A device for sharing knowledge and experiences on experimental farm station to sustain the agroecological transition

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Abstract:*This paper presents a social experiment (2016–2018) on an experimental farm station (eastern France), certified in organic farming since 2004, to support the agro-ecological transition by exploring new ways of producing, capitalising and sharing knowledge and experiences. One thousand participants (students in technical programmes and higher education, farmers and Agricultural Knowledge and Innovation System actors) were received to discover and exchange on the autonomous farming system experiment with the practitioners. A learning device mixing innovative learner-centred approaches (phenomenology, dialogue, problem-based learning, tactile space, etc.) was designed, implemented and evaluated. The farm practitioners drew on different resources (storytelling, photos, facts and figures, graphs, markers, indicators from everyday life), and various situations to reflect environmental and work conditions (fields, nearby animals, the milking parlour). A diversity of knowledge, values and experiences were presented, as well as pragmatic research, science in the making, living, unpretentious to restitute complexities, variabilities and uncertainties inherent to autonomous farming system. The issues focus more often on the process, experiences and changes in visions and attitudes than on numbers and figures that are site-specific. Intellectual, social, technical and material pathways are made visible and reveal unresolved issues, difficulties, mistakes and unexpected levers, seen as potentially useful resources for diverse end-users. The farm station, as a tactile space where knowledge is embedded and embodied, nurtures new intelligibilities. The study shows interesting learning outcomes among participants, who leave with increased knowledge on autonomous farming systems. On evaluation forms, 65% of the respondents declared that they intended to use the knowledge gained.*

Keywords: *social experiment, knowledge, experience, system experiment, agro-ecology, learning*

Introduction

The agro-ecological transition has challenged the production and circulation of knowledge as practiced in the dominant agricultural regime (Wezel et al., 2009). It calls for a critical reformulation of the epistemological foundation for both research and higher education in agro-ecology and revising professional practices in the AKIS (Agricultural Knowledge and Innovation System) (Coquil et al. 2016). The core idea of agro-ecology is the symbiosis of different elements in interaction into a whole system. So, by definition, it should be multi-epistemic, including an assembly of many sources of expertise to address complex issues of sustainability. New forms are needed to support farmers' (and future farmers') transformations, taking into account the specificities of their farms and how they consider it. Individual farmers' particular viewpoints and environments are voiced in how they live their work as well as their ability to give value to a diversity of knowledge and a variety of sources available for the agro-ecological transition (Cayre 2013). This demands learning to handle more complex and less predictable knowledge than those mobilised in artificialised systems. This new paradigm of ecologisation implies revising methods, concepts and knowledge in agronomy (Doré et al., 2011). It involves adopting less prescriptive approaches based on command and control management strategies (Holling and Meffe, 1996) and more adaptive management strategies (Williams, 2011), in order to manage uncertainty and the unknowns (Brugnach, 2008).

In that respect, the tasks entrusted to experimental farm stations have been harshly challenged. Historically, and this is still a predominant trend in France, the experimental stations of the French Institute of Agronomic Research (INRA) have been dedicated to the production of quantitative data within factorial studies, in order to assess the factors affecting the performance of agrosystems. This has to do with controlling the conditions of the experiment, including minimising environmental disturbances and heterogeneity, via the use of external inputs (pesticides, synthetic fertilisers, etc.). Such experiments lay down a reductionist paradigm that consists in reducing the real into subsystems with constant, universal, predictable properties. They belong to the realm of accuracy and produce analytical knowledge. They could provide technical references and a set of ready-made solutions based on the control of biophysical processes and the optimal use of natural resources (nutritive elements, water, genetics, etc.), which are transferred to farmers through extension services and the dissemination of many standardised management tools. The experimental stations have thus played a crucial role in the promotion of new agricultural practices in the productivist context of agricultural modernisation, through a top-down diffusionist mode, based on a linear vision of the innovation process that comes from the expert agronomist to “ignorant” farmers.

In the 1990s, certain researchers had distanced themselves from the factorial approaches and stressed the need to adopt a systemic approach to come to terms with environmental and sustainability issues. They therefore suggested designing system experiments to test different kinds of agricultural production systems (animals and crops) over several years, evaluating the performance provided by the practices designed under test conditions. This strategy is referred to as “testing prototypes”. When the complexity increases in the tested system, the practices could not be stabilised, Coquil et al. (2014) talks about “step-by-step design”. This approach is particularly appropriate for agro-ecological systems based on biological regulation mechanisms at the technical level, because it engages farmers and practitioners in a progressive apprehension of multiple interactions within the system through observing, interacting and learning by doing without defining practical modalities and decision rules in advance. It is a design approach that serves the acquisition by the practitioners of experiential knowledge, know-how, practical and soft skills, relevant in the production systems tested. The step-by-step design of autonomous and sparing systems intrinsically raises the question of the formalisation of the acquired experience gained at the workplace (Coquil et al., 2017), but it also raises the question of the sharing of this situated knowledge. Interacting is a core component of the production of this kind of synthetic knowledge mainly oriented toward utility and efficiency (Asheim and Coenen, 2005). Therefore, it deserves less vertical and descendent approaches between research, extension and production, in favour of more horizontal ones which more fully take into account the effects of context, and fosters a hybridisation of different kinds of knowledge.

There is also a call to reform agriculture education curricula (in initial training and continuing education) and pedagogy with major epistemological and attitude shifts. It would be better take into account uncertainty, and the study of diversity implies more interdisciplinary approaches, and a reinforcement of on-farm action knowledge. This is not only about revising the framework of knowledge, but also transforming pedagogical practices. All the pedagogical approaches and teaching methods used to explicitly enhance autonomous and social learning for responsible action in a complex and uncertain environment are considered to be socio-constructivist and not diffusionist-based approaches to education. In this paper, we present a 2-year social experiment on the INRA experimental farm station at Mirecourt in Eastern France, which aimed at sharing knowledge and experiences, acquired over more than 10 years by practitioners in a context of a breakthrough innovation engaging a range of values and a revision of professional norms. This experiment is conducted through the visits of the experimental station dedicated to the conception of autonomous farming systems. It brings in a wide range of visitors from the agricultural sector: farmers, advisors, teachers, and students in technical and higher education in agriculture, variously aware and mindful of environmental issues. We address the question of a new form of knowledge production and circulation in agro-ecology in an original science–society interface, an innovative space of intermediation between research and the farming community. We formalise new ways of interacting and evaluate the experiment's first effects on visitors and the research team.

