Orchard redesign towards pesticide-free fruit production

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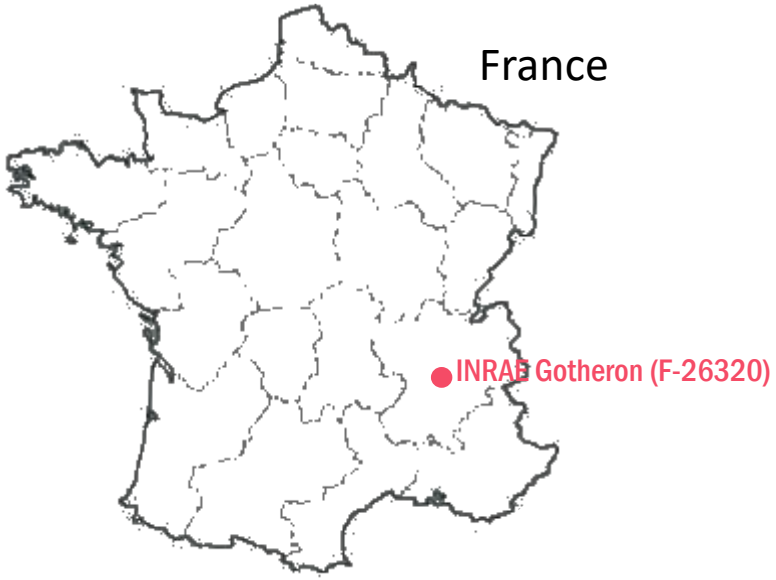
https://ueri.paca.hub.inrae.fr/contrats-et-projets/expe-dephy-ecophyto-ii-alto
https://ecophytopic.fr/dephy/concevoir-son-systeme/projet-alto

Context and aims

-**Need to change intensive specialized orchard systems** towards more sustainable fruit production areas

-Aims: To <u>explore</u> how **crop diversification and ecological intensification** through an increase in plant diversity can reinforce ecosystem services towards 0 pesticide



Challenge

To design from scratch a pesticide-free fruit production area relying on ecosystem services, especially pest suppression...

Proof of concept

Our partners

Farmers, teachers, advisers, experimenters, researchers (biotechnical and social sciences), naturalists...

Both an eco- and a co-design experience

General approach to design

Pest control through plant diversification

Resource sharing among crops and associated plants

Work organisation and load

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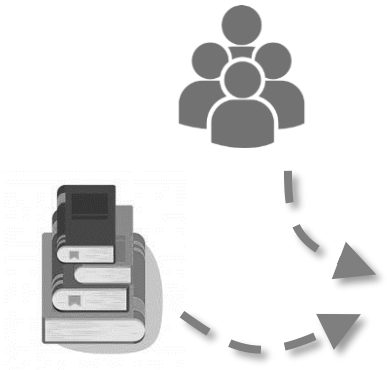


Pest-suppressive plant assemblages

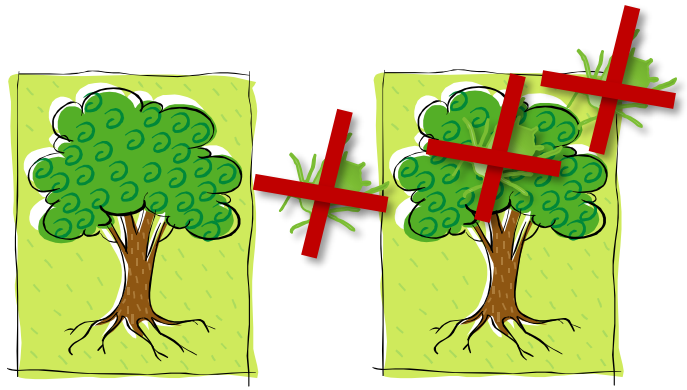
Agronomic efficient assemblages

Operationality

?

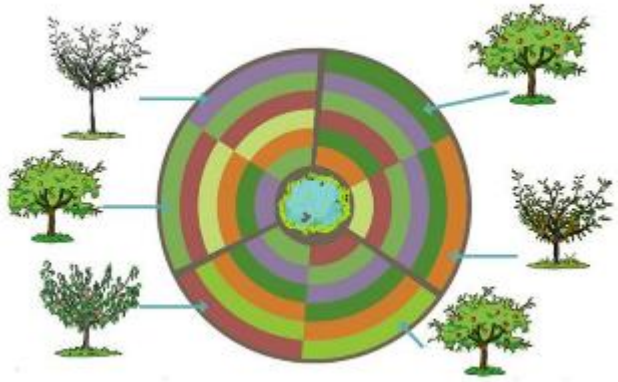
‘Pest suppressive’ design: diversification of crops, companion plants, habitats…

> Design of biodiversity-based agroecosystems



To disadvantage pests & diseases and to welcome natural enemies

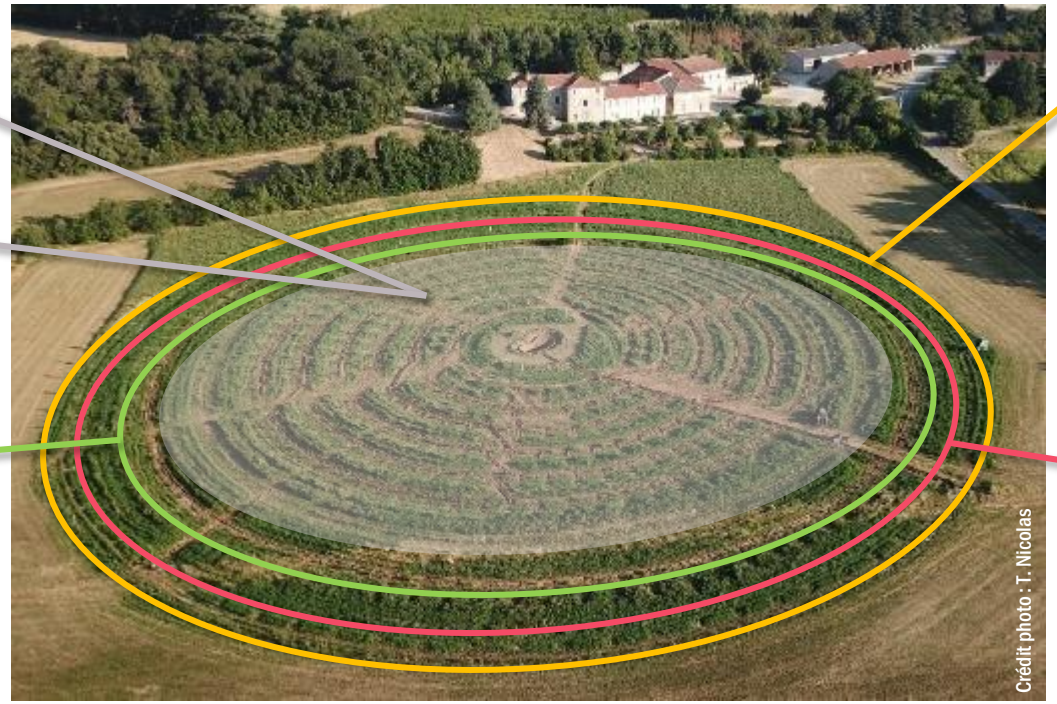
‘Pest suppressive’ design: diversification of crops, companion plants, habitats…



General outline
Barriers
Trap cv, repellent plants
Low-susceptibility cv

Species (between circles) and cultivar (within circles) mixture
Low-susceptibility cv

Barrier: hedgerow

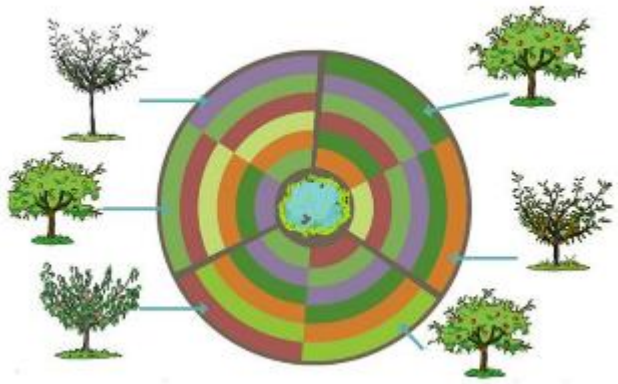


Barrier: diversified fruit production circle (fig, hazelnut, soft fruit…)

