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## What ecological traits and functions are important in a crop mixture for effective weed management?

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# What ecological traits and functions are important in a crop mixture for effective weed management?

*Malick OUATTARA, Raphaël PAUT, Muriel VALANTIN-MORISON, Safia MEDIENE*

## 19th European Weed Research Society Symposium

20 - 23 June 2022 Athens Greece

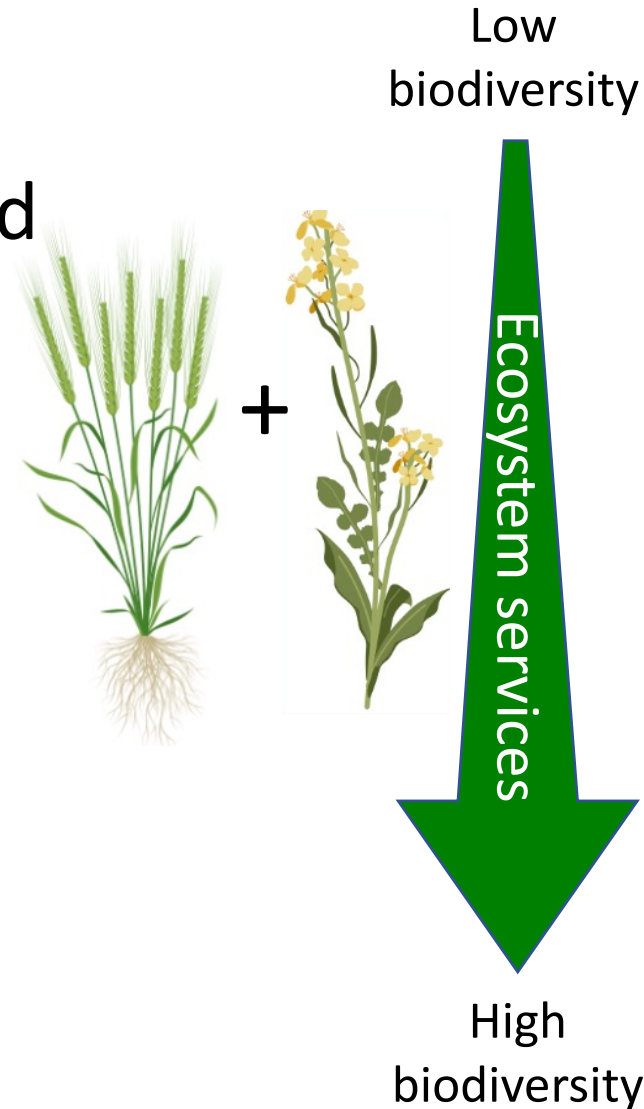
# ➤ Why to promote a biodiversity-based agriculture ?

## Mixing species:

🌾 Increases biological and functional diversity in agroecosystems

🌾 Provides ecosystem services

🌾 Reduces the external inputs by promoting biological regulation



## Agroecosystem type

### ARTIFICIALISATION for:

