowledge production by growers themselves, advisors and researchers for the needs of the activity. |

supported to understand their activity systemically and historically so that contradictions are identified and solutions are envisioned and tested. The process consists of a minimum of 6 to 7 sessions in which participants are stimulated to analyze the contradictions within and between their activity elements, and to design and implement a new model that could solve these contradictions. The results of a Change Laboratory are initially local and their diffusion typically takes place as further experimentation, development and enrichment rather than as direct transfer and multiplication of the created solutions (Virkkunen and Newnham, 2013).

### 2.2. Transformative agency and its operationalization

For transformative agency to emerge in an intervention, there first needs to be a situation of conflicting motives (Lund and Rasmussen, 2008; Sannino, 2010). When the conflict reaches an impasse, participants realize that the problems in the activity cannot be explained away by using the old knowledge or framework – new knowledge and understanding of the situation, i.e., expansive reframing, is needed (Dewulf et al., 2009; Dewulf and Bouwen, 2012). Second, psychological tools and productive instruments of expansive thought are needed as "auxiliary stimuli" to facilitate breaking away from the problematic or conflicting situation and overcoming "the pull of the past" (Sannino, 2014). Third, the subjects must invest in agentive initiatives and volitional actions in order to transform their activities (Engeström and Sannino, 2013).

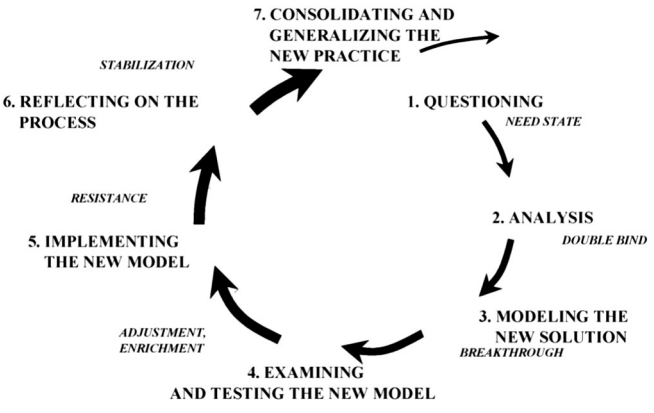


**Fig. 2.** A developmental cycle of an activity showing its ideal-typical phases (Engeström and Sannino, 2010, p. 8).

Transformative agency may be expressed in discourse, understood as a specific type and instrumentality of language-mediated organizational action in which the participants express and transform an object, e.g., an idea or problem related to the material world (Engeström, 1999b; Hall and Seidel Horn, 2012). Such discursive transformation (involving reframing) is not purely cognitive but always related to material things and practical actions. Through discourse, actors become co-oriented to an object and create a basis for collective action by fashioning agency in conversation (Taylor and Robichaud, 2004). Transformative agency may be manifested in talk in six types of expressions (Haapasaari et al., 2014): (1) resisting the change and the intervention, (2) criticizing the current activity and organization, (3) explicating new possibilities or potentials in the activity, (4) envisioning new patterns or models for the activity, (5) committing to take concrete change actions, and (6) taking (or reporting to have taken) consequential actions to change the activity (Table 2). Criticizing, resisting and explicating typically lead to envisioning that guides the discursive reconstruction of the object of activity (roughly corresponding to re-designing the motive and purpose of the activity). This may eventually result in practical transformation of the activity by actors who commit to and take actions through implementing the new concept of activity guided by its reconstructed object.

Among the six forms of transformative agency, resistance is not considered as disruptive opposition or conservatism, but as manifesting early forms of transformative agency aiming at authorship and a prompter of mutual learning in situations of conflicting perspectives about the issue under development (Sannino, 2010), a source of surprise and novelty (Engeström, 2011), and as a channel that makes visible the contradictions that serve as the drivers of change (Heikkilä and Seppänen, 2014). During Change Laboratories, resisting is usually targeted at the intervention, interventionists, the change in general, topics and suggestions aimed at bringing change, or the ideas and suggestions presented during the intervention.

## 3. The case

### 3.1. Case description

The Change Laboratory intervention analyzed in this study had a total of six sessions between February 2011 and September 2012. The demand for conducting the intervention was associated with shared problems caused by the greenhouse whitefly (*Trialeurodes vaporariorum*) in greenhouse firms located within the natural dispersal limits of the pest in the

**Table 2**
Examples of the six types of expressions of transformative agency from the Change Laboratory of the current study.

| Type of expression of transformative agency and its description | Examples from the corpus of discourse of the recorded Change Laboratory sessions |
|---|---|
| 1. Resisting the change, new suggestions or initiatives; directed at management, co-workers or the interventionist | Kari (session 1): "I realize that this is perhaps nothing for me and it is not necessary for me to join you next time. […] The growers need to handle this among themselves." |
| 2. Criticizing the current activity and organization; aimed at identifying problems in the present practice and ways of working | Paul (session 1): "But we had a warning bell for 6, 7, 8 years ago and that was when we had *Pepino* [virus]. What would have happened if we wouldn't have succeeded in emptying all those greenhouses and getting rid of the virus? […] It is incredible that we have made it so long in [our area] without washing the boxes." |
| 3. Explicating new possibilities or potentials in the activity; often relating to past positive experiences or known successful practices | Snej (session 1): "I think it is interesting with the monitoring since Kerstin started to visit us, already since the autumn we began to see whiteflies. But when we were in January [before monitoring was not done with sticky traps] the workers had not seen any whiteflies yet. […] But with the help of the sticky traps we knew that we had whiteflies." |
| 4. Envisioning new patterns or models for the activity; future-oriented suggestions or presentations of a new way of working | Paul (session 3): "I think maybe, like I said yesterday, that we should maybe have a small coffee meeting once a month, every second month, every sixth week, every second week. Talk about the situation that you have experienced, what you have done, that this I thought worked well, but this again didn't. - Maybe this!" |
| 5. Committing to take concrete actions to change the activity; the speaker expresses his or her intention to act in a specified way | Kerstin (session 6): "Sure I can make some material to the meetings and I can also call everyone to the meetings. This is not the issue." |
| 6. Reporting having taken consequential actions to change the activity in between or after the laboratory sessions; going beyond talk and actually performing consequential change actions. | Ritva (session 6): "Then the orange line [shows a graph], when you have 150 or 200 pcs per trap per week. This is something that I have calculated and I must say it is very rough calculations.[…]. From there I have continued to Kerstin's method and made rough calculations of what the quantity of whiteflies means here." |

production cluster in question (Ovčarenko et al., 2014). Two production forms co-exist in the study area: the traditional seasonal production form that has a winter break in November-February, and the technologically newer form of year-round production. Today, due to competitive market reasons, the schedules of the production cycles of the two forms are so arranged that they enable the spread of whiteflies from year-round crops established in the autumn into new seasonal crops in the following spring and summer, and *vice versa* in the autumn.

The initiative of the intervention came from the first author of this paper, prompted by the severe whitefly problems and the attempts of the local plant propagator to spread awareness of preventive pest management measures in the area. Initially, a local advisor negotiated the agreements with seven greenhouse entrepreneurs in the pilot village A. They were explained the idea of the Change Laboratory process in general terms and by framing the problem loosely as follows: There seemed to be a need for a regional approach to the whitefly problem instead of the current individual farm based approach, but it is not known how this could be achieved. Through work in a sister-project concentrating on whitefly ecology and regional population genetics (Ovčarenko et al., 2014), four growers of village B got interested in the process and joined it in the last session. The committed participants eventually included nine year-round and five seasonal greenhouse entrepreneurs, one seedling propagator, one representative of plant protection research (who acted also as a process facilitator), three advisors (one of whom acted also as a process facilitator), one packing house, and one representative of the plant protection authority. The number of participants simultaneously present varied from 6 to 11, depending on the session.

### 3.2. Discourse data and methods of analysis

The Change Laboratory sessions were audio-recorded and transcribed. First, topical episodes were identified based on their substantive contents, resulting in 9–17 episode topics and 12–29 episodes altogether per session (episode topics recurring in the discourse were grouped under one topic). Then, the discourse data within the episodes were divided into speaking turns consisting of uninterrupted talk by one participant. There were a total of 3137 speaking turns in the six sessions. The speaking turns were categorized into those expressing (749) and those not expressing (2388) transformative agency. The former were analyzed in four steps. First, they were classified into six types of transformative agency (Table 2) using deductive content analysis with predetermined categories to identify the phenomena of interest (Elo and Kyngäs, 2008). In cases that were difficult to decide, two other researchers validated the analysis. Speaking turns mostly, but not always, contained one type of expression of transformative agency. Second, the agentive speaking turns were subjected to further deductive content analysis using the elements of the activity system diagram (Fig. 1) as the categorizing device to identify what exactly was being resisted, criticized, explicated, or envisioned, and what the commitments and actions were about. Third, expressions of criticizing and explicating were subjected to inductive content analysis to understand in more detail what the problem really was about and what could be done with it. Fourth, the distribution of expressions of transformative agency among the participants was analyzed to examine the contributions and perspectives represented by participants representing different stakeholder positions.

## 4. Results

### 4.1. Evolution of expressions of transformative agency

All six forms of transformative agency were manifested during the intervention in varying proportions. Among the 749 expressions of transformative agency, explicating, envisioning and criticizing were the most frequent, while resisting, committing and taking consequential actions were expressed less often (Table 3). The proportion of agentive expressions started from a rather low level of 16% and 17 % in the first and second sessions, then grew and reached 33 % in the sixth session, evidencing a constant growing trend with time. Commitment and taking actions increased from session four and onwards, when the obstacles working against a systemic solution to the problem began to be understood through modeling. The most important drivers of the process were the gradual modeling of the whitefly problem as a vicious circle in sessions 1–3, and the surprise turning point that happened in session 4 (see below). These factors were associated with reframing the problem and with changes in the target of criticism between the 2nd and 4th sessions, the turning point in session 4 was associated also by a temporary decrease in explicating when the new target of criticism surfaced and started driving the process.

The 4th session changed the initial plan and introduced an element of surprise and related deep learning in the process: the absence of the seasonal growers in the session. It prompted a great deal of analytical, non-blaming criticism on the role of the entrepreneur actions and community in the problem which drew our attention to the depth of the split among the entrepreneurs of the two production forms. Some signs of the split had surfaced in interviews of seasonal entrepreneurs conducted outside the sessions to understand their lower interest to participate in the process. In the 4th session, the year-round entrepreneurs took the process

**Table 3**
Absolute and relative numbers of agentive expressions representing different types of transformative agency during the six Change Laboratory sessions.

| Session | Resist-ing | Criticiz-ing | Explic-ating | Envi-sion-ing | Commit-ting | Taking actions | Non-agentive | Total agentive | Total turns |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 24 | 40 | 4 | 4 | 1 | 410 | 80 | 490 |
| 2 | 0 | 41 | 51 | 3 | 0 | 1 | 466 | 96 | 562 |
| 3 | 5 | 21 | 56 | 21 | 0 | 0 | 396 | 103 | 499 |
| 4 | 3 | 42 | 35 | 35 | 6 | 9 | 384 | 130 | 514 |
| 5 | 6 | 13 | 36 | 61 | 19 | 2 | 331 | 137 | 468 |
| 6 | 1 | 25 | 75 | 88 | 9 | 5 | 401 | 203 | 604 |
| Total | 22 | 166 | 293 | 212 | 38 | 18 | 2388 | 749 | 3137 |
| % of all turns | 0.7 | 5.3 | 9.3 | 6.8 | 1.2 | 0.6 | | 23.9 | |
| % of agentive turns | 2.9 | 22.2 | 39.1 | 28.3 | 5.1 | 2.4 | | 100.0 | |

in their hands from the facilitators. Instead of being discouraged by the surprise turn, the year-round entrepreneurs reformulated the action plan for the process to attract more of their seasonal colleagues to the 5th session, with success. There, the amount of criticism decreased considerably when the participants focused on planning trials of some aspects of the new model of activity in both types of firms.

### 4.2. The contents of expressions of transformative agency

#### 4.2.1. Resistance

There was no resistance towards the intervention as such in this Change Laboratory. The resisting remarks by the growers representing the seasonal production form indicated that they were initially aiming at eliminating the whitefly problem whereas year-round growers were aiming at its reduction.

The topics of the resisting expressions revealed there were split conceptions of the whitefly problem among the participants, and differing views on how responsibility for solving the problem should be distributed. Among the 22 resisting expressions, eight were targeted at the webpage , i.e. a new tool suggested by the advisor-facilitator as a means of information sharing between growers, whereas the growers preferred face-to-face meetings. Five resisting expressions were targeted at the object (how and when the whitefly problem should be controlled), five at the subject (seasonal entrepreneurs attempting to shift away responsibility from themselves in solving the whitefly problem, i.e. they did not acknowledge the systemic nature of the problem), three about the too intense (year-round growers) or too slow (seasonal growers) speed of the Change Laboratory, and one about rules (whether packing houses should wash bins before returning them to greenhouse firms).

Some examples of resisting is the CEO of the packing house who saw the whitefly problem as non-systemic initially, insisting that packing houses had no role in solving it, but subsequently he reinterpreted it, stating that packing houses "were involved…somehow"; he then committed to attract more seasonal entrepreneurs to the sessions.

#### 4.2.2. Criticism

*4.2.2.1. Deductive content analysis.* Criticizing which highlights the need for change occupied a 22.2% of agentive speaking turns. As expected, the first peak of criticism occurred in the 2nd session devoted to analyzing and reinterpreting (reframing) the whitefly problem. Criticism decreased in the 3rd session where solution design to the re-interpreted whitefly problem was initiated, but increased again in the 4th session devoted to planning the details of the changes of the whitefly IPM activity.

Among the activity system elements, criticizing was most frequently targeted at the community (35% of all criticizing expressions) and the current problematic object (29%), followed by tools (18%) and the subject (15%) (Fig. 3). Such distribution indicates that the systemic problem can be traced to how the whitefly behaves in the techno-ecological system (object-related criticism), but even more so to the people trying to manage the pest (subject-related criticism) and their relationship with each other (community related criticism among growers who influence each others' pest situations through their decisions).

The first peak of criticism in the 2nd session coincided with its topic: "What is the problem?" The main issues were tools that were considered insufficient to manage the whitefly, and subjects, i.e. how individual entrepreneurs themselves contributed to the whitefly problem. The second peak in the 4th session was principally attributed to grower-community-related criticism (see Section 4.1., which, however, evidenced a drop in the 5th session when the participants concentrated on planning the whitefly monitoring trial. In the 6th session community-related criticism obtained a new target: bottlenecks of information delivery to the greenhouse entrepreneurs by the supporting communities (advisors, researchers, plant protection authorities).

Whitefly or object-related criticism decreased almost linearly from the 1st until the 5th session, except a slight increase in the 6th joint session where village B participants vented out their opinions about the problem. Otherwise the decrease of the object-related criticism was associated with the increase in grower-community-related criticism, indicating a shift in how the problem was perceived. Rules and division of labor were not criticized much, although the new organization of the latter would eventually form the core of the new model of activity through collaborative production of new knowledge.

An important issue of subject-related criticism was the relaxation of whitefly control during the last 5-6 weeks of the tomato production cycle when it is no longer economical for individual firms to control the pest. Such relaxation results in the whiteflies spreading from year-round crops to seasonal crops in the spring and vice versa in the autumn. Whitefly control decisions based on short-term economic considerations of each individual firm contribute, in the long term, to persistence of the problem, creating a vicious circle and enforcing the systemic nature of the problem.

The inductive content analysis of criticizing expressions revealed seven categories of problematic issues in the current activity (Table 4).

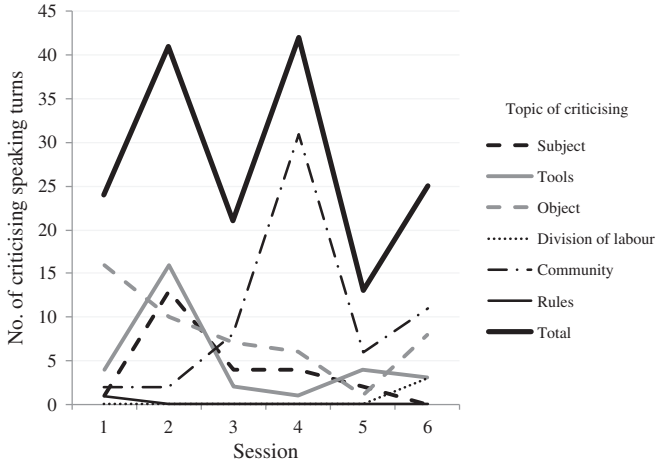


**Fig. 3.** Topics of criticizing agentive expression during the six CL sessions.

**Table 4**
Specific topics of criticizing agentive expressions according to the inductive content analysis.

| Specific topic of criticism | Object | Tools | Subject | Community | Rules | Div. of labour | Total |
|---|---|---|---|---|---|---|---|
| 1. Systemic nature of problem | 15 | | | | | | 15 |
| 2. Whitefly dispersal | 13 | 2 | 7 | 1 | 1 | | 24 |
| 3. Factors decreasing control success of the pest | 1 | | | | | | 32 |
| 4. Deficiencies in monitoring pest densities | 6 | 15 | 1 | 15 | | 3 | 32 |
| 5. Conduciveness of the two production forms to pest reproduction | 6 | 13 | 7 | 3 | | | 6 |
| 6. Issues inhibiting collaboration for solving the pest problem | 6 | | 9 | 37 | | | 52 |
| 7. Miscellaneous | | 2 | | 3 | | | 5 |
| Total no. of criticizing speaking turns | 47 | 32 | 24 | 59 | 1 | 3 | 166 |

Category 6 was not among the mirror data and was interpreted as issues that inhibit collaboration between the entrepreneurs representing the two production forms, and resulting in a fight against the social expansion of the new model of activity. The 6th category included object-related differences in perceiving the whitefly problem. Subject- and community related criticism revealed that not all growers perceive

**Table 5**
The contribution of envisioning transformative agency to the development of the new object and remediation of the new model of activity based on the corpus of discourse of the six Change Laboratory sessions. The stages of envisioning the new model of activity are summarized, together with the information on which elements of the activity were developed and who contributed to the design.

| Ses-sion | Elements of the new model of activity | Agency targeted at | No. of people, role groups and speaking turns |
|---|---|---|---|
| 1 | **Introducing the core elements** :<br>1. reduce whitefly levels permanently (since elimination cannot be achieved)<br>2. systematic monitoring to collect quantitative data on pest densities in crops<br>3. improving biological control | 1. defining the new shared object of collective IPM<br>2. new tool<br>3. better use of an existing tool | 3 people, 3 role groups, 4 turns |
| 2 | **Stabilizing the core elements** :<br>1. collaborative learning from monitoring data collected from firms<br>2. decision to establish a knowledge sharing platform | Tools associated with the new division of labor for knowledge production and collaborative learning. | 3 people, 2 role groups, 3 turns |
| 3 | **Expansion and further instrumental and conceptual development**:<br>1. Grounding the new collective object better with reality: reduce whiteflies to lower levels, since elimination is not realistic<br>2. Webpage with tentative rules of use is suggested as the knowledge sharing platform by an advisor, but is resisted by growers.<br>3. Face-to-face meetings are suggested by the entrepreneurs as the form of the knowledge sharing platform<br>4. Action thresholds for whitefly management decisions are introduced as the central outcome of collaborative learning<br>5. Integration of the research and advisory collectives to the new model of activity. | 1. New partially shared object<br>2.-3. New tools to support the new shared object<br>4. New tool anticipated to result from new division of labor for knowledge production<br>5. Expanding the role of the key support activity systems for achieving the new shared object | 6 people, 3 role groups, 21 turns |
| 4 | **The new object becomes owned by year-round growers** :<br>1. Elaborating the new collective object to ground it with reality.<br>2. Knowledge sharing and mutual learning based on explicit data collected from greenhouse firms by monitoring are established as the core of the new model of activity. Shared understanding that learning will bring results only with time.<br>3. Whiteflies are seen as the model organism to develop collaborative IPM also for other pests.<br>4. Webpage as the knowledge sharing platform is brought up by one of the entrepreneurs, but is resisted by others.<br>5. Integration of the research collective with the new model of activity. | 1. Ownership of the new shared object<br>2. New division of labor and tools for achieving the new object<br>3. Expansion of the new object to cover IPM as a whole<br>4. New collaborative tool for achieving the new object<br>5. New division of labor for knowledge production. | 5 people, 3 role groups, 35 turns |
| 5 | **Further development of the instrumentalities**:<br>1. Action thresholds for IPM decision-making as the central outcome of collaborative learning<br>2. Grounding the new model of activity with reality: the role of the local advisor as the new emerging subject in the new model of activity contains a risk of continuity and expansion: one advisor can only serve a certain number of firms that buy the outsourced monitoring service from the advisor.<br>3. Geographical expansion of the learning club starts to tempt the participants.<br>4. Webpage prototype is presented and stimulates envisioning, but is also resisted.<br>5. Face-to-face meetings win over the webpage as the platform of knowledge sharing and learning. | 1. New tool anticipated to emerge from new division of labor for knowledge production<br>2. New division of labor for knowledge production: the role of support activity systems.<br>3. Use of a tool to achieve a new division labor for knowledge production.<br>4.-5. New tools for achieving the new shared object | 8 people, 5 role groups, 58 turns |
| 6 | **Further development of the object and instrumentalities**:<br>1. Collaborative learning for long-term improvement of IPM is embraced by all entrepreneurs of village A and B.<br>2. A new emerging subject, the local advisor, as the link between participating companies, is explicitly mentioned.<br>3. Final decision of face-to-face meetings as the knowledge sharing platform. Envisioning the practicalities and long-term benefits of the meetings.<br>4. Further development of the database of monitoring results.<br>5. Envisioning on how to develop action thresholds based on of the monitoring data | **Geographical expansion of the object**<br>1. Sharing and stabilizing of the new object with new members<br>2. A new subject<br>3. New tool for achieving the new shared object.<br>4.-5. New tools anticipated to emerge from new division of labor. | 10 people, 4 role groups, 85 turns |

the problem to be equally serious in their crops which influences their willingness to solve it collectively.

Criticism related to the lack of communication about the pest situations in the different firms despite frequent contacts between growers brought up feelings of under-exploitation of the experience and knowledge pool among the growers who share a problem. The growers also lacked tools to deal with the problem collectively: they had no knowledge sharing platform dedicated for learning based on data from their own crops.

### 4.3. Explicating

The amount of explicating was frequent and rather stable throughout the intervention (Fig. 4). The participants were constantly scanning the search space of potential solutions to their whitefly problem based on their previous experiences with the pest, and from other systems they knew. Explicating yielded way to criticism in session 4 where new target of criticism surfaced, encouraged by the absence of seasonal growers.

The inductive content analysis revealed five key substance categories of explicating: the need for a standardized monitoring method (107 speaking turns); learning from variation in the system, the variation being caused by inter-firm differences in whitefly densities and control success (52); reducing pest dispersal with various means (45); reinterpretation of the whitefly problem and how to solve it (24); knowledge sharing potentials and benefits (23); and miscellaneous (42). Explication was mostly about tools, but knowledge sharing explicating expressions was about the community, and those of rethinking the whitefly problem were about the object. Community-related explicating included considerations of the current communication forms and contents between entrepreneurs, and the possibility of learning from each other's practices. Communication-related explicating was interpreted as precedence for reorganizing the division of labor for knowledge production in the ensuing new model of IPM activity. Explicating served as a filter that selected material for envisioning which then resulted in gradual formation of the new model of activity and the reconstructed object.

### 4.4. Envisioning

Envisioning increased almost linearly from the 3rd session onwards once designing of solutions began, the remediation of the new model of activity was planned and parts of it were tested over the summer of 2011 (Table 3). The joint 6th session of villages A and B induced further envisioning (Table 5). The systematic increase of envisioning serves as the first evidence for a comprehensive transformation of the current pest management activity, i.e. a reconstruction of the object and reconceptualization of the functional concept of pest management that mediates the subjects' relationship to the object at a cognitive level.

By session 4, the object and the tools were most often mentioned as the target of envisioning. In session 5, the community received most attention of envisioning, as the need of having the whole entrepreneur community implementing the new model of activity was emphasized (Fig. 5). Object-related envisioning resulted in collaboratively agreeing that eradicating the pest is not possible due to the existence of year-round firms that enable its overwintering, but reducing pest densities was deemed possible, and seasonal growers also agreed on this. By session 5, the new model of activity was more or less in place, and its details were developed further by envisioning its tools and rules concerning the organization of knowledge sharing between entrepreneurs to improve whitefly management (Table 5).

### 4.5. Committing and taking consequential actions

The frequencies of expressions of committing to and taking consequential actions were rather low (Table 3). Verbally committing to material actions to advance the change increased after the 3rd session where the new model of activity was planned for partial testing and the split of the community as the obstacle for a holistic solution to the whitefly problem began to be better understood. Not all actions taken to materially transform the activity were mentioned during discourse. Such actions included the work done in village B by the two facilitators with firm X that essentially became a test bed for the standardized pest monitoring method that came to form the core tool of the new model of activity. A direct connection to X was formed in the 6th session when entrepreneurs of village B, including owner of firm X, joined the process.

The commitments made in the discourse concerned tools (19 speaking turns), the advancement of the intervention process (14) and new division of labor for knowledge production (5) (Fig. 6). Commitments regarding the process aimed at encouraging the participation of

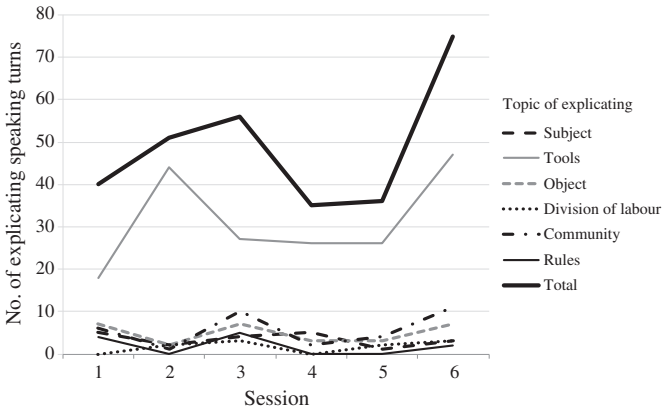


**Fig. 4.** Topical contents of explicating agentive expressions during the intervention.

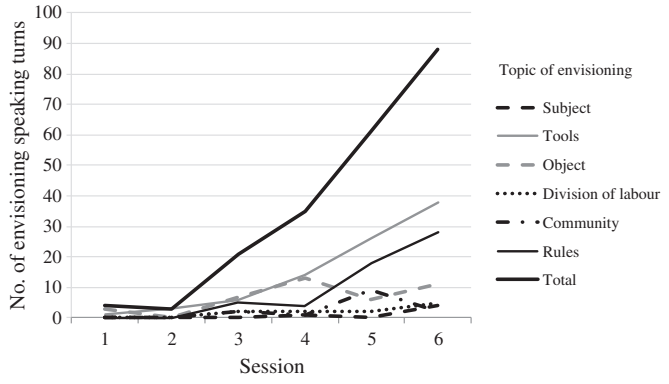


**Fig. 5.** Topical contents of the envisioning agentive expressions during the intervention.

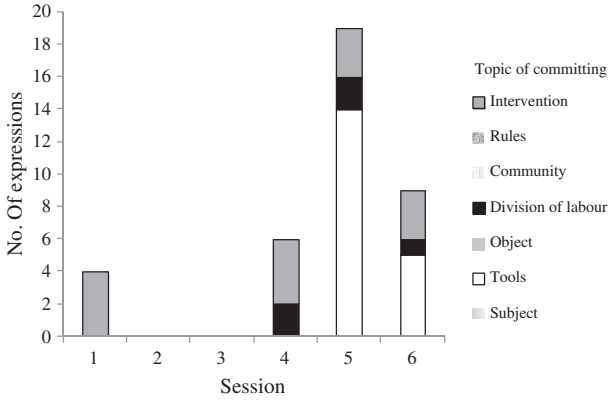


**Fig. 6.** Topical contents of committing agentive expressions.

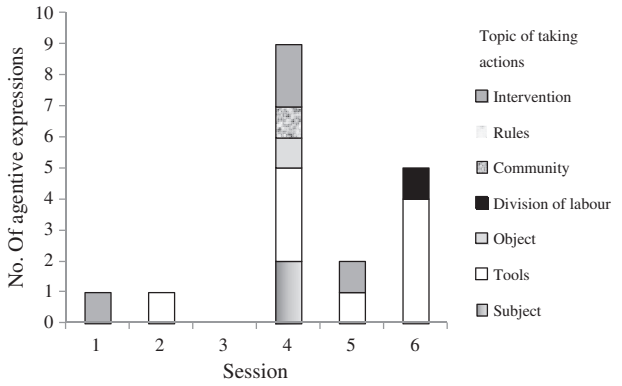


**Fig. 7.** Topical contents of the transformative agency of taking consequential actions.

seasonal growers plus how to continue the process after the 4th session. The most important tool-related commitments concerned two seasonal growers agreeing to try sticky traps for monitoring in the summer of 2011. Another important commitment was made by Peter, the seasonal grower in village B: he committed to pay for the expenses of the facilitator-advisor for arranging the meetings of the learning club. With this, he reciprocated the favor that his year-round neighbor X did to him by taking consequential actions to reduce his whitefly populations starting in 2011, which greatly reduced the need of bio control use in Peter's firm.

The actions that were reported to have been taken concerned the process (9) (execution of commitments that were made to advance the process), and tools (14) (mostly production of information by the researcher and the advisor-facilitator for the discussions) (Fig. 7). The consequential actions not mentioned in the discourse included a spontaneous meeting among the two facilitators and two key change agent entrepreneurs during a horticultural exhibition in the area in April 2011 to plant how to attract more seasonal entrepreneurs to the process. The actions by firm X in village B served as a crucial testing ground of the monitoring method (Pinto-Zevallos and Vänninen, 2013) and its potential to contribute to successful whitefly management.

### 4.6. Distribution of agentive expressions among the participants

Year-round entrepreneurs produced the highest number of agentive expressions except resisting that was dominated by seasonal entrepreneurs, and committing that was dominated by the researcher-facilitator

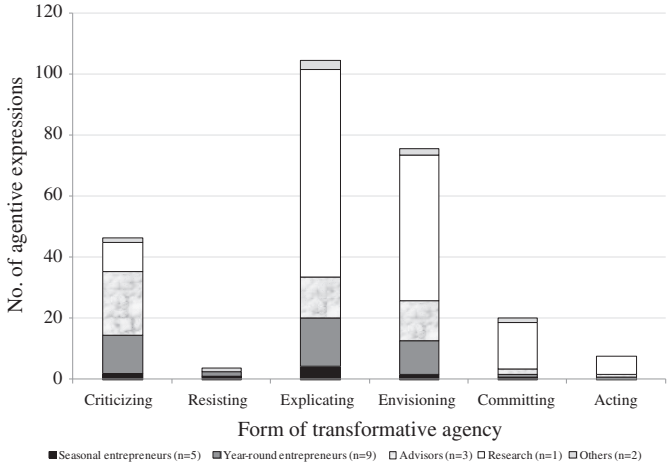


**Fig. 8.** Distribution of discursive agentive expressions among the role groups of participants on a per person basis.

(Fig. 8). The advisors and the year-round entrepreneurs were the most active in highlighting the need of change (criticism). The researcher-facilitator was the most active in explicating, envisioning, committing and taking process- or tool-related consequential actions. Year-round entrepreneurs were the second most active in explicating and envisioning, while the advisors ranked third. The transformative agency of the seasonal entrepreneurs during was smaller than that of other groups – they were fewer and may therefore have felt they were in an underdog position. They had, however, strong resisting opinions regarding who was responsible for changing the situation, however those participating in envisioning and trials agreed on the new object of activity that embraces reduction, and not eradication, of the pest.

The core elements of the new model of activity were designed collectively by representatives of 2-5 role groups (Table 5). The new model of activity was also geographically expanded when the entrepreneurs of village B accepted it and further refined it with their suggestions. The entrepreneurs stated themselves that learning will bring benefits to them only with time, foreseeing a future trajectory for the consolidation phase of the new model of activity. By the third meeting of the learning club thresholds for both biological and chemical control were preliminarily determined based on collaborative learning from the 25 greenhouses implementing standardized monitoring with sticky traps, with information becoming available for analysis and discussion at the meetings.

### 4.7. Reconceptualization of the problem

The object of pest management was qualitatively transformed during the intervention, but the new model of activity became owned principally by year-round growers. Seasonal growers located in the nearest vicinity of year-round companies in particular, however, showed interest towards it as well, both in talk and in consequential actions. The object was reconstructed gradually through criticizing, resisting, explicating and envisioning talk, and consequential actions were taken in practice to try its elements. Criticism was targeted mostly at the bio ecological object (the whitefly), the entrepreneurs themselves through their pest management decisions, and the split of the growers according to the two production forms. In this way, the problem was gradually reinterpreted. Explicating agency brought up the need and sowed the seeds of reorganized collaborative knowledge production. Tools occupied an important role in both explicating and envisioning talk, but so did the object (the whitefly), the community (how to act together instead of as individual firms), and the rules governing the interaction patterns of the new knowledge production platform.

The results of the primary analysis of contents of agentive talk were combined with other data for conducting a secondary analysis: the model of the cropping schedules of the two production forms (not shown), bio-ecological understanding of pest reproduction in the two production systems, and pest density data collected during the monitoring trial in the summer 2011. The researcher-interventionist used the combination of different types of data to construct the hypothesis summarized in Fig. 9 on the differing motivations of seasonal and year-round entrepreneurs to solve the whitefly problem collaboratively. The model received strong support from growers when presented at the last meeting of the project steering group.

The differing conditions of the two techno-ecological production forms result in differences in spatio-temporal variation of whitefly population densities, with higher densities and more regular occurrence of the pest in year-round crops. On average, differing experiences of pest levels accumulate to growers depending on their production form. It is known that experience with the realized risk modulates subjective perceptions of and visceral reactions to risks (Weber, 2006). Subject-related differences in perceiving the problem lead to motivational differences regarding what the entrepreneurs see appropriate and economical of doing to alleviate the problem.

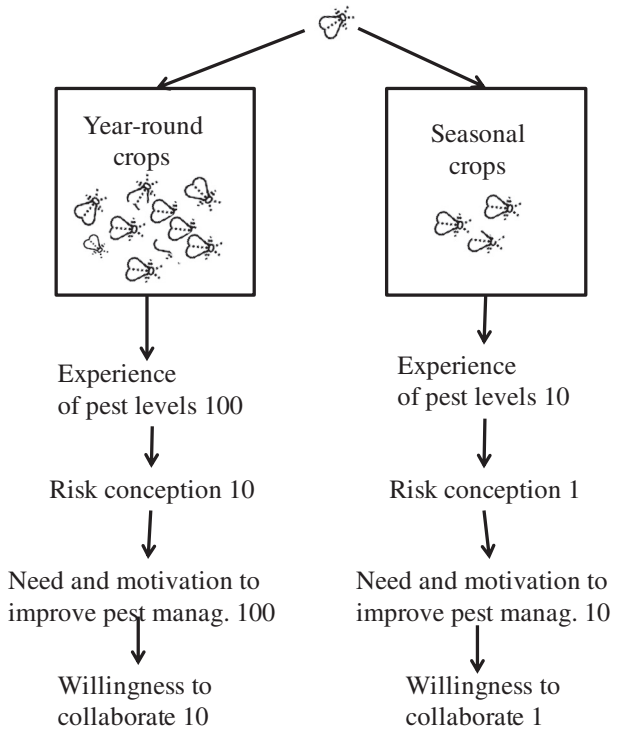


**Fig. 9.** A hypothesis for the chain of causes and effects that results in relative differences (indicated by arbitrary values of 1, 10 or 100) between seasonal and year-round entrepreneurs in their willingness and motivation to collaboratively solve the whitefly problem.

## 5. Discussion

This study was aimed at two contributions: what type of transformative agency actions can be expected to happen when agency increases among actors in facilitated innovation processes (Engeström and Sannino, 2013; Haapasaari et al., 2014), and what it takes to make people the owners of their own innovations and the development of their productive activity (Virkkunen, 2006).

### 5.1. Types of transformative actions

The study shows that criticizing, explicating, and envisioning were the most important forms of discursive transformative agency that contributed to cognitive reconstructing of the object of IPM activity. Expressions of criticism of the current activity particularly served the purpose of cracking the old concept of activity and exposing it for reinterpretation. Committing to act and taking consequential actions formed only a small part of the discourse data. This indicates that only a small part of the potential outcomes can be seen immediately during and after the intervention (Virkkunen and Newnham, 2013). Therefore, discourse data must be complemented with other type of data in order to understand to which extent the new model of activity materializes as concrete actions during the learning process.

Another important finding was the importance played by models in the process of re-conceptualization of the pest problem. Such models function as shared boundary objects (Jakku and Thorburn, 2010; Klerkx et al., 2012) that help participants to understand the complexity and dynamics of the system that was leading to the problem, and consequently design more suitable solutions.

Too few studies on the evolution of transformative agency during interventions are available at the moment to see any patterns; rather, it looks like each case is unique and follows the idiosyncrasies and serendipities of the process (Haapasaari et al., 2014; Haapasaari and Kerosuo, 2014; Heikkilä and Seppänen, 2014). In formative interventions, the whole idea is to enhance the agency of the participants by utilizing explicit tools such as models, pictures, tasks, and questions about certain themes (Virkkunen and Newnham, 2013). The deviation of the 4th session from the planned script was a strong promoter of the participant's transformative agency and created an unintended reflection space for those present. The same phenomenon was observed in interventions arranged by Engeström et al. (2013) and Heikkilä and Seppänen (2014). The interaction of the planned script, deviations from the script, and the learning-promoting second stimuli used and produced during developmental interventions deserve further study.

Klerkx et al. (2010a, 2010b) propose the term effective reformism than involves strategies and practices that innovation networks deploy to create changes in their environment. Effective reformism is made possible by boundary spanning actors. Their activity aims at establishing a more conducive context for the realization and durable embedding of innovation projects of the networks. Our study contributes to understanding the types of actions that are needed to make the boundary spanning actors to become agents of transformative change. In the study, we showed how important criticizing agentive actions were for cracking the old problematic concept and initiating the reframing of the current problems in the activity. We also emphasized the importance of resisting agentive actions, purporting that although resistance to change is usually seen as a negative thing, it is in fact part of the process where people are supported to change their conceptions.

### 5.2. Making growers the owner of their innovation

The study reveals three important processes that were involved in building transformative agency among growers: 1) transformation of the concept of IPM, 2) the creation of a learning platform and 3) dealing with split community.

Although the growers do collaborate in many things such as a co-owned energy plant for heating their greenhouses it was only during the Change Laboratory that they started systematically communicating in IPM issues. They reframed their pest problem and designed a new model of IPM that enables also the contemplation and enactment of negotiated order for synchronizing IPM between firms. The initial concept of IPM corresponded to partial optimization (technical elements) which is not satisfactory when the problem is systemic. Spatially, the new concept of IPM moved from individual firms to the level of one or more villages. Temporally, the growers themselves acknowledge the long-term nature of the process.

Another important process in building transformative agency was the creation of a learning platform. In the study, the learning club as the outcome of the intervention addresses the specific, idiosyncratic needs of missing knowledge creation and sharing among the greenhouse entrepreneurs who are locally interdependent through the movements of a pest. Therefore, it is a true innovation by and for the local actors. The club forms the kernel around which further innovation activities can be built and structured. This is in accordance of understanding co- innovation as the outcome of collaborative networks and the contextual re-ordering of relations in multiple social networks where information is exchanged and learning processes happen (Knickel et al., 2009; Leeuwis and Aarts, 2011; Toiviainen, 2003). Other studies shows that study groups and learning partnerships are a rather ubiquitous solution to advance IPM (Crawford et al., 2007; Gallagher, 2000; Kroma, 2006; Röling and Wagemakers, 1998).

The generation of transformative agency is assumed to be particularly problematic in settings where the community is split into competing or oppositional groups which nevertheless need to act together to achieve necessary changes. Communities of practice (Wenger, 1999) and collaborative communities (Heckscher and Adler, 2007) are usually depicted as relatively unified entities, perhaps with diverse memberships but seldom with divisive internal tensions. In reality, such tensions

are common as the interests of different sub-groups within a community may diverge and lead to conflicting motives and visions for the future.

In system learning, the system perspective helps reduce the threat that single actors are blamed and held responsible for the perceived problems (van Mierlo et al., 2013). In practice it is, however, often hard for people participating in a given activity to understand its tacit, embedded systemic nature and the relations between its elements. In our case this was evidenced by the slow unfolding of the importance of reorganizing the division of labour for knowledge production among growers and the differences between the two types of growers in attributing importance for the new division of labour for solving the problem.

In this study, the Change Laboratory intervention only partly overcame the split between growers representing two historical forms of the same activity. Therefore, the new object became mostly owned by the year-round growers. Nevertheless, at the level committing to act and action, seasonal growers also embraced the new model of activity. Importantly, these growers were not involved in the most active phases of envisioning the new model of activity. This is encouraging in the sense that the geographical and social expansion of the new model of activity among other growers who were not part of the process may succeed in the future. On the other hand, the new concept of IPM activity was most readily embraced by those seasonal growers who were located in the near vicinity of year-round firms. This suggests that firms that most clearly share problems are the most likely collaborators in collectively alleviating the problem in the short term irrespective of their production form, as suggested also by the model produced by the secondary problem analysis.

The revealed depth of the split among the growers informed us on the need of organizing a separate Change Laboratory to the seasonal growers so that they, too, could analyse their situation in a safe reflective space (Sannino, 2010). Our idea of a learning process organized specifically for the seasonal growers is supported by the findings of (van Mierlo et al., 2013), who organized researcher-facilitated system-learning workshops for actors from the value chains in two Dutch poultry subsectors. The authors concluded that seeking completeness by trying to bring all relevant value chain actors to the table at the same time may not be the best option for system learning.

### 5.3. Contributions to grasping co-innovation and social learning

The EU framework directive 128/2009/EC provides general principles of IPM that is to be applied in 'local conditions". We propose that the CHAT-based approaches to change that involve reconceptualization of the object of activity may contribute to informing interventionists and participants of co-innovation processes on how 'local conditions' should be understood: not only as the ecological and economic context, although they both are very important (Kaine and Bewsell, 2008; Wyckhuys et al., 2010), but also the human factor and social interactions that can have a crucial influence on IPM implementation (Palis et al., 2002). We argue that a localized developmental view based on how an agricultural activity system is seen in terms of CHAT is able to capture the locally conditioned conceptions of IPM as an activity, and in so doing, may help in positioning the local IPM concept among the developmental variations of IPM (Hill, 2014). There is relatively little literature on farmers', advisors' or crop protection researchers' conceptions of IPM (Cerf et al., 2010; de Buck et al., 2001; Palis, 1998; Wossink et al., 1997). Therefore, revealing such conceptions through analysing either transformative agentive actions or learning actions during formative interventions of IPM implementation would appear to be in demand to complement other approaches.

The object of activity as the target of collective learning and agency, and the activity system as the unit of analysis, could contribute also to resolving the issue surrounding the content of social learning (Bos et al., 2013; Reed et al., 2010; Scholz et al., 2013). The content often tends to remain abstract, universalistic and ahistorical instead of being linked to the local contingencies and historical challenges of learning (Paavola et al., 2004; Virkkunen, 2009; Virkkunen and Kuutti, 2000). The conceptualization of social learning has also struggled to reconcile the individual and social aspects of learning and agency (Reed et al., 2010; Stetsenko, 2005; Wals and Schwarzin, 2012) and to identify the theoretical unit of analysis for social learning (Virkkunen and Kuutti, 2000). The change in the object could perhaps be used as an evidence for convergent, collective learning having taken place, which is one of the criteria of social learning as proposed by Reed et al. (2010) and (Scholz et al., 2013).

Co-innovation is a collective process that to be successful often requires changing the way farmers, researchers and advisors communicate with each other (Sewell et al., 2014). Change Laboratory helps people reflect on their object of activity in order to change it when it has become problematic. This corresponds to reflexivity, with system diagnostics and analysis in its core (Dogliotti et al., 2013; Klerkx et al., 2010a, 2010b; Van Mierlo et al., 2010, 2013). According to Arkesteijn et al. (2015), reflexivity (or reflexive monitoring) is 'an interactive methodology to encourage reflection and learning within groups of diverse actors that seek to contribute to system change in order to deal with complex problems'. People doing reflexive monitoring attempt to "develop or change local rules, practices and relations within the network". Change Laboratory has similar aims, but is more specific in the sense that it promotes a specific type of learning that is expansive and is directed at the object of the activity. Reflection helps subjects understand the relations between rules, practice and relations; in addition, CHAT-based reflection concerns also tools and division of labour, and, most importantly, the object of the activity.

Change Laboratory creates a specific situation where the elements and their relations are made visible to be reflected upon, customarily with the help of theoretical models such as the activity system triangle that induce system learning The importance of system learning through reflection is that both the problem and its solution are constructed by the participants themselves who thereby are more likely to become owners of the produced innovation and overcome their activity's systemic stability caused by historically grown mechanisms. Arkesteijn et al. (2015) considers historically grown systemic stability to be among the dimensions that explain why interventions often fail to produce solutions to complex problems. CHAT, for its parts, takes contradictions within and between activity systems (which it considers as the products of historical changes in the activity) as starting points of innovations whereby solutions emerge from identifying the contradictions through theoretical-historical, object-historical and actual-empirical analyses of the activity in question (e.g.

## 6. Concluding remarks

In a Change Laboratory process, the premises of successful social learning come together through the object that captures the community, content, interest and alignment aspects of participant learning that occurs through participation in a community (Sewell et al., 2014). We propose that participating in Change Laboratory processes has several implications to the development of agricultural knowledge workers' (advisors, interventionists, change agents, and even scientists) communication and problem solving skills. Today's advisors are increasingly becoming facilitators who support farmers' transformative agency towards agricultural innovation instead of merely disseminating information and telling farmers what to do in regard to operational–tactical issues (Dogliotti et al., 2013; Ingram, 2008; Kilelu et al., 2014). Such a change in the advisor's role require new tools, new ways of knowing and new ways of relating, through knowledge exchange encounters with clients (Cerf et al., 2011; Ingram, 2008).

The way reflection and reflexivity are targeted at the systemic level in Change Laboratory interventions, reframing that utilizes the principles of double stimulation to crack up the old problematic concept, and the shared object of activity that promotes intense talking and

listening among participants all serve to develop communication and analytical skills of agricultural knowledge workers and increase their awareness of the potentials of facilitative approaches as the basis of knowledge exchange encounters. When such interactional experience is transferred to one-to-one farmer-advisor knowledge exchange encounters, these, too, may become more facilitative and partnership-like (Ingram, 2008).

Participation in the diagnosis and reframing of collective systemic problems with the help of the theoretical and empirical models is likely to promote advisors' understanding of systemic relations, i.e. increased level of abstraction and overview, which is always beneficial for knowledge and communication workers. Systemic thinking increases the advisors' ability to identify farmers' constraints and may reduce making contradictory recommendations, a problem that, according to Ingram (2008) can occur in advisory work when certain knowledge exchange encounter models are used. Learning to reframe problems can be expected to enhance the ability of advisors to identify latent client needs that are not easily detected in the context of provisioning demand-driven advisory and innovation services (Kilelu et al., 2014). Another thing that supposedly increases advisors' (and scientists', for that matter) ability to deal with systemic issues is learning to recognize the different kinds of discursive transformative actions, such as resistance, criticizing and envisioning which, according to our study, are to be expected during co-innovation processes.

We did not explicitly study the learning experiences of advisors in the context of the Change Laboratory. During informal discussions with the advisor-facilitator she explained, however, that she was learning of "not being as much controlling" with her clients compared to her customary knowledge exchange encounters with them. The farmers, in turn, regarded the Change Laboratory approach different than what they had experienced before. They stated that the intervention was the first one where they actually learned a lot while it was running, instead of learning only after the project was finished – if even then. This suggests that participating in the Change Laboratory triggered the advisor to think of her ways of acting with the clients, and her clients began to expect something new from knowledge-provisioning professionals. This is in line with the findings of Sewell et al. (2014) who studied how farmers' learning changed when they participated in learning community with agricultural scientists. Further studies are needed to establish to which extent participation in a Change Laboratory influences the skills development of agricultural advisors.

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