



6th International Symposium for
Farming Systems Design



The step-by-step approach for farming systems design, in the frame of agroecological transition

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- The agroecological transition calls for **disruptive innovations**, and a **huge effort to design** farming systems.
- To support farming system design, **prototyping** in workshops and **model-based** design have been so far the most frequent approaches (cf FSD 2015).
- But these approaches both focus on the **invention** of a target system (what it will look like at its final state), and they don't consider the **pathways underlying the evolution of practices** (the way to change from an initial state, Lamine, 2011).

Objective:

➔ This presentation aims to introduce a new approach, the **step-by-step design**, which explicitly considers farmers as designers of their own farming system, and takes root in the way farmers change their system.

Various case studies in France (Duration > 5 years), mainly addressing input reduction and autonomy, in real and experimental farms (arable systems, mixed crop-livestock farming, market gardening).




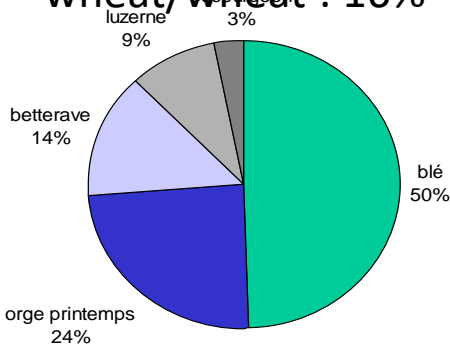
- A posteriori analysis of the design by farmers of their farming systems (around 25  farms)
- Action-research with farmers (2 groups of 6-8 ) and 3 experimental farms (), aiming to support design of farming or cropping systems.
- In this communication:
 - ➔ Cross-case analysis ➔ Identify, in all cases, 5 traits of step-by-step design
 - ➔ In the conclusion: How could we enhance step-by-step design?



Illustration of step-by-step design by a farmer who aimed to decrease pesticide use in his farm (Northern France, 2003-2009)

2002 : Agronomic and environmental diagnosis

- TFI (pesticide use) 8.08
- 5 crops
- Short rotations
- wheat/wheat : 16%



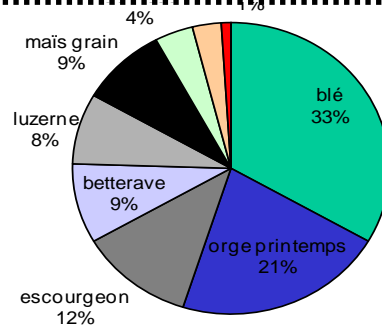
→ The farmer implemented new practices, either invented by himself, or suggested by his advisor or by other farmers.

→ He tested the innovative practices in one field, combining them and adapting them to his specific constraints.

→ A gradual design process, spread over several years,
→ Mobilizing scientific and empirical knowledge

2009 Agronomic and environmental diagnosis

- TFI : 3.65
- 9 crops
- Wheat /wheat : 0%
- Longer rotations
- No change in labour or economic returns





Results: The 5 main traits of step-by-step design

1. A situated design fuelled by action
2. A design process fostered by learning
3. The progressive shaping of a future-related intent
4. The specific resources that support the design process
5. The collective dimension of the design



Trait 1-

A situated design fuelled by action

- In our case-studies, the pilot of the step-by-step approach is a farmer or a person in charge of managing the farming systems in an experimental farm. He designed a farming system, adapted to his own expectations, and to his own singular situation (*soils, climate, farm structure, available resources, commercial outlets ...*).
- The step-by-step design is fed with the knowledge and the experience of the pilot, who chooses in real time the new practices or organisations that he wishes to « experiment » in his farm.

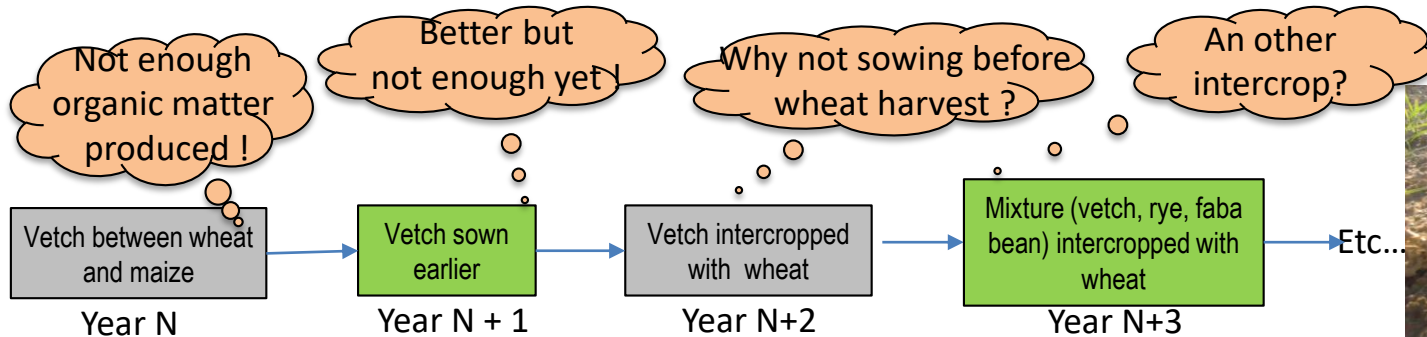
➔ Step-by-step design is a process of situated design,

- Because it is fed by the test in local conditions
- Because it is fed by the situated experience of the pilot

A situated design fuelled by action

- Step-by-step design combines an implementation and an on-farm assessment of new practices. The pilot implements, observes, and then interprets, finally deciding to adopt, to reject or to modify the new practice.

➔ **Step-by-step design is a process fuelled by action.**



From Catalogna, 2018

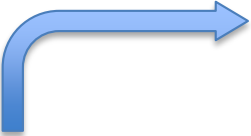


To introduce a legume cover crop between wheat and maize, the farmer manages a trajectory of experiments, leading to the progressive invention of a new cropping system adapted to his farm and aims



Trait 2-

A design process fostered by learning




Evaluation: the pilot observes, assesses the results, and learns from his observations: he feeds its conceptual model with his learnings, completes it, modifies it, and even challenges it.

Diagnosis, Then a new diagnosis is performed, to determine new priorities, and engage a new loop.


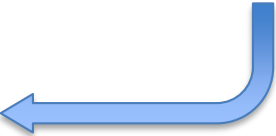
A continuous



learning loop



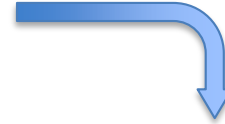
Exploration of technical or organisational changes that could contribute to improve the performances of the farming system. The exploration is fostered by the pilot knowledge, and also by proposals from his advisor or other farmers...



Implementation: The pilot selects one of the changes from the exploration phase, and implements it. *He also learns how to implement it, while doing.*

An example: design of a zero-pesticide cropping system in market gardening (INRA, south France, from Lefèvre & Salembier)

Diagnosis: Observation of Mites (*tetranychus urticae*) on organic production of eggplants → What could be done to manage these mites?



Exploration :

- Release of natural enemies (*phytoseiulus persimilis*) : not efficient enough.
- Using sprinklings? Humidifying the leaves could limit the development of mites, while fostering the populations of natural enemies. But when to do it? Which amount of water?

Evaluation (based on observations):

- A decrease in the spread of mites populations
- A decrease of verticillium (wilting of the leaves)
- BUT a development of botrytis on eggplant fruits



Implementation: 2mm/day, every day; Combining sprinkling with the release of enemies, and the removal of the very affected plants



The (rare) litterature on sprinkling

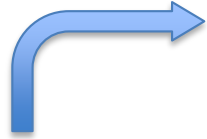
Exchanges with experts



An example: design of a zero-pesticide cropping system in market gardening (INRA, south France, from Lefevre & Salembier)

Evaluation (based on observations):

- A decrease in the spread of mites populations
- A decrease of verticilium (wilting of the leaves)
- BUT a development of botrytis on eggplant fruits



New diagnosis: How to maximize the positive effects of sprinkling, while minimizing its negative effects? impact on yield, microclimate, pests....



A continuous



learning loop

New exploration on resistance of eggplant to botrytis, and other means to control botrytis :

Etc...





The progressive shaping of a future-related intent

- **Design is goal-oriented**: there is no design without a « will relative to the future » (*Béguin and Cerf, 2009*).
- Yet, **the goal is generally fuzzy at the beginning of the design process**: e.g. targeting a reduction in pesticide use or an enhanced self-sufficiency toward external inputs does not describe precisely what the future system will look like.
- This fuzziness facilitates the involvement of farmers, who could hesitate if they were aware of the magnitude of the change that may be required.
- **The design target becomes more precise along years**, influenced by the evolution of the diagnosis from a loop to the following one.



An example: Evolution of the target by the farmer in northern France who aimed to decrease pesticide use in his farm

- **2002: reducing pesticides, without important change of the farming system:** on-farm test of a low-input wheat management route → The success of this wheat management route triggered an evolution of the farmers' representation of his agro-ecosystem and of the effects of his actions, and convinced him that a reduction of pesticides by systemic effects was possible without income reduction.
- **2005: higher reduction of pesticides, based on systemic anticipations of risks, and important changes in the crop sequences:** lengthening rotations, through the introduction of new crops, has become a “thinkable” solution.
- **2009: after the success of strongly reducing insecticides and fungicides, priority to herbicides reduction, by testing a multi-annual action plan adapted to the weed flora.**



The specific resources that support the design process

To implement the step-by-step design approach, farmers and advisors use specific tools, either invented by themselves, or by their peers, or by R&D actors

Dashboards: (structure d organization of indicators and observation tools fostering a diagnosis)

Simple simulation technico-economic tools, helping to anticipate the consequences of a change

Library of innovations:

- (i) description of innovative techniques or machinery,
- (ii) Interactive web tools to share knowledge,
- (iii) Accounts from innovative farmers...

Diverse indicators, aiming at

- (i) checking that the targeted effect of a new practice is reached,
- (ii) a posteriori analysing the unexpected effects of practice change

Tools to support the observation in the field of the impacts of innovative practices



The specific resources that support the design process

To implement the step-by-step design approach, farmers and advisors use specific tools, either invented by themselves, or by their peers, or by R&D actors

Dashboards: (structure and organization of indicators and diagnostic tools);

Diagnosis
and
evaluation

Simple simulation technico-economic tools, helping to anticipate the consequences of change

Exploration

Library of innovations:
(i) description of innovative techniques or machinery, interactive web tools to share knowledge, inputs from innovative farmers...

Diverse indicators, aiming at
(i) checking that the targeted new practice is
(ii) a posteriori and unexpected effects of p

Implementation

Tools to support the observation in the field of the impacts of innovative practices



The collective dimension of step-by-step design

- **Gathering farmers who share the same target (but not necessarily the same solutions) have many positive effects on step-by-step design:**
 - Advising each others, by collectively diagnosing problems and exploring solutions;
 - Giving moral support, especially after a failure or a change in the context;
 - Building a collective identity in a professional world that may be largely skeptical.
- **These groups can take various forms:**
 - Local groups of farmers who know each others, and share the same agricultural conditions;
 - Groups formed on web forums, mixing farmers faced with similar problems, in various territories;
 - Groups structured around types of agriculture (e.g. conservation agriculture).
- **These groups = communities of practice.** Collective learning make up a common culture, which facilitates further interactions (*Ingram et al., 2014; Goulet et al., 2017*).

An example for traits 4 and 5 : a dashboard to help step-by-step design of farming systems restoring water quality

(Prost, Reau et al., 2018)

Don't kill volunteers of oilseed rape and pea



Sow cover crops before or immediately after cereal harvest



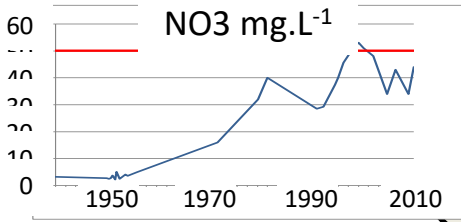
Efficient nitrate pumps in the fields in autumn



Inorganic N in the fields in November



N leaching during winter



Nitrate (NO3) at the catchment level



These indicators build causal links, from farm practices to targeted results

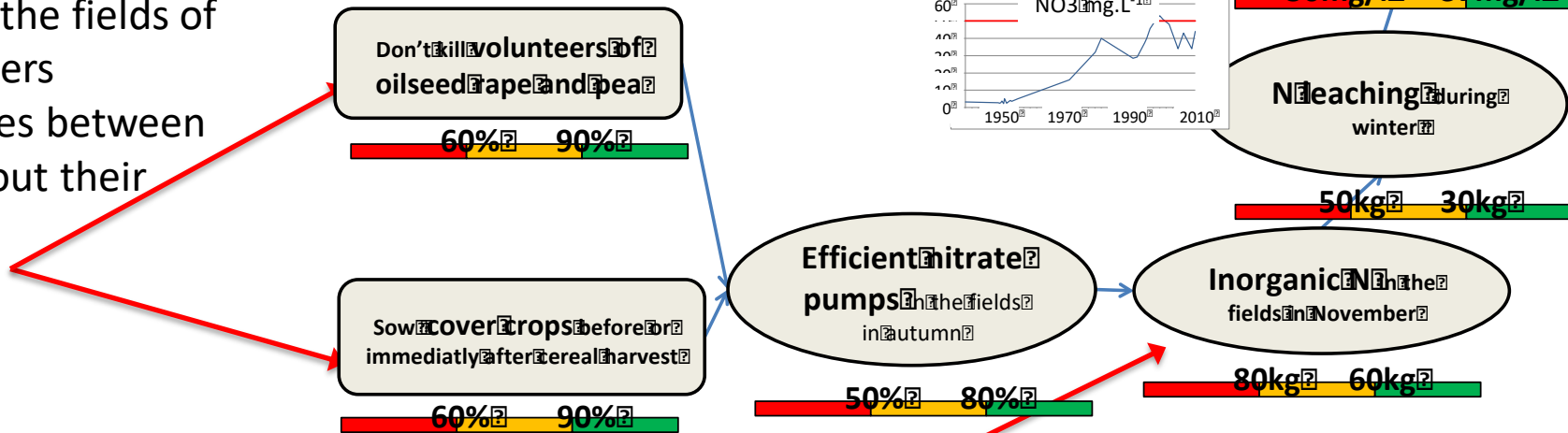
Role of the dashboard in the collective dynamics



Autumn: Cover crops & volunteers « field tour »

=> Visits of the fields of all the farmers

=> Exchanges between farmers about their results



Winter: Collective meeting about the results of « Soil mineral N contents before winter »

During the tour and the meeting, all farmers play a role of consultant for the others, proposing their interpretations and their solutions.



Conclusion: in summary, what is step-by-step design?

- A design approach mobilizing both scientific and farmer's knowledge and fostering learning, strongly linked with implementation : a methodological approach for the agroecological transition;
- A situated design, spread over time, which allows the farmer to invent a new farming system, while he learns to pilot it, understands how it works, convinces himself of its interest, and progressively reorganizes his working time and his means of production;
- A process coupling the design of new systems, and experience development, which will permit the farmer to design again in the future.



Conclusion: How could we stimulate Step-by-step design?

The role of agronomists to stimulate step-by-step design:

- researchers:
 - Designing indicators, dashboards, knowledge database, to support the different steps of the learning loop;
 - Formalizing the design method, to teach it
- advisors:
 - Supporting farmers in the framing of their project, without haste, valorising the learning resulting from their experiments,
 - Supporting farmers to implement, monitor and assess the experiments;
 - Facilitating exchanges in collectives of designing farmers



- **Thank you for your attention**
 - **Gracias por su atención**
 - **Merci pour votre attention**

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