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Topic 1 - Ecological approaches to systems' health

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SHARED RESEARCH QUESTIONS ON SOIL QUALITY IN ORGANIC FARMING SYSTEMS

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Abstract: In 2018, a participatory national workshop was organized by ITAB (Organic Food and Farming Technical Institute) and INRA (National Institute for Agricultural Research) in order to highlight issues on soils in Organic Farming (OF) systems. The objectives were: i) to identify the key research questions to be addressed on soils in OF, ii) to make it possible to facilitate network and project building from interactions between academics and stakeholders.

Over 150 participants from academic and professional origins attended the workshop which was designed according to The Town Hall Meeting (THM) methodology.

High level discussions among participants and panel experts ended up with a list of 20 research questions which confirmed the important lack of knowledge on that topic and the needs for research on the following issues: soils functioning with a focus on biogeochemical cycling and biological interactions; long term effects of agricultural practices, more or less specific to OF; soils protection; tools for soils diagnosis and management.

Introduction: Soils perform a multitude of key environmental, economic, social and cultural functions, vital for life, and provide a large panel of ecosystem services (Pereira et al., 2018). Among those services, international agencies have recently raised awareness on their major role in sustainable farming systems development (FAO, 2015). This question is particularly relevant for OF production systems where soils quality maintenance and improvement are considered as key issues and effective levers for development of such systems.

In that context a participatory workshop was organized by a transdisciplinary committee for stakeholders with academic and professional backgrounds.

The objectives of the seminar were i) to collectively define key research questions to be addressed on soils in OF systems ii) to facilitate networking and research projects building.

Material and methods: Over 150 participants from large professional backgrounds (research and technical institutes, universities, farmers, extension services, NGOs, design firms) and diverse cropping systems (crops, forages, fruits, vegetables...) attended the workshop in Paris on November 22nd 2018.

The workshop was designed according to a THM methodology (Tchamitchian et al., 2017): the general idea is to work on questions on a funnel like processes allowing participants' feedbacks. For each question, ideas are discussed by each small group (15 tables with 10 participants representing the diversity of backgrounds, 1 facilitator per table) and, once validated, transmitted to a panel of 3 experts chosen for the complementarity of their expertises. Similar ideas are, then, grouped by the expert panel which allows for a reformulation taking into account the different nuances. Reformulations are projected on a full screen visible to anyone and the participants can react, either by reinforcing or proposing new ideas. This methodology was implemented with 3 successive rounds, a question being submitted at the beginning of each round to initiate the debate process within and between tables.

The 3 successive questions and output instructions (*italic*) for participants were the following:

- **Round 1 : "For you, what is a high quality soil in OF ?"**

>to provide a list of criteria (characteristics) of high quality soils in OF ;

- **Round 2 : "Which are the locks to undo, in order to obtain a high quality soil in OF ? (as defined in Q1) ?"**

>to provide a list of locks to undo ;

- **Round 3 : « Which research questions do we need to answer in order to undo the locks (identified in Q2) ?"**

>to formulate questions

Results: The first and second rounds produced a total of 144 and 136 ideas respectively, which were grouped in 18 criteria (R1, data not shown) and 21 locks items by the 3 experts (R2, data not shown).

Soils quality criteria's list (1st round) showed a large contribution of items relative to global evaluation of soils (i.e. taking into account interactions between ecosystem component or processes). We noted a special focus on soils intrinsic properties, expected ecosystem services and biological properties. The list of locks (2nd round) comprised a first set of items highlighting the lack of scientific knowledge on closing nutrient cycles, organic matter mineralization processes, soil ecology, and the lack of long term field experiments. Another set highlighted OF specific locks at the farm and agricultural system levels, as well as specific needs on input management (control of fertilizers quality and of crop protection products).

The third round produced a total of 105 ideas aggregated in 20 research questions (table).

Discussion: The first 2 rounds revealed the diversity of issues on soil quality from OF stakeholders and important lacks of knowledge. The 20 questions, final outcome of the seminar, confirmed the needs for research on the soils for OF systems. Nevertheless we observed that several questions addressed were quite generic and concerned needs of research on soils functioning (Q3, Q10) with a focus on biogeochemical cycling (Q4, Q15); biological interactions and soil ecology (Q6, Q 20); tools for soils diagnosis and management (Q10).

