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Participatory design and assessment of diversified Mediterranean cropping systems – Method and results for two case studies

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2. Title

Participatory design and assessment of diversified Mediterranean cropping systems – Method and results for two case studies.

3. What is the thematic challenge addressed and for which type of agri-food system ? What was the result of the analysis, assessment or design of farming systems in this context.

The thematic challenge addressed is the **diversification** of agricultural systems. Eight case studies are involved in Northern (France, Greece, Italy, Spain) and Southern (Algeria, Tunisia) Mediterranean countries. Three production systems are studied: (1) arable **cereal**-based cropping systems for grain and forage, (2) **vineyards** for grapes and wine, and (3) olive-based agroforestry systems for olive and oil production.

In the Biodiversify PRIMA ERA-NET project, we aim to **design and assess**, with stakeholders, new cropping systems using diversification as a main lever, in several case studies. To reach this objective, we designed a method based on simple tools, beginning with the definition of the reference cropping system in each case study. We will present the results for the Algerian and the Spanish arable case studies, as they will have performed the whole process by the colloquium.

In Spain (Ebro Valley), the workshop gathered 12 participants (farmers, advisors, regional administration, input sellers, researchers). Two new four-years rotations were designed: barley-wheat-pea-wheat and barley-wheat-rape-seed-wheat (grain, feed and food) rotation under supplemental irrigation (as in the reference system). Objectives were to reduce tillage (weakness: high production costs and concomitant soil degradation processes), to emphasize fertilization with pig slurry (weakness: costs linked to synthetic fertilizers; strength: livestock integration), and to reduce pesticides (threats: glyphosate's prohibition and weed resistance). Overall, diversification was seen as an option to face yield variability to climate change, reduce production costs (especially for legume species), and face weed issues.

In Algeria (Sétif region), the workshop Gathered 17 participants (farmers, advisors, researchers). Two types of diversification were designed: (1) intercropping (pea-oat, barley-oat, barley-oat-pea), (2) two- or three-years rotation (durum wheat-fodder crops-legumes, durum wheat-market gardening, durum wheat-legumes), with pea or vetch as fodder crops. Only market gardening species are irrigated. Diversification in general was seen as a positive alternative to mitigate the negative effects



of monoculture and fallow, and to reduce the risks associated with climate change. Legumes were more specifically seen as a possible answer to the difficult access to expensive N fertilizers.

4. What's new in the methods used in this approach ? Was there a **scaling out or up process in the methods and/or the systems designed ? with which stakeholders/actors beyond research ?**

Our objective was to design a simple method for co-designing diversified systems, based on a set of existing methods. We used a three-step method: diagnosis, co-design, and co-evaluation. First, a diagnosis of current systems was performed with farmers' surveys and/or existing databases (national statistics, or from previous projects), during which key stakeholders regarding diversification were identified. Second, a co-design workshop was organized with stakeholders to (1) present and discuss diagnosis' results; (2) build a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of current systems (3) design new diversified systems, using the SWOT to identify levers allowing to increase the strengths/take up the opportunities, and/or decrease the weaknesses/limit threats' effects; (4) highlight the assessment indicators important for the stakeholders. The third step is the co-evaluation of the diversified systems (perceptions of performances by stakeholders), for validation of designed systems or eventual re-design of new ones. Assessment is based on (1) modelling exercises, with crop model (e.g., STICS for field crops, HiSafe for olive-based systems, CropWat for market gardening) and a socio-economic framework, allowing an assessment of agronomic (e.g., yield, grain protein, soil nitrogen mineralization), socio-economic (e.g., income, material costs, work load) and environmental indicators (e.g., pesticide and energy use, soil carbon sequestration, reactive nitrogen losses); (2) workshop to discuss modelling results' with stakeholders along with experimental outcome from Biodiversify's trials; (3) definition and justification of final diversified systems.

This method is being applied on a set of 8 case studies, i.e. it was developed to be scaled out in a diversity of contexts (stakeholders, but also researcher's capacity on participatory approach). Its originality lies in the fact that participatory and modelling approach are linked and contribute to each other. Regarding scaling up, while new rotations are designed at plot scale, they will be scaled up to the farm level, using farm typologies. In fact, the agro-environmental evaluation will be conducted at plot level while the socio-economic assessment will be conducted at farm level.

5. What's next ? questions you would like to discuss ?

In Biodiversify, next is a transversal analysis of both the co-designed systems, and the assessment of their performances by stakeholders.

Some challenges:

- Foster participatory approaches in the south Mediterranean
- Design transitions and stimulate them (i.e. from design to implementation)
- Implement more innovative methods in the Mediterranean, relying on exchanged knowledge from south and north parts of the basin
- Bring knowledge to foster creativity (here we used models and results of external experiments only)
- Involve stakeholders far from research, e.g. in the north of Mediterranean those farmers with very intensive practices, and in the south women, young people
- Involve policy makers at different levels, to favor exchanges of perceptions (e.g., using serious games)



Agricultural systems
by design

- Create conditions to share knowledge and innovations between farmers (e.g., on climate change, using the analogies to design cropping systems adapted with climate change; on a specific regulation, to design system adapted to a specific pesticide suppression)

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Project website: <https://www1.montpellier.inra.fr/wp-inra/biodiversify/>