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Digital decision-support tools for designing agroecological farms? Reflections inspired by the multi-actor development of an online software for vegetable growers in France.

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Although increasingly presented by mainstream actors as key pillars of a transition toward sustainable agriculture, digital decision-support tools (DDST) can face criticism from agricultural networks defending a radical view of agroecology. Indeed, DDST can be perceived as supporting dynamics of agricultural industrialization or threatening farmers' decisional autonomy. This perception is strengthened by the fact that farmers are rarely involved in the initial design of DDST. Nevertheless, DDST can also be considered as promising options to support the design and management of agroecological systems which are knowledge-intensive and complex. Our objective was to explore the characteristics of a DDST that could match the specific expectations of agroecology networks. Our main assumption was that involving farmers and farmers' networks in all steps of the DDST design and development would be necessary to reach our objective. Our analysis relies on a case-study in France where we have been developing an online software (La Pépinière-Mesclun¹) for vegetable growers since 2020. For vegetable growers, agroecological practices relying on diversification (longer rotations, cover crops) can increase drastically the complexity of spatial and temporal crop planning. Moreover, farmers need to assess the impacts of such practices on the farm sustainability and ensure the possibility

¹ Will be freely available online in December 2023.

to match marketing objectives. The online software we developed aimed at supporting vegetable growers in addressing such challenges in the (re)design of their farm. To do so, we carried out a participatory approach involving 10 partners of the agricultural sector inspired by agroecology (R&D, Farmers' organizations and agricultural support, Education), 1 IT startup and 1 freelance designer. We followed an iterative co-design and development methodology relying on frequent interactions (37 design and test workshops all across France) with 256 end users: current or future (students) vegetable farmers, agricultural advisors and trainers. Each iteration involved qualitative analysis of participants' feedbacks, IT design, structuration of database and software development. We systematically kept tracks of the design and development choices and analyzed them. This participatory process showed that our DDST had to:

- (i) **respect the diversity and complexity of farming systems:** allow a systemic and multi-objective approach of the farm with indicators that make sense for farmers; provide dynamic interfaces which allow different approaches of crop planning; allow flexibility regarding a diversity of socio-technical contexts; account for uncertainties; value users' expertise rather than modelling to account for complex biophysical processes of agroecological systems;
- (ii) **empower farmers in their decision rather than providing prescriptive solutions:** enable simulation and assessment of contrasting strategic options rather than providing an optimal solution; show alerts when farmers do not respect the rules that they are free to set (e.g marketing objectives, spatial constraints, rotation criteria); provide software outputs with a layout supporting collective discussion (with other farmers, trainers or advisors);
- (iii) **being accessible to a diversity of farming profile and contributing to digital commons :** present user-friendly interfaces; provide default data that farmers are free to personalize to reduce the amount of initial input data required; develop a business model allowing farmers to use the software for free; open-access of data and models.

We will illustrate and discuss these characteristics based on concrete examples. We will reflect on the major challenge we have faced in the process: establishing a shared governance and business model involving a variety of public and private organizations with contrasting interests. Our work shows that involving agroecology actors (especially farmers) at all steps of

the design process allowed to develop a digital tool that was judged salient, relevant and legitimate by these actors. It could inspire further research on the design and development of digital tools for agroecology.