‘Trap’ apple cultivars (e.g., aphid low-susceptibility cv)

Surface area = 1.7 ha (including hedges), organic certified

‘Pest suppressive’ design: diversification of crops, companion plants, habitats…

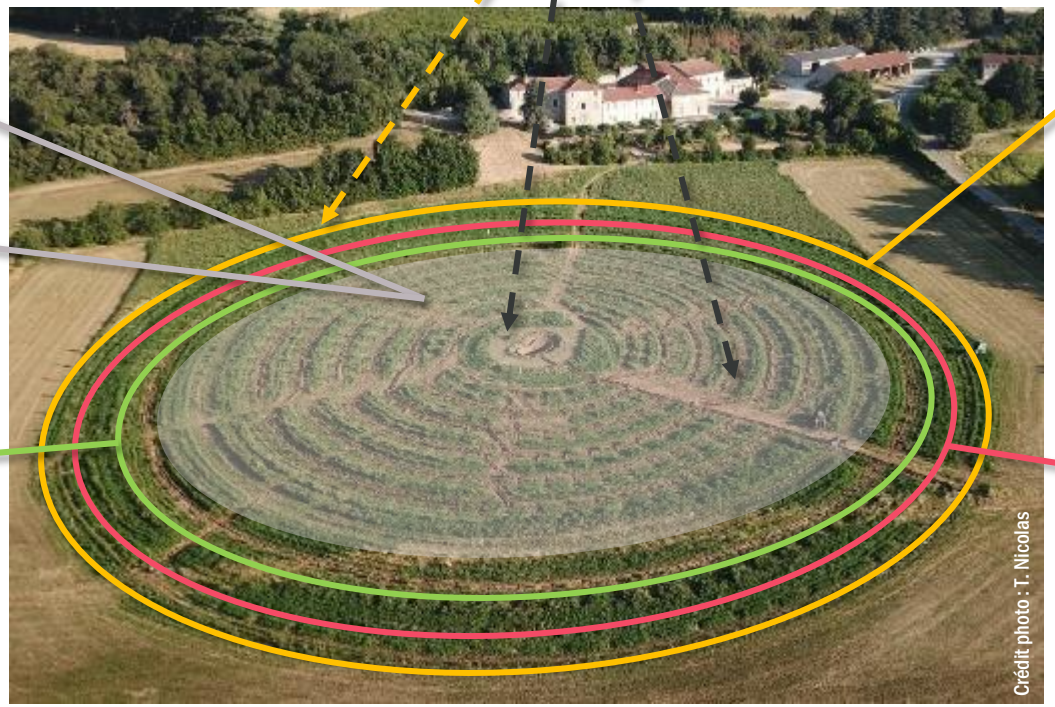


Dessins : © INRA C. Ulrich

Conservation biological control : plant assemblages and habitats

Species (between circles) and cultivar (within circles) mixture Low-susceptibility cv

Barrier: hedgerow



Crédit photo : T. Nicolas

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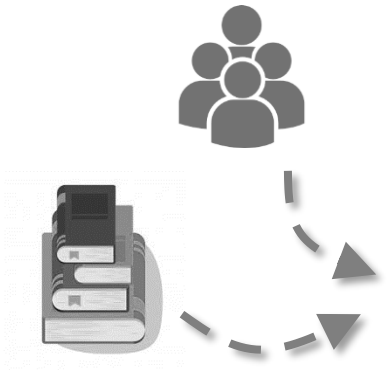


Pest-suppressive plant assemblages

Agronomic efficient assemblages

Operationality

?

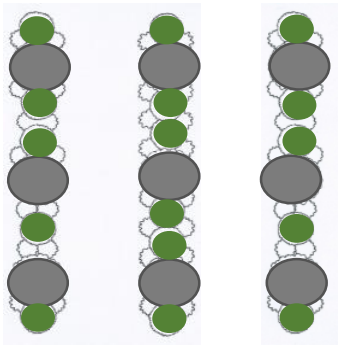
Resource sharing to design ‘efficient’ assemblages

Temporal and spatial scales: Co-planting or delayed planting? Species choice to optimise resource sharing?

Light interception

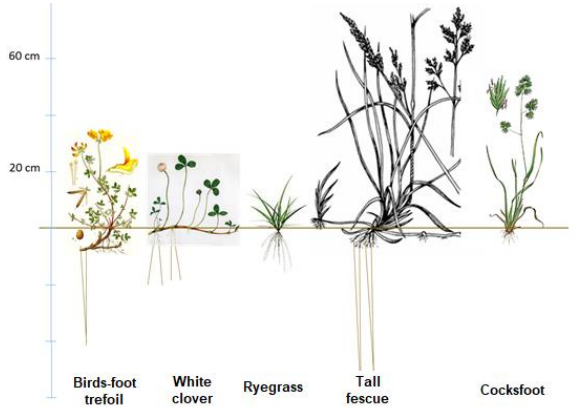
- Tree height and shape
- Row orientation (if any)
- **Spatial** arrangement

(vertical & horizontal)



Water and nutrients

- Rhizosphere: with different root system behaviour and distribution



Here: fruit trees planted in alfalfa that is used as fertilizer

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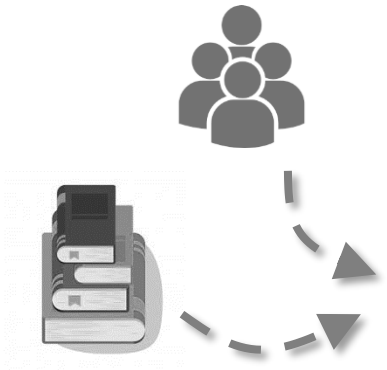


Pest-suppressive plant assemblages

Agronomic efficient assemblages

Operationality

?

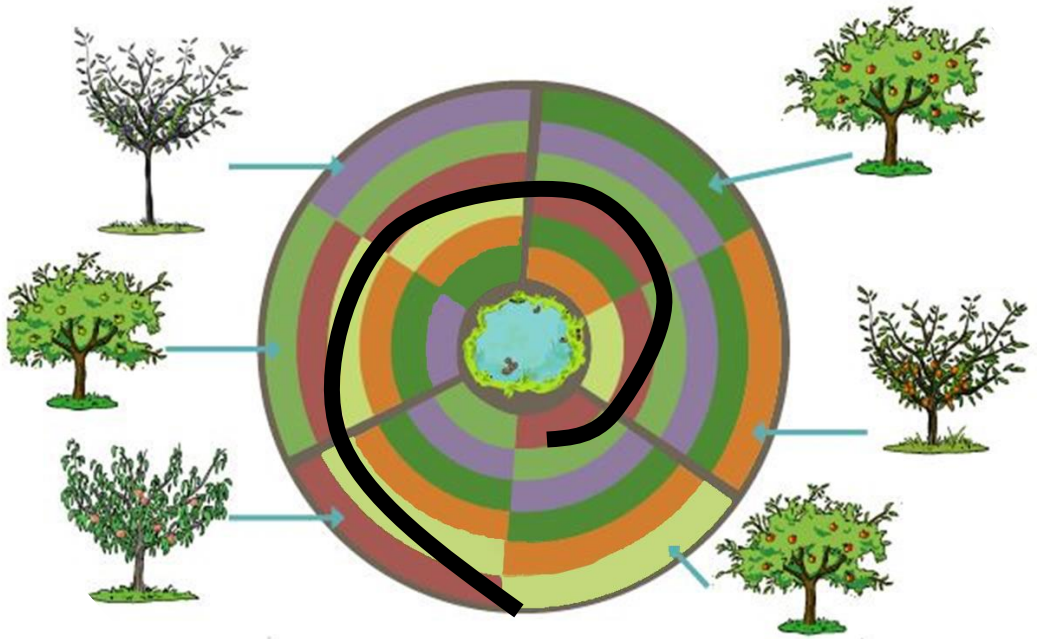
Orchard design for operationality

Work organisation

- To ease within field orientation and traffic (avoid empty runs)