The first part of the paper describes the material and methods used in this social experiment. Then we will present the original learning device that was designed to share knowledge and propose a first evaluation of its effects from the learner's perspective. Finally, we will discuss the relevance of this type of device in a landscape of emergent learning approaches in agro-ecology, and analyse how it has engaged new roles and postures in the station.

Material & Method

The INRA Mirecourt experimental farm station

The INRA experimental farm station in Mirecourt is situated in the Vosges region (eastern France). From its creation in 1961 to the middle of the 1980s, experiments (animal feed, varietal studies, fertilisation, etc.) were conducted in an intensification paradigm serving a productivist optimisation model. The approaches were factorial, sectorial (animal/vegetal) and disciplinary. The knowledge produced on the station was presented as a model of good practices and assorted with prescriptions, such as dairy feed recommendations to increase milk production based on reference tables and cross curves. In the 1990s and 2000s, the station engaged in an extensification process, focusing on dairy cattle grazing and water quality issues stemming from manure composting. During these two periods, results were also promoted through visits to the experimental station. These visits, lasting about 2 hours, were essentially formal thematic demonstrations of stabilised results through numbers and figures exposed in the classroom by the engineer in charge of the topic, and were completed by a very brief tour of the milking herd facilities with the farm manager.

Between 2004 and 2015 the centre's approximately 20 practitioners undertook a step-by-step design of autonomous (with no external inputs) and economic farming systems (Coquil et al., 2014). The step-by-step design is a project development centred on the acquisition of experiential knowledge and know-how by the practitioners. Within the station, the design was carried out in two circles of exchanges: seven to ten practitioners were mainly involved in the design of strategic orientations and in the evaluation of the experiment's performance, and ten to 13 practitioners worked on the practical design of the autonomous system and recorded experimental data. Those two circles were interdependent and frequently exchanged to adjust the design through action.

On the 240 ha of the experimental farm, two production systems were designed from the natural and social potentialities of the site and experimented: a dairy cattle grazing system with 40 dairy cows on 80 ha of permanent grassland, and a mixed crop and livestock farm with 60 dairy cows, 50 ha of permanent grassland and 110 ha in crop rotation. The farm has been certified in organic farming since 2006 (Coquil et al., 2009). Most practitioners had practiced conventional farming. The transition to autonomous farming systems has led to major professional development enriched by new experiences (Coquil et al., 2017).

Since 2016, a new strategic orientation has emerged, aiming to re-orient the practitioners toward a professional transition process, to learn and build new resources of interest for potential end-users. The economic and autonomous orientation is maintained, but production goals are revised to contribute to a sustainable local agro-food system and to increase the added value for the creation of lasting employment. The design approach is being progressively opened to citizen considerations, involving a few of them in the design groups. In this new experiment, the development of research on knowledge sharing is called upon to assume a pivotal role.

At the technical level, the farming system is now composed of one 100-cow dairy system (exclusively fed with grazing and hay), 30 pigs raised on alfalfa pastures and complemented with the cereal by-products and cow milk residues unfit for human consumption, sheep rearing (meat) of 130 ewes, which should improve the use of grassland in conjunction with cows. Arable land is entirely dedicated to cash crop production for human consumption.

The social experiment

The participants

For 2 years beginning in January 2016, we conducted a social experiment on the experimental farm involving the practitioners of the experimental station, and various visitors from the agricultural sector (27% farmers, 57% students in technical and higher education in agriculture, 16% from technical and research institutes), who were received on the farm over 46 days (Table 1). A typical farm visit lasted all day (9 a.m. to 5 p.m.), but we also tried a longer format with a 1-week study tour. The visitors mainly came from the Greater East region in France (57 000 km²) and other areas in France and Belgium. Collaborations exist with high schools specialising in agricultural technical education (vocational baccalaureate, professional degrees, certificate program in organic agriculture), that visit every year, with student groups comprising 10–60 people, in the context of agro-ecology learning modules. Most students have already actively worked on farms (but rarely on organic farms) in family settings or during internships. Groups made up of farmers were generally composed of about 15 persons (with one or two advisors), with contrasted livestock systems (conventional farming most often). Most visitors came for the first time, except some groups of organic farmers who regularly experiment at the station in the context of professional exchange groups, and some accompanying teachers.

They came with a panel of varied and vague expectations, that we addressed through phone interviews and pre-visit questionnaires: (i) the discovery of an alternative system, a concrete space to give substance to the notion of agro-ecology (ii) new agricultural practices on various topics (breeding, animal feed, grazing, farm without chemical inputs, technological innovations, etc.), (iii) various technico-economic references (advisors) and agro-environmental indicators (soil fertility, water quality, biodiversity, etc.) on autonomous and organic systems, (iv) looking for a “model to inspire the future of agriculture”, (v) the discovery of research activities: “What does an experimental farm look like? How is research done? What results can be attained?” Nonetheless, the vast majority of the participants could not express any expectation other than “discovering something new”, and a captive audience was present.

Table 1. Characteristics of the visits during the 2 years of experimentation (2016 and 2017).

Type of visitors	Nb participants	coming from the region (%)	Nb of days	Duration (h)
Farmers	273	46	18	82

Higher agricultural education	313	70	9	43
Technical agricultural education (14–18 years old)	260	70	12	40
Technical and research institutes	154	21	7	23
Total	1000	56	46	188

Design approach

The first two authors of this paper ("we" in this manuscript) were directly involved in designing and conducting the visits and also participated in the farm's weekly functional staff meetings, and other strategic meetings to reflect on the design and set-up of the future experiment. We assumed research in action and for action. The inductive design approach of the visit device is a "continued design in use". Everything cannot be scripted in advance, neither the expectations nor the challenges. There is an interplay between a range of factors that cannot be controlled: who is coming, who is available as volunteers to share knowledge and experiences, the agricultural calendar, etc., and a range of factors on which some control can be exercised, a range of beliefs and preferences that reduce the choices available. The term "device" encapsulates the heterogeneous elements, statements, technical layouts, knowledge and incorporated skills assembled (Callon 1995), all needed to conduct the visits.

We created a cell including the practitioners to collectively prepare and capitalise on the visits. Before and after each visit, several group meetings and individual sessions were organised to discuss the situations, materials, resources of interest and problems, to facilitate knowledge sharing depending on the visitors and current agricultural issues. This is a collaborative action–research approach (Pelt and Poncelet, 2011; Brighton and Moon, 2007) that aims to contribute to professional development through increasing reflexivity on action. Practitioners and researchers are both co-analysts and co-authors of change.
We developed a pragmatic, iterative, recursive, didactic engineering approach in an ever-changing environment focused more on knowledge transmission and appropriation processes than on content to learn. The visits were scheduled partly to draw on prior experiences and partly on exploring the literature on emergent learning methods in agro-ecology. We also borrowed concepts used in professional didactics to build educational resources based on work situations for the development of professional skills (Pastré and Vergnaud 2011). We were guided by the performativity of the device, its capacity to create new sharing practices to foster exchange, to question visitors and practitioners in their action, to accompanying critical, autonomous and systemic learning, but also its capacity to become an open space in which learning and changes are perhaps not those that were originally envisaged.

Data collection and analysis

The evaluation of the outcomes of the visit is a delicate question, especially when the learner's perspective is taken as a didactic starting point and no longer a baseline of knowledge. Should we talk of learning outcomes? New skills? Enhanced reflexivity? Emancipation? Changes in thought, perceptions, or in action?

The first author of the paper practiced observant participation (Bastien et al. 2007) for 2 years during the 46 visits, within the reflexive cell, to design and capitalise on the visits. The analyses were largely based on her recordings (extensive notes, audio recordings, photos, full transcripts for nine visits). Five visits (four groups of ten to 15 farmers and one group of 40 students) were also partly filmed, including debriefing interviews with one student, one teacher, one advisor, two farmers and one practitioner.

During the visits we were particularly attentive to the interactions among participants and the dialogue between the different types of knowledge and how they made sense. Observations of the appropriation sequences provided particular insight into how the participants perceive the pedagogical process and content of the visit. This analysis was completed with post-visit evaluation forms providing an additional window into the participant's reactions and learning. Questionnaires were to be completed over the month following the visit, in a paper or digital format depending on the user's choice. They contained a few quantitative indicators to evaluate overall satisfaction and the learning intensity of different learning times (presentations, peer exchanges, observations), and open questions on striking elements (interests and resistance), questions and intended uses. We sought to assess the capacity of the device to foster knowledge circulation on agro-ecology and autonomous farming systems among a diversity of visitors including the uninitiated and the reluctant to organic farming. We were seeking indications of socio-cognitive moves. We also wished to evaluate if and how the situated knowledge and experiences shared could be remobilised in other contexts. The self-evaluation made by the participants through individual questionnaires was thought of as an integrative part of the learning process engaged during the visit. A total of 237 questionnaires from 16 visits, representative of different types of audience (farmers, advisors, students) were analysed. Feedback from the questionnaires was regularly deliberated during debriefing sessions and thus participated in the continuous design of the device.

Results

A learning framework for experimental farm visits

Each visit is unique because it focuses on the interplay between the different visitors and practitioners and is embedded in situations reflecting the agricultural calendar with its typical and particular events. Progressively, however, while experimenting many ways of interacting during the visits and taking into account feedback from the participants (visitors and practitioners), a common framework took shape. The following section presents an overall picture of the learning device, describing the core components of the farm visits (Fig. 1).

First encounter

Just after welcoming the participants, a preliminary period to get acquainted is a prerequisite to effective dialogue throughout the rest of the day. Breaking the ice in this way allows us to make contact with the visitors and helps us to understand the needs of the group. Several mediating tools are used, such as successive round tables “in one word” so that all the group members could introduce themselves, positioning games in space to discuss personal positions on the various topics to be addressed during the visits: agro-ecology, autonomy, sustainable agri-food system, etc. We also organised discussions on the future of agriculture, listing and explaining today's constraints in agriculture and the range of socio-ecological levels. In this collectively built overall picture, we then discuss the concept of autonomy, attempting to provide a concrete picture of the challenges and objectives of the system experiment at the centre. When weather permits, this sequence takes place outside in the farmyard so as to immerse the visitors in the context.

Interacting within a tactile space

The system experiment is discovered by the visitors where it actually takes place. In various environments (forage shed, pastures, fields, milking parlour, stalls, among cattle), selected by the practitioners for their potential to astonish visitors and their capacity to point out key features of autonomous agricultural practices, the participants are invited to immerse their senses, before any dialogic interaction. A simple instruction of ‘individual attentive observation without communication’ is given, and each person is free to discover the situation as he or she pleases with all five senses: noses in the haystacks, hands on the muzzle of a cow, eyes observing three multi-coloured calves suckling a Holstein nurse dairy cow, hands feeding fresh alfalfa to outdoor grazing pigs, in the prickles of spelt husks, pulling up an unknown crop to examine it, the tongue tasting radishes in an intermediary cover crop , hands making a bouquet of weeds, eyes noting the presence/absence of hedges and water points, ears listening to singing birds, the skin sensitive to the wind, hands crumbling clots of earth, the participants standing tall to measure themselves next to an ancient variety of wheat 1.80 m high…

Then the participants share their perceptions, presented on posters when possible, and associated representations and analyses are compared and debated. The first language expression of the previous mute and intima immersion experience is first laid out in description, in a pre-reflexive dimension dissociating perception (e.g. different shades of green in a plot) and judgement (e.g. different maturity stages, different varieties, diseases, etc.) as much as possible. We facilitate exchanges in a kind of never-ending hyper-dialectic, with established meanings, in definitive answers, to create a movement of decomposition/recomposition, revising norms and ground knowledge in a new context.

The underlying idea of this full sequence is that participants make sense, literally and figuratively, of the world around them, by fostering corporeal knowledge and social learning through dialogical exchange. This is not only a question of offering a sensuous supplement but rather an opportunity to mix distal and proximal forms of thinking in order to build a systemic view with multiple connections between people and their surroundings.

Interacting with practitioners

Another core component of the device is the possibility for the participants to interact with a diversity of practitioners who have mobilised a wide variety of heterogeneous knowledge, know-how and experiences. The plurality of speakers allows paying more attention to the diversity of perspectives that people have on a particular reality and their diverse ways of building interpretation and acting in a situation. The agents draw on different resources such as storytelling, photos and figures, and various situations to reflect environmental and work conditions (fields, nearby animals). We can distinguish two contrasted modalities to share knowledge and experiences: presentations and testimonies.

“Presentations” refer to scientific knowledge presented by the practitioners (scientists) in charge of strategic orientations and performance evaluation. Their presentations are prepared in advance to expose the design of the experiment, rationale and technical choices, and quantified analysis of the bio-technical results acquired over the long term (milk production, yields, weed pressure, economic balance sheet, etc.). Presentations are made to the entire group in indoor plenary sessions via powerpoints, or exposed in conditions via posters, to discuss multi-annual reviews or more recent data (previous agricultural campaigns). Through graphics, quantified indicators and photos the practitioners emphasise the how much the results depend on the context, which has been amplified by removing inputs. Their teaching emphasises most particularly spatio-temporal variabilities more than averages (pedo-climatic variability, variations in milk production, differences in grazing times, harvest variations in wheat, alfalfa, cereal-protein mixtures, straw, etc.).

During this focus on performance and its variability, practitioners highlight the need for adaptive management in autonomous farming systems and stress the balances and compromises at the systemic level, relying in particular on the diversity of resources and the complementarity between animal and crop production. They also reveal unexpected levers found to overcome difficulties, such as longer lactation and advanced calving time, in order to entrench the pasture herd facing fertility problems.

Most of the indoor talks given in the presentation mode are quite formal; they propose a scientific reading of the facts that leaves little scope for interactions with the non-experts, except during a question time in which discussions are generally focused on production and economic performance. When the presentations are held in less formal conditions outdoors, in the presence of technicians, they are much more interactive, and a dialogue can occur between a variety of knowledge and experiences.

“Testimonies” refer to experiential knowledge acquired in action by the practitioners (technicians), who work on the practical design of the autonomous system and record the experimental data. The practitioners give their testimonies in context, to ground their knowledge, demonstrate their work conditions, and encourage real-life questions. Alone or in pairs, the practitioners briefly present their activities (agricultural and experimental) on the farm and respond to what the participants observed in the attentive observation phase. The conversation engages the agro-ecology debate with visitors. Most presentations are extemporaneous, not written in advance, although photos can be used to illustrate situations dependent on the agricultural calendar, which are key to the practical design of the system (e.g. a grazing period), or episodic experiences stored for their singularity (e.g. alfalfa grazing).

The testimonies mix detailed driving elements (e.g. seed drill brand, row spacing, forward speed of the tractor, etc.), professional development (resulting from the conversion to organic farming, and more recently related to animal and plant diversification), changes in visions and attitudes, critical moments (e.g. the first treatment of cows with essential oils), problems, concerns, mistakes, levers, etc. Reported experiences are marked by deictic references, inseparable from place, time and subject of enunciation (“I”, “here”, “now”), and are related to inferential, heterogenic and evolutionary action knowledge. By contrast with the scientific results of the experiment that refer to a given analysis period (e.g. a campaign report or a crop rotation), experience is continuous, changing, without well-defined contours, always enveloping something past and something in process, so that the testimonies refer to both past and current situations.

Some practitioners have made it a habit to use catchy tag lines to amplify the dynamics of the question time, dismantling prejudices, and help revise conventional standards: e.g. “If we were using the conventional standards to estimate the wheat yield loss taking into account the density of blackgrass, we would have negative yields yearly.” These tag lines are also sometimes used as benchmarks for actions built over the long run in the farming autonomous system. “To handle the eventuality of successive years of drought, and if we don’t want to buy feed, we need to have remained in the forage shed half a winter at the moment of putting cows out to graze . We prefer to sell cows than not have enough fodder.”

The point is not to provide ready-made thinking, but rather to encourage reflection. Moreover, capitalisation process of experience essentially occurs throughout dialogic interaction with the visitors, who transform embodied knowledge into accessible knowledge depending on their ability to question the practitioners. Visitors’ questions concern technical aspects (e.g. “What are the protein–cereal mixture seeding rates?”) as much as feelings (e.g. “How does it feel to see your field in such a mess, looking like a blackgrass field? Can you stand it? Aren’t you afraid?”). The possibility for dialogue seems to be reinforced by the capacity of the practitioners to depict pragmatic research, living, uneven, unpretentious, with its mistakes and uncertainties, and to recognise that a diversity of knowledge can contribute to progress in open-ended cases. When pointing out their difficulties, it is common that visitors share similar or contrasting experiences in other contexts and contribute to imagining solutions.

Appropriation

In a developmental perspective, we consider that development occurs when a subject “comes to claim the meaning of the episode he has just experienced” (Pastré, Mayen, and Vergnaud 2006). Therefore, after the phases of sensory immersion and interactions with practitioners, we provide a reflexive sequence of “appropriation” several times during the visit, to assist participants in learning from their experience and accompany a sense-making process. It is less about reaching a mere rational cognition of the situation and more to discover personal coherence. The principle is as follows: contextualise, help visitors remember and digest information, step back from the context, and draw on their previous experience and knowledge to construct meaning.

The sequence is organised in three steps. The first step requires individuals to spend 5 minutes writing a very short reflective essay, called an “astonishment report”, to provide personal reflection on any unusual aspect of the observation/testimony sessions that has provoked surprise. The second step is a 10-minute session in small groups of two to five people, in separate rooms, to discuss the surprises written down in the first step and then to explain this astonishment sharing their contextual experiences, in order to avoid a purely descriptive account with little personal analysis. The groups were instructed to dialogue and debate with goodwill, avoid judgement and provide arguments. Only if these instructions are not followed do we intervene at this time in the peer exchange groups. Discussions can be organised on a collective mind map (on a poster) that also supports sub-group reconstruction. The appropriation phase ends with a general group debriefing session, where people report their findings and questions.

Sometimes the practitioners assist this developmental sequence and in the final reconstruction gather the direct feedback on the pertinence of the system experiment for end-users.

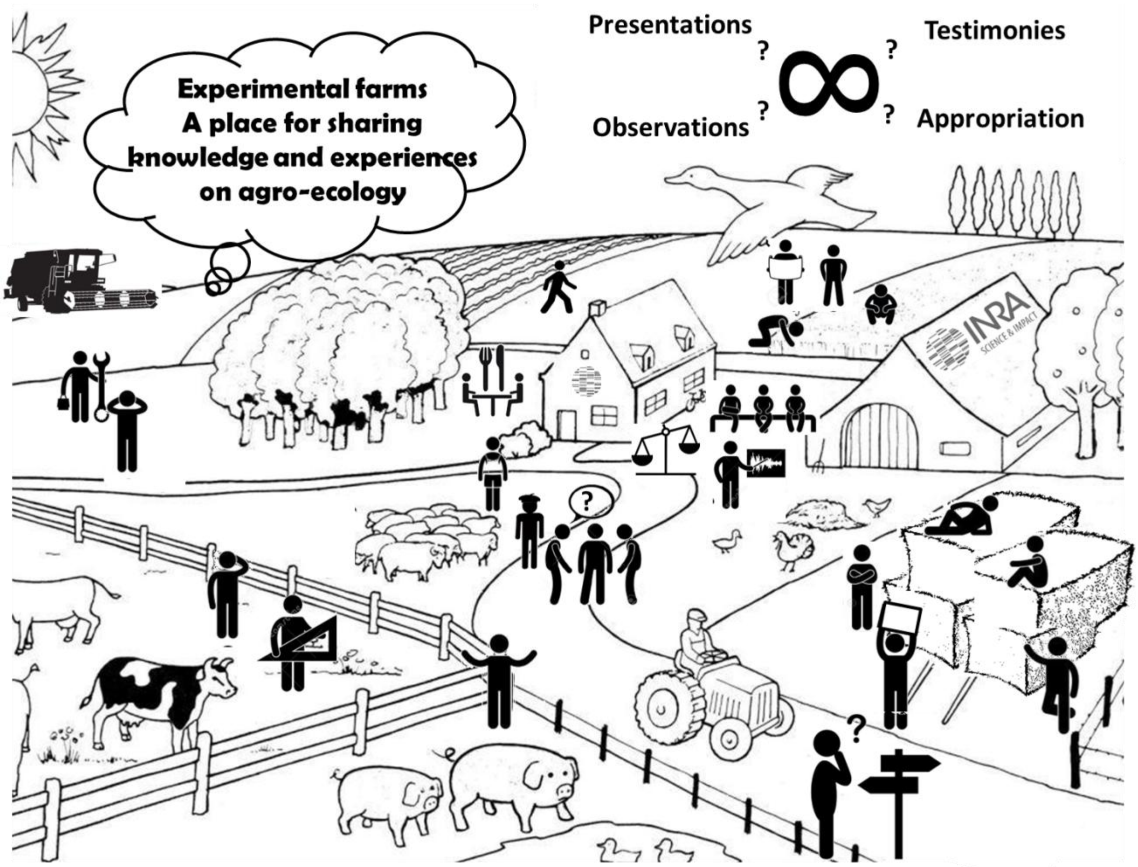

Figure 1. Overall picture of the learning device for sharing agro-ecological knowledge and experiences on the INRA's farm station.

Visitors' learning outcomes

Satisfaction and disappointments

Most visitors declared they were generally satisfied with the visit (34% very satisfied, 58% satisfied, 5% dissatisfied, 3% very dissatisfied). Given the extreme diversity of visitors, we take this high rate of satisfaction as an indication that the device works well for a wide range of people with different backgrounds.

The first positive point expressed was that: "it sounds possible!" Autonomy is a way out, a credible tried-and-proven alternative to the dominant current intensive agriculture system. They also greatly appreciated the diversity of interlocutors, their knowledge, clarity of the explanations, authenticity, credibility, engagement, open-mindedness and humbleness. Many mentioned the discovery of active pedagogical approaches to deal with complex and practical situations (observation, astonishment, inquiry-based learning, collective mind maps). Dialogue with practitioners and in peer exchange groups was very well received, as was the concrete exploration of the farm activities and results.

The (few) dissatisfactions were firstly caused by the agricultural orientation chosen, judged far too "radical". For some, working exclusively on organic systems reflects a political commitment incompatible with science. They deeply regretted the absence of comparative approaches with other farming systems (no-tillage, precision agriculture). Disappointments were expressed on the absence of advanced technologies. Some voiced unease with site-specific results, uncertain statements, the lack of stabilised references. They called for more analytical analysis, generalisation and causal relationships (e.g. the relationship between weed density and yield). Finally, some could not stand the imposed inter-subjectivity during group sharing, with the expression of divergent values and points of view.

Visitor’s self-evaluation on learning about agro-ecology and autonomy

We saw in the acquaintanceship phase that visitors were most often quite sensitised with agro-ecological concepts and theory (“why and what”): sustainability, ecological principles such as recycling, system thinking, etc. Nonetheless, it remained a fuzzy concept with few practical applications, and many doubts about its feasibility (“how”) were raised. The concept of autonomy was also largely misunderstood or only addressed from the livestock perspective (feed autonomy). At the end of the day, visitors expressed a more complete and well-defined vision of agro-ecology and autonomy in farming systems, the systemic interactions and trade-offs between the animal and vegetal components, and practical, social and economic realities. At the beginning and at the end of the visit, the visitorsmade self-evaluations, with position games on how deep is their knowledge on agro-ecology, and on autonomous farming systems (on a scale from 1 low, to 10, high). At the end of the day nearly all moved in the sense of an overall increase. We illustrate this in the following figure (Fig. 2) with the self-evaluation of 28 students in 5th year of agronomy engineering school (ISARA), specialising in animal production and the environment, who came for four days in September 2017. They showed an average increase of 2 points in agro-ecology and 1.5 points in autonomy with a wide dispersion in both cases (range, 0–7). It is notable that the less knowledge they had beforehand, the more they learnt.

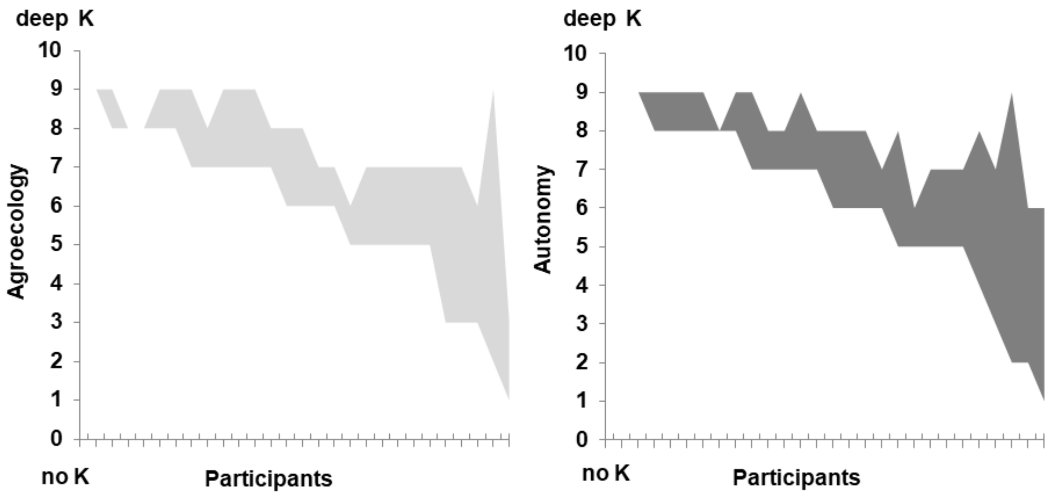

Figure 2. Visitors’ position before and after the visit on a 1 to 10 gradient to self-evaluate their knowledge on agro-ecology and autonomy on farms (agronomic engineering students). The lower limit corresponds to the students’ position at the very beginning of the visit, and the upper limit represents the final position.

Knowing intensity in different learning phases

In the last visits, participants were asked to evaluate, on a scale of 1 (low) to 10 (high), the intensity of their learning experience in different phases of the visit which were: observation, exchanges with INRA practitioners, exchanges in peer groups, scientists’ presentations, group restitution, and informal times (lunch, sidewalks between workshops). Figure 3 illustrates the results of the ISARA engineering students (see previous section).

On average, exchange times obtained the highest scores, 8.5 points for exchanges with INRA practitioners and 7.3 points for sub-group exchanges between peers during the appropriation phase. The other phases were quite highly noted as well: 6.1 points for observation, 6.3 points for scientists' presentations, 6.3 for informal times and 6.4 points for group restitution. The most significant is the presence of a great variety of learning profiles, reinforcing the utility of combining different learning approaches in an inclusive setting to meet diverse needs

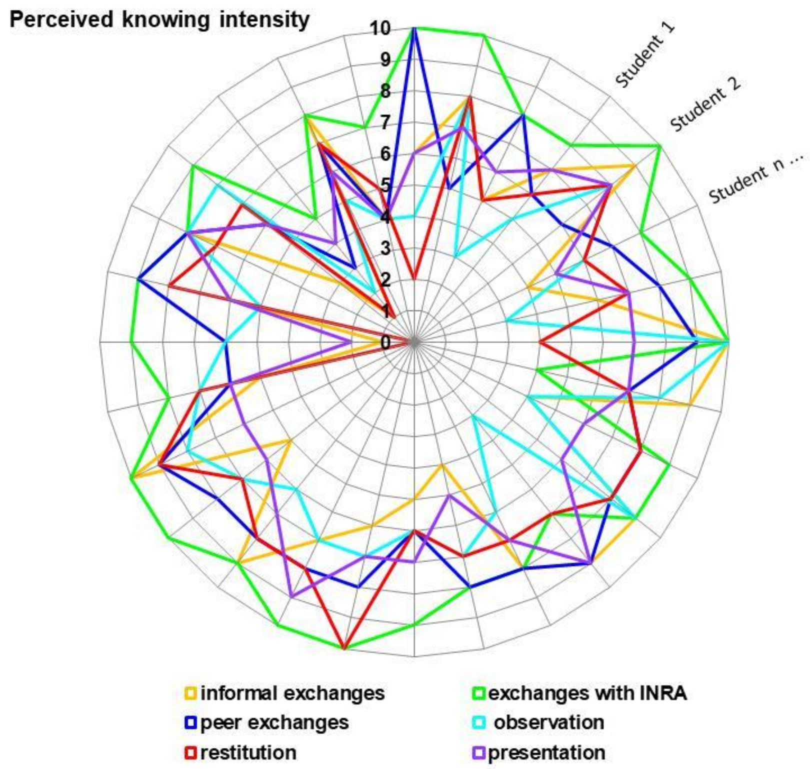

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Figure 3. Agronomy engineering students' self-evaluation of the intensity of different knowing times during the visit

Similar scores and patterns were observed for other students' and farmers' visits, consistent with our observations and records. Indeed, exchanges with practitioners were generally rich. Being questioned as much on their technical skills as on their feelings, most experiment technicians gained self-confidence and legitimacy and became able to express and affirm synthetic knowledge.

During peer exchanges, quite intense and informed debates occurred on the basis of what was observed, presented from different points of view and the participants' previous experience and knowledge. The discussions did not solely focus on scientific results, but engaged socio-scientific reasoning (Sadler et al., 2006), interweaving cognitive, affective, sociological and axiological dimensions, and a critical eye on information. We noted that some teachers, not used to this kind of exercise, tried to focus discussions on technical results and to evacuate values from the debate.

The score obtained for the observation phase demonstrates good responsiveness to evaluation devices based on sensory experience, whereas this first appeared to students as a surprising and outlandish idea. We observed that the appeal to perceptual frames was much more anchored for farmers and in particular for organic farmers.

We also found instructive results from the transition perspective of the AKIS sector when comparing the farmers' and advisors' evaluations. On several occasions it appeared that very divergent feelings were expressed, in particular regarding the utility of the "appropriation" phase. One advisor (giving 2 points to the peer exchange time) said "Far too much time was spent on reflection and not enough on simply giving technico-economic references." During the same visit, a farmer (giving 10 points to the peer exchange time) said "What allowed me to evolve was the entire process, first and foremost small group reflection, and the sharing of experiences and questions."

Intended uses

From the discovery of a new farming system to effective changes in farms there is a big step. During the appropriation phase, even though the farm experiment benefited from an aura of "realism", its commercial relevance was more delicate and many transposability issues were raised. In the evaluation forms we questioned the intended uses. On average, 65% of the respondents indicated that they intended to use the knowledge gained (or, in a few cases, mostly farmers, had already implemented certain practices). The intended uses varied depending on the category of visitor (students, farmers, teachers, advisors) and on the granularity level (a practice, a set of practices, systemic changes) (Table 2). In view of the number of intended uses referring to technical dimensions, we conclude that the learning device was of practical relevance for many visitors. Interestingly, new uses were also reported concerning the development of critical thinking through the mobilisation of the facilitation methods experimented. We received complementary feedback from a few visitors for which the visit was a turning point, and they are looking for further support to (re)-design their farming system from the potential of their own context. At this point, this feedback questions the role of an experimental station and the new synergies that must be found with extension services.

Table 2. Practices, ideas or attitudes that participants declared they intended to use or were using after the visit. The frequency of the remarks on each use is indicated by a gradient of plus (+: few remarks to +++++: many remarks).

Farmers	Advisors	Teachers	Students
Exchange with farmers and advisors +++	Extension on autonomous farming systems (articles, advice, meetings) +++	A paragon of autonomous farming systems ++++	A reference for system comparisons in class +
Adopt similar approach for installation project ++	Gain confidence in autonomous grazing system performance ++	Comparative approach of organic livestock farm visits +++	Adopt similar approach for installation project ++
Produce food for human consumption +	Facilitation methods: observation, question, dialogue, debriefing +	Pedagogical tools: positioning game, mind-maps, observation ++++	Facilitation methods: observation, question, dialogue, debriefing +++
Raising calves on nurse cows +++++	Call for INRA's testimony for local professionals and political meetings ++	Pedagogical concepts: inquiry-based learning, cooperation, socio-cognitive conflicts ++	More overall autonomy ++++; conversion to organic farming ++; produce local food for human consumption +

More global autonomy +++++	Accompany reflection on system coherence +; group founding experience +	Debriefing sessions, debates (sustainability, experimentation) ++	Sharing this experience with farmers, colleagues, family +++
Feed autonomy ++++	Develop similar long-term system experiment +	Come back in the coming years with the same format +++	More observations +++; sensory diagnoses ++
Making efficient use of grass with grazing and as fodder +++	Rotational grazing management ++	Bring this experience back to other students +++	Raising calves on nurse cows +++++ ; milk yogurt for calves +
Wheat varietals in association +++; cereal–protein crop mixture ++	Animal feed: forage autonomy ++; zero concentrate ++	Encourage autonomous systems ++	Livestock autonomy ++; diminish concentrates +++ ; limit new equipment +
Selecting cull cows on fertility criteria +	Cereal–protein crop mixture ++; reduce tillage +, grassland planting under cereal cover +; old varieties +	Encourage system thinking , open-minded, question one's own choices ++	Optimise grazing +++, diversity of hays +; stock of standing grass +++; hay stock management +++; wilting of alfalfa ++
Raise pigs on alfalfa +	On-farm experiments on the efficiency of cereals in milk cow feed +	Reusing technical concepts ++	Milk cows once a day +; long-lasting dairy cow lactation +; boards in the racks +; mobile milking parlour +
Mixed cattle sheep grazing +		Written evaluation ++	Alternative medicines (aroma therapy, homeopathic) ++++
Sheep grazing on cereals +			Raise pigs on alfalfa + ; mixed cattle/sheep grazing +
			Varietal and species mixtures +++; cover crops ++; reduce tillage +; adapting crops to soils +; less pesticide use +++
			Crop trials +; visit other experiments +; farm gate balance +

Discussion

A landscape of learner-centred learning approaches in agro-ecology

The learning device experimented in the Mirecourt experimental farm mixed a panel of innovative approaches in agro-ecology (Fig. 4) that consist in learning from both people and things. The concept of “tactile space” (Carolan 2007) for the visit of the farm station is particularly appropriate given that it refers to embedded and embodied knowledge to nurture new intelligibilities and behaviours. Experiential learning (Francis et al., 2011; Roberts, 2006; Kolb, 1984) builds on examples, and phenomenon-based learning has been promoted in agro-ecology education for responsible action (Francis et al. 2013; Østergaard, 2010). In addition, recent focuses have been on dialogue-based education to encourage autonomous and critical thinking. This is also in line with a new research trend on didactic socio-scientific and urgent societal issues (Simonneaux, 2014) that argues in favour of contextualising science and using auto- and allo-confrontation (decentring and confronting with divergent views), and socio-cognitive conflict as key components of learning. The social experiment presented in this paper showed a concrete application of these emerging approaches.

Through the process of the farm visits, we also suggest that another passage between these innovative learning approaches is learner-centred inquiry. Indeed, the visits operate as an enigma-going, a spiral process, a movement of centring-decentring, that always maintains a space for questioning in the world, with the world and with each other. In a debriefing session a farmer said: “We came to find answers, and we are going back with more questions.” The mainspring of the inquiry process is astonishment. It is through astonishment that one experiences the limits of one’s knowledge, and engages learning (Thievenaz, 2017). Throughout the learning device process, a set of methods were employed by the practitioners to trigger astonishment and support its development Thus, during the observation phases, practitioners chose baffling situations and media to confront the visitors with counter-intuitive experimental results. (e.g. grazing cows in advanced grass), to create a perturbation and bring about changes in perception. The construction of didactic situations to foster astonishment has resulted from several experiments and has needed to take into account the learner’s perspective in designing the visits.

Appropriation phases also aimed at the verbalisation of astonishment, a posteriori, in a reflexive process, first individually, then within discursive spaces, in order to recreate a new coherence. We noted that astonishment could not be triggered for audiences with little agricultural experience, for the simple reason that they did not have the necessary reference points.We would also like to stress the importance of socio-cognitive conflicts in peer exchange groups, in which an oral resolution could be found by raising arguments on several dimensions (agronomy, economy, sociology) in order to structure complex thought. For students it allows a new level of awareness on arbitrage activities and complex reasoning, necessary agricultural professional skills. During this group exchange phase, and even in the dialogue with the experimental practitioners, we would also recommend not abandoning values in favour of a supposedly more neutral scientific point of view.

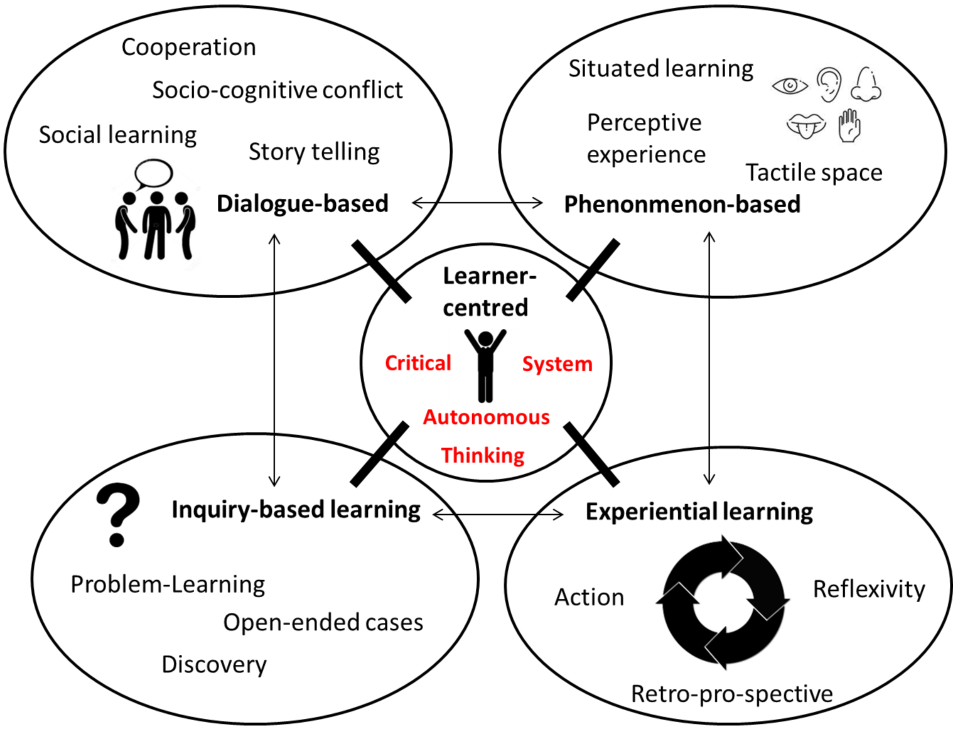

Figure 4. A landscape of learner-centred approaches in agro-ecology.

Recomposing knowledge and opening science: the role of experience

The social experiment conducted on the experimental farm station has considerably amplified a difficult and painful process of reconsidering the nature and the role of scientific knowledge and experiences to support the agro-ecological transition. In a team, previously highly focused on engineering knowledge, the revaluation, during farm visits, of experiential knowledge as a key resource for potential end-users produced a major shift, although it is clearly not stabilised. The practitioners engaged in practical design, acquired arduously and sometimes unwillingly, a new form of legitimacy in a previously seriously anchored hierarchy of knowledge with scientific reasoning at the top.

If experience was most often recognised as unassailable knowledge, what counts as experience is neither self-evident nor straightforward. Two positions contrast: “experience spearheads explanation” vs “experience is what we want to explain”. Some practitioners were therefore very concerned about the need to reinforce or even prove testimonies based on experience with scientific, quantified evaluations that would be less uncertain than memory and not influenced by affect, whereas for other practitioners, analytical and reductionist approaches could never embrace the richness of an experience and could lead to misunderstandings. The same kinds of considerations were pointed out by Schön and Donald (2011) when speaking about the dilemma between the rigor of science and the relevance of practice.

Another major discrepancy was anchored in configurations and postures for sharing knowledge. We were directly confronted with colleagues with a traditional diffusionist way of communicating scientific results from the experiment, as has always been done since the experimental farm was created in 1961. This historical posture faced the socio-constructivist learner-centred approaches that we wished to develop as the core component of the visit device in the social experiment. Without denying de facto asymmetric relationships between the INRA practitioners and visitors, one central challenge was to offer the conditions for a genuine dialogue between different types of knowledge within the perspective of sustainability. The main way to achieve this was to foster sharing experiences and synthetic knowledge between experiment practitioners and visitors that allow for strong reactivity to questions on what people are observing.

This entry of science in a socio-constructivist vision is in line with the concept of “science-in-the-making” developed in the 1980s by the new sociology of science, in particular Bruno Latour (1987). In this social experiment, we found that experience, both considered as a product and a process, was particularly relevant to restitute pragmatic, living and reactive science-in-the-making, and thus to align science and society and bring them into contact to address knowledge gaps. We consider that the greatest resource of our device was the diversity of values, sensitivities, experiences and interpretations, in sum of subjectivities that participate in a major reorganisation of knowledge.

In conclusion, the two major shifts operated in this social experiment, i.e. the revaluation of experiential knowledge and the challenge of conducting a learner-centred and phenomenon-based educational program, opening the way to open innovation. In this perspective, the experimental farm station could claim to support the agro-ecological transition, not only as a primary producer of knowledge but also, and perhaps mainly, as a third place to engage a variety of types of knowledge in dialogue and nurture ambitious development projects.

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