On the other end, several topics referred to issues more specific to OF (or more crucial for OF): assessment of the impact of OF systems on CNP fluxes (Q4, Q5); on soil ecology (Q6) and soil health (Q1), long term dynamics and soil resilience (Q16, Q8), the impact of specific technics (Q5, Q14, Q9) and inputs (Q14); the needs for OF system design (Q8, Q12) and evaluation tools (Q1, Q7, Q13).

In addition to questions pointing lacks of knowledge, several topics referred to socio-technical and organizational issues which were not strictly targeted on soils (Q5, Q11, Q15) and stressed the role of academic teaching and knowledges transfer to end-users (Q2, Q15). This confirmed that, at some point, there is a need for interactions between "agronomic (*s.l.*) sciences and social sciences in order to answer questions addressed in the workshop. Adewopo et al (2014) drew similar conclusions from a collaborative approach which aimed at identifying priority research issues on soils. These

authors emphasized the needs, for soil scientists, to develop collaborations within agronomic disciplines, as well as policy experts and young professionals (including students).

Finally, this workshop highlighted the key role played by crop-livestock production systems in maintaining, and even improving, soils quality and resilience in OF (Q17, Q11). This topic appeared essential for OF systems sustainability. This workshop allowed the shared definition of research questions on soil quality. If the exercise was about OF, the results show that many of the questions are generic and may be of interest to a wider community.

The global approach of soil quality and the importance of the systemic challenges raised during the workshop demonstrate the interest of OF as an innovative and relevant research object to question soil functionalities for a greater sustainability of production systems. Many of these questions appear multidisciplinary and systemic, as a result of the diversity of the participants, and of the funnel process that led to express these questions. It emphasized the need to cross boundaries that were rather closed up to now.

The constraints of the method limited the number and accuracy of the results. Some interesting but isolated ideas may also be under-represented. Nevertheless, the co-design process and adherence of all parties to these research questions make them an intermediate subject offering perspectives to build research and development networks and projects.

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Image:

Table. List of research questions resulting from the participatory workshop

1	How to manage soil contaminants (initial removal and maintenance of quality) and evaluate their effects?
2	How to connect (capture, accrue, evaluate, disseminate) different forms of knowledge (local, academic), experience and research to each other?
3	What are the relations between biodiversity, soil functioning and ecosystem services?
4	How do soil and climate conditions influence the ability of OF systems to store C? How to assess short-term C fluxes?
5	What conditions (agronomic, economic, organisational) favour the closure of biogeochemical cycles (especially of P) at farm and territory levels? What mechanisms (e.g. organic amendments, biological activators) to use to improve nutrient management? What are the impacts of using them?
6	How do soils, soil organisms, soil communities and plants interact, in particular in associated crops? How to improve soil health, crop nutrition and variety selection?
7	What are long-term impacts of agricultural practices on soils of OF systems and how to evaluate them?
8	How to design autonomous, sustainable and resilient (in the face of climate change) cropping systems that protect soil quality?
9	Which cropping systems (design and evaluation) manage weeds and minimise tillage (e.g. conservation tillage)?
10	Which indicators to use to assess and manage adequate soil functioning (biological and physical)?
11	How to organize farming activities at the territory level (e.g. crop-livestock interactions, production chains): stakeholder coordination, public policies?
12	What knowledge and mechanisms to use to maintain the integrity of OF systems (to avoid creating "conventionalised" OF)?
13	Which tools/methods to use to evaluate ecosystem services provided by soils in OF systems and to manage tradeoffs among them?
14	Which agricultural equipment to use to improve soil quality in OF systems?
15	Which innovations (e.g. didactic, organisational, actor-related) to use to build collective dynamics and improve consumers' perceptions of the importance of soils in OF?
16	How to build an observatory or field network of soil quality in OF systems?
17	What role does livestock farming play in maintaining soil quality ?
18	How to characterize the influence of the diversity, specific characteristics and trajectories of OF systems on soil quality?
19	To what extent does research on OF contribute to other types of farming systems?
20	How to make a root happy?

Disclosure of Interest: None Declared

Keywords: THM method, participatory workshop, soil quality, biogeochemical cycle, ecosystem service, fertility,