Workload and sales

- Sufficient fruit quantities for sale
- Workload distributed over time



6 tree spirals of various tree species

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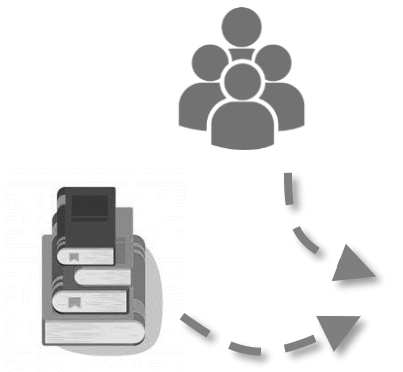


Pest-suppressive plant assemblages

Agronomic efficient assemblages

Operationality

Tradeoffs!

The prototype

1.7 ha including lining circular hedgerow
15 fruit species and 33 cultivars
23 companion plant species
Planted in 2018

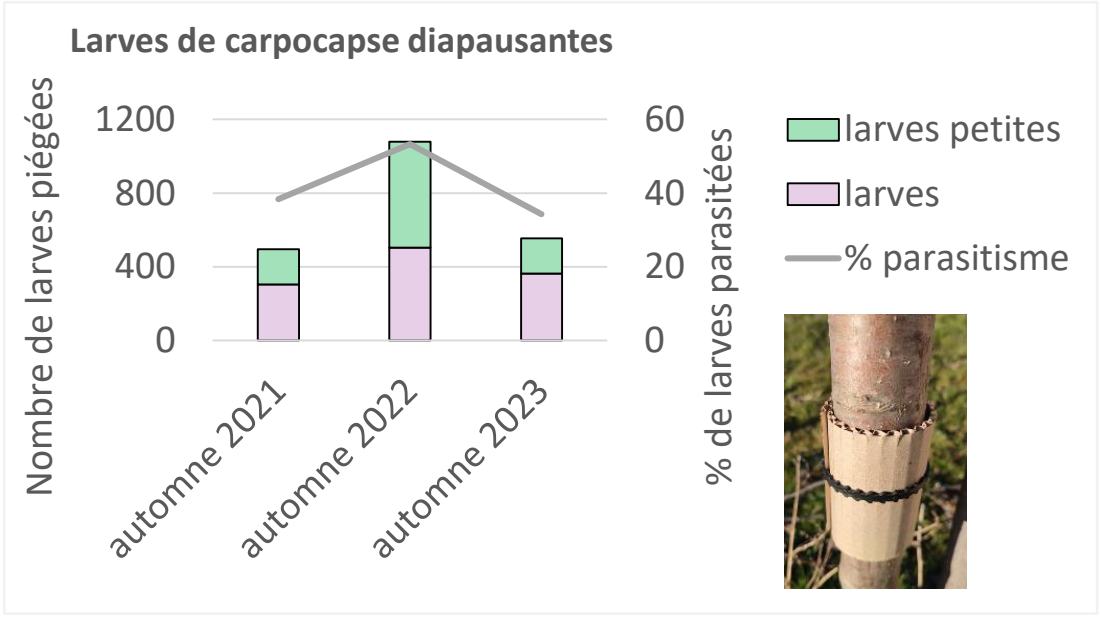
First feedbacks: Increase in biodiversity

Abundant and diversified communities and predatory groups

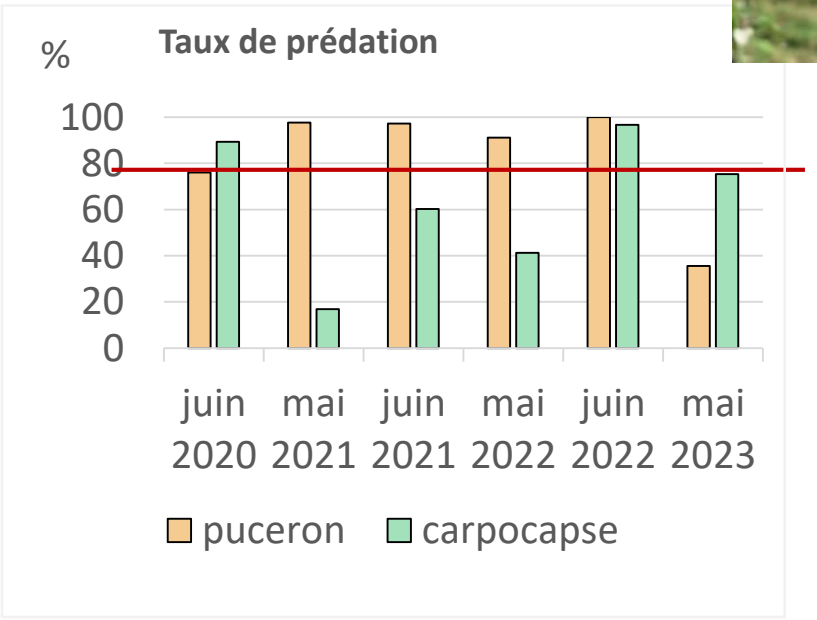
First feedbacks: Increase in parasitism and predation

- High parasitism and predation rates

Parasitism rate



Predation rate (sentinel preys)



First feedbacks: Increase in parasitism and predation

> Pest and disease control varies according to years

Regulation

-En 2022-23, **régulation du puceron cendré** (pas de dégâts) vs. contexte régional/national difficile en 2023

-Carpocapse : 10-20% de dégâts sur fruits depuis 3 ans
(0 confusion, 0 virus de la granulose ; piégeage massif et augmentorium)

-> Un fort potentiel à préserver

First feedbacks: Fruit production (1/2)

No pesticide (synthetic, biological), no mating disruption

- Trees: good establishment

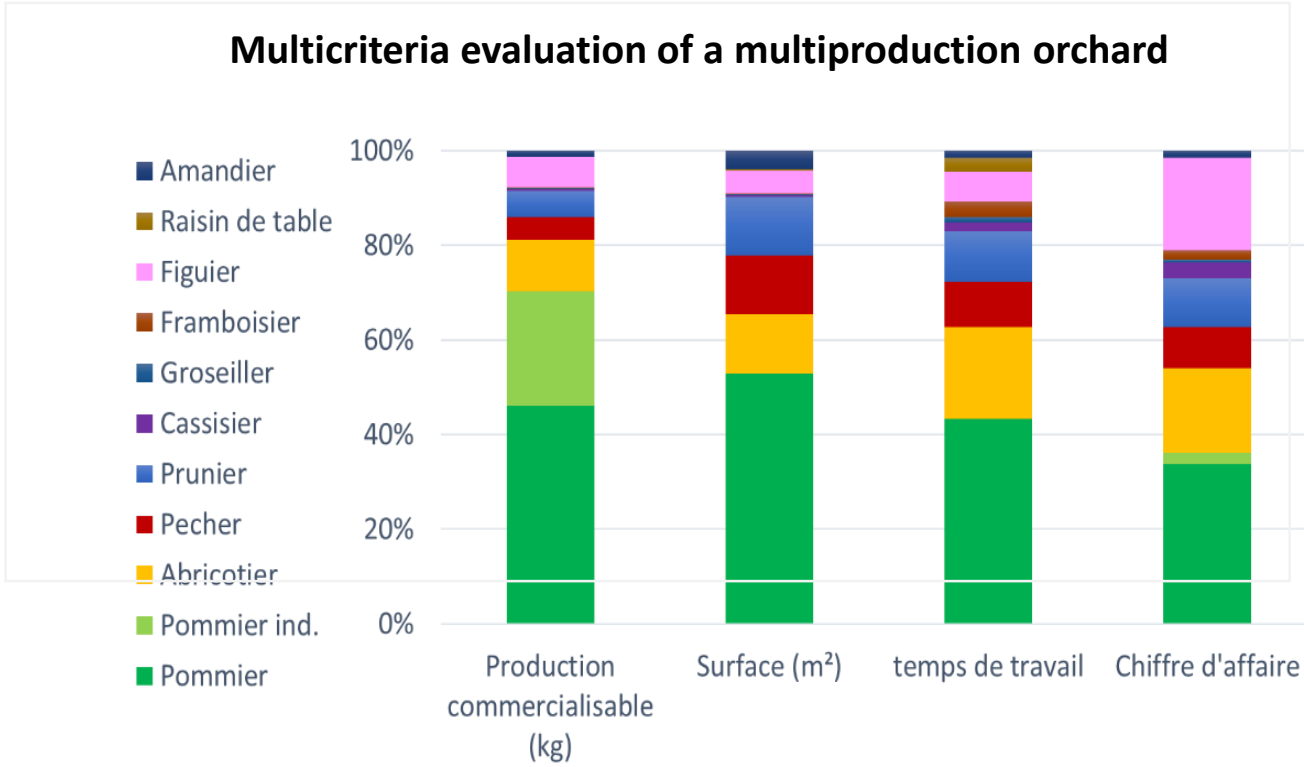
- **/!\ Climate!**
  Hail (2019), early snow (2019) et frost (2021, 2022)

First feedbacks: Fruit production (2/2)

-Yields vary according to species and years (because of climatic hazards and pest damage), to be validated across years

-Production every year whatever the context & very low input loads

-> Need to valorize production, e.g. through short channels



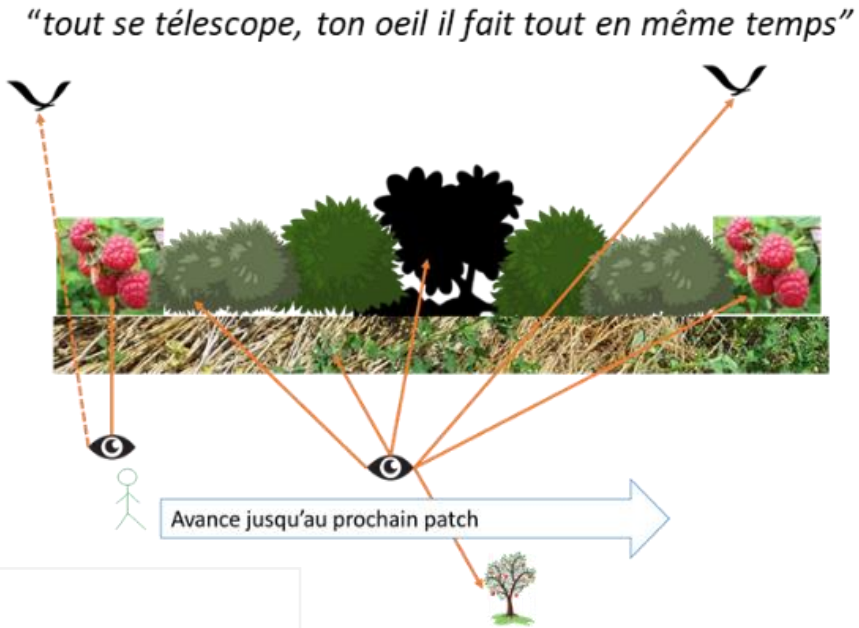
Source MIN LYON Bio 2023

	prix HT /kg
Pommier	2
Abricotier	4,48
Pecher	5,1
Prunier	5,1
Cassisier	21
Groseiller	12,4
Framboisier	20
Figuier	8,38
Raisin de tab	3,31
Amandier	3

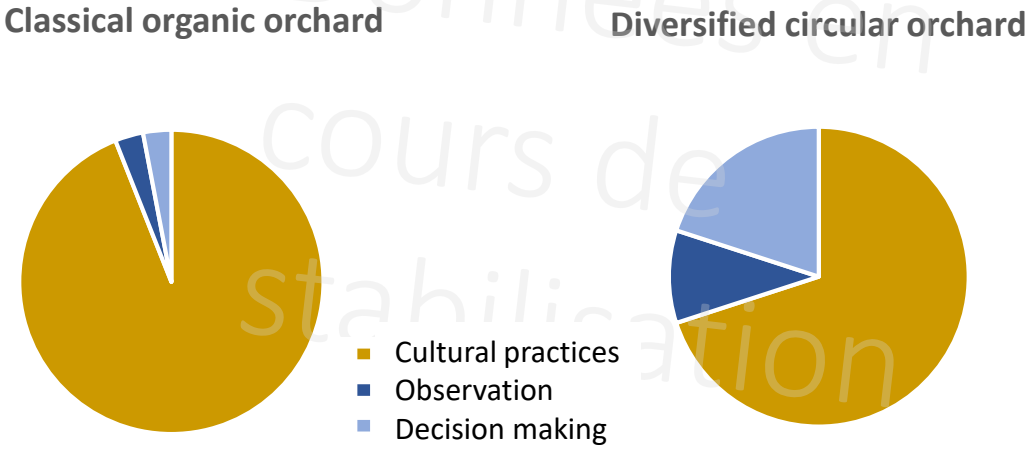
Young orchard ! Only 1 year of fruit production because of climate hazards

First feedbacks: Work in diversified orchards

‘Vigilant’ observation of this complex system to build benchmarks and have an adaptative management



Work type



Open innovation

Scarce stabilized knowledge on diversified systems or innovations in fruit production

The ‘Cafés Agro’, for information exchanges and experience sharing among research and farmers to explore innovations

-One theme generally proposed by previous attendees, e.g. poultry in orchards

-One or a few guests (farmer, researcher) who is experienced on the subject

-Facilitation

-Field visit for concrete experience

And coffee!

-> 13 Cafés Agro in 6 ans

To conclude

> Co-design is a key element to obtain tradeoff between all presented axes and to consider agroecosystem interactions and complexity

> ‘Proof-of-concept’ approach

-A knowledge-intensive project: to design, to understand the underlying processes such as pest suppression

> Agroecological co-design
-> innovative design and a sharing / learning experience...
but also many questions related to the agricultural sector and the food system!

A design to assess across time...

Photo credits: INRAE Gotheron unless otherwise specified

Thank you for your attention!

For further information

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https://www6.paca.inrae.fr/ueri/Contrats-et-projets/Expe-DEPHY-Ecophyto-II-ALTO

Acknowledgement

The ALTO project (Fruit tree production systems and agroecological transition) is partly supported by the French national Ecophyto II program within the frame of the DEPHY EXPE network. Ecophyto II program is managed by the French Ministries of Agriculture and Environment, and benefits the financial support of the French Biodiversity Agency and the taxes for diffuse pollution allocated to the program.

Le projet ALTO

Système agroforestier pommiers, noyers et légumineuses (2016, 1.5 ha)

3 dispositifs AB très bas-intrants & une dynamique multi-acteurs

Verger multi-espèces re-conçu de novo et biodiversité (2018, 1.7 ha, 0 pesticide)

Vergers monovariétaux -> multi-espèces, zone de biodiversité (2019, 1.2 ha)

How did we proceed?

De novo design

Step by step design

Towards pesticide-free orchards

Workshops

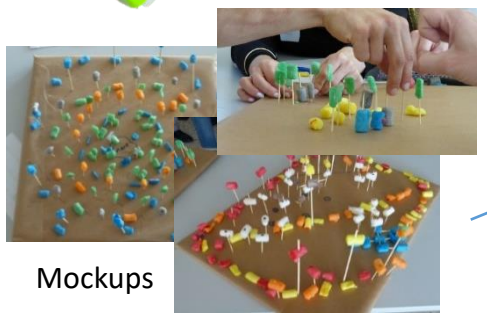
Planting

On the way management...

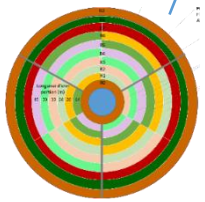
2015 — 2017 — 2018 — 2030

Context, main objectives = framework definition

Basic research on processes



Mockups



Final prototype

Co-design: learning, experience sharing, multi-actor dynamics...

After C. Goutines (internship 2016-2017), B. Chieze (internship 2017)