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How multi-species and pesticide-free orchards affect the observation practice?

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Introduction, context and objectives

Relying on ecological processes and diversifying agroecosystems to maximize ecosystem services and pest regulation is challenging: the range of spatial-temporal biotic and abiotic interactions to consider entails management complexity and uncertainty. We assume that the activity of observation and 'active monitoring' is at the cornerstone as it enables adaptive management (Duru et al., 2015), sound intervention thresholds for agroecological pest management (Deguine et al., 2021), and learning dynamics (Coquil et al., 2018).

This study aimed to analyze how the activity of observation could contribute to the orchard management, especially in unpredictable multi-species and pesticide-free orchards.

Materials & Methods

This study was carried out in two French experimental orchards which were recently (re)designed as multi-species and low-inputs orchards managed by field teams used to classical orchards (Fig 1). For each site, our approach consisted in four steps:

- (1) A survey of the staff working in the orchard;
- (2) *In situ* observations of a variety of tasks;
- (3) *In situ* observation of team meetings and documentary analysis;
- (4) Feedback seminars and discussion.

Figure 1: Description of the two study sites.

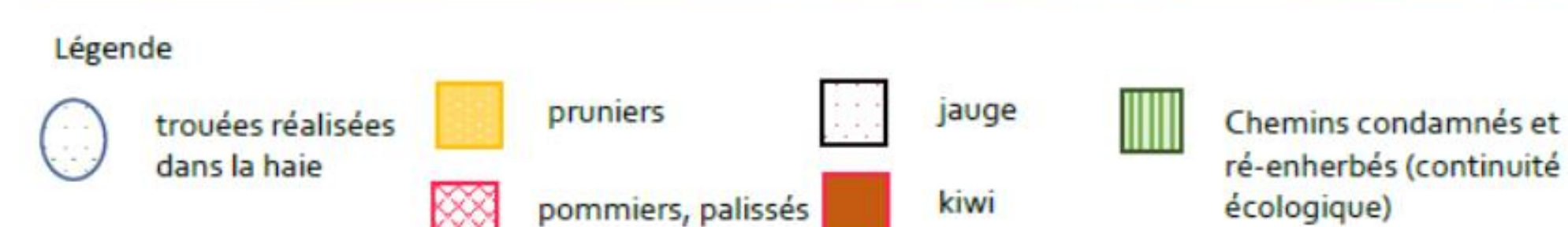
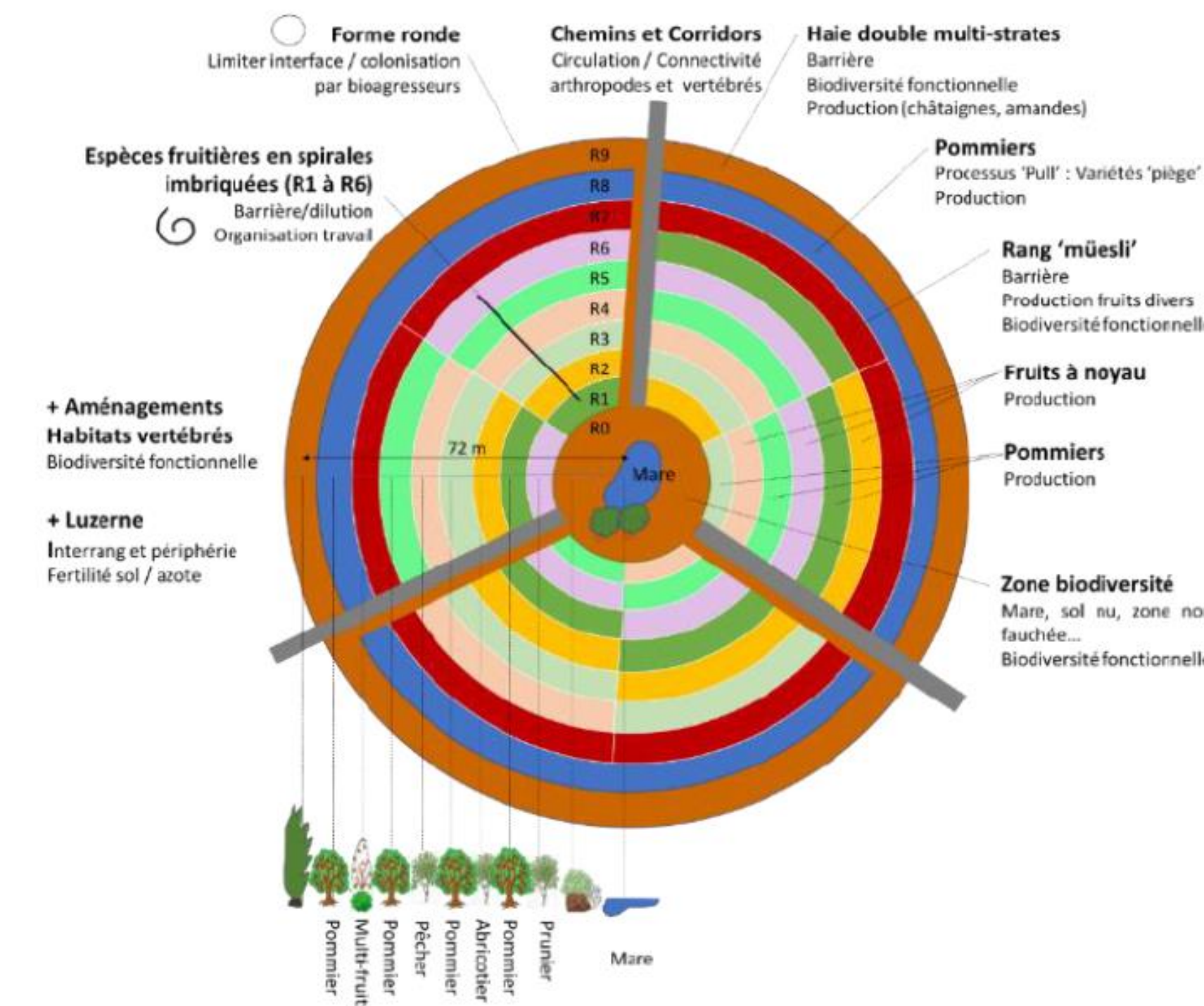


Figure 14 - parcelle ALTO après sa diversification



Gotheron: Orchard design from scratch.
Low-input organic farming, no plant protection input

Balandran: Incremental diversification.
Low-input organic farming based on biocontrol methods and mineral compounds

1. The prominent place of observation: to know the system better, in its parts and in globality

> Observation as a connecting activity to the orchard

- Well established protocols for orchard monitoring;
- *Vigilant observation*: operators also constantly 'keep an eye' during the daily tasks in the field. Such vigilant observation is constant, more present when moving in the orchard or during tasks with low cognitive load.

> Eyes capacity to offer a holistic perspective

The operators in the orchard usually go back and forth between different dimensions and spatial scales (Fig 2).

"Everything telescopes, your eye, it does everything at the same time"

> Observation enables for adaptive management

- Different signals are noticed at all scales, making possible a rapid diagnosis of the situation;
- Decision making to meet the requirement of the task or about next operations to carry out, e.g. harvest, treatment, more precise monitoring of a pest.

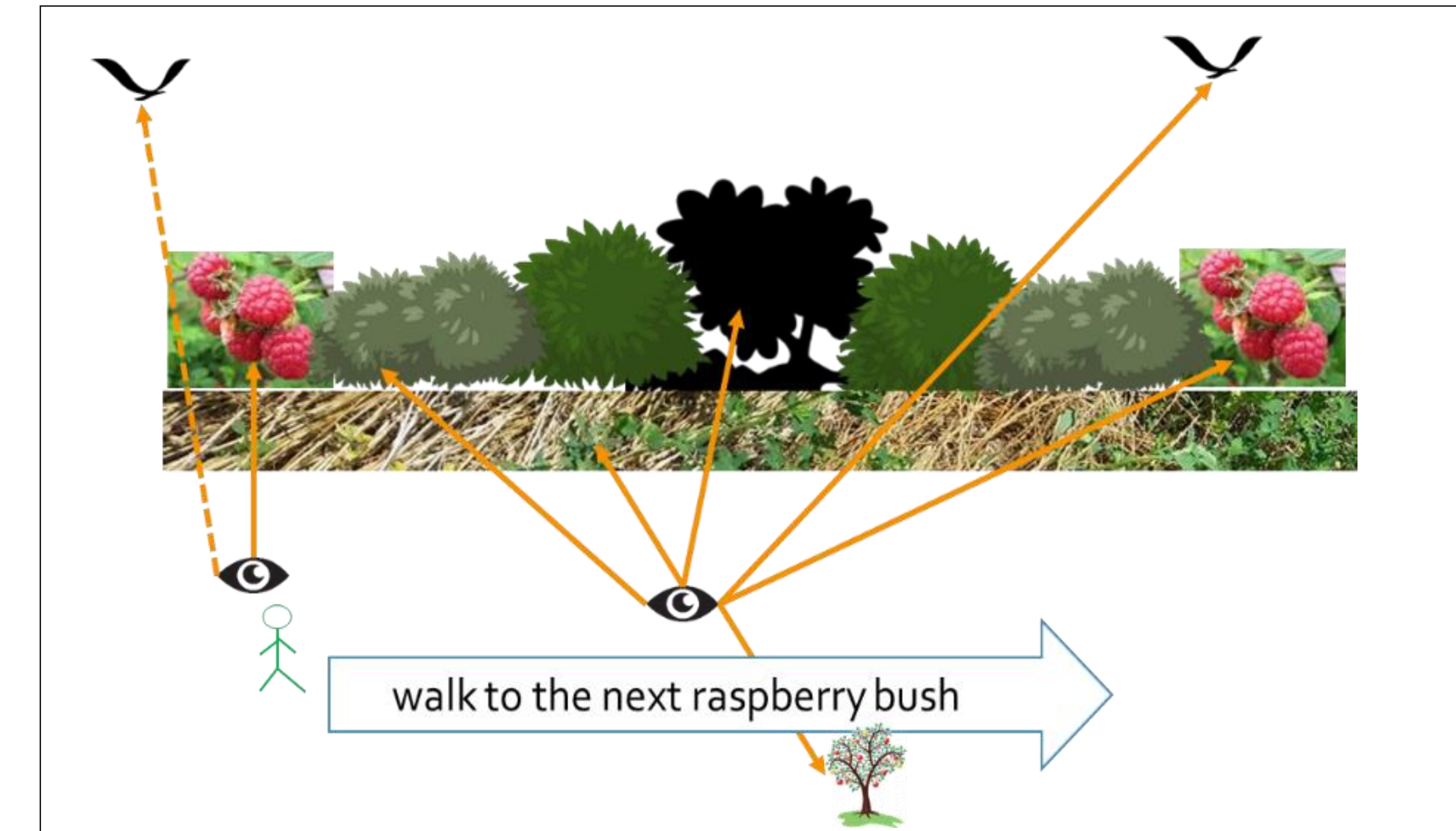


Figure 2: Representation of the different objects observed by the operators during the raspberry harvest in Gotheron. The operator is focused on the bush to spot ripe raspberries. However, his gaze scans all the strata of the orchard and he is receptive and reactive to notable events in the environment.

2. Redesigning the way we observe: a collective challenge to adapt to multi-species orchards

> Elaborate new spatial and technical benchmarks in diversified orchards

- Many categories of observable "objects" at the same time
- Skills to spot a range of warning signals, e.g. different pests on different species.

> Recognize and share the different 'eyes' and points of views

- A diversity of ways to carry out incorporated vigilant observation,
- Attention to objects depends on operators' function and experience.

> Valorize the information collected

Generally no written notes of the observation... team organization is crucial to share this information.

Conclusions and perspectives

Observation activity can be done following established protocols for orchard monitoring and experimental surveys, or in an incorporated way by 'keeping an eye'. This vigilant observation allows for an assessment of the overall health of the orchard and its environment and is a source of adaptive management of the system. Hardly formalized, it seems essential for multi-species orchards to (re)design new benchmarks, and for collectively managed orchards to recognize and share the different eyes and points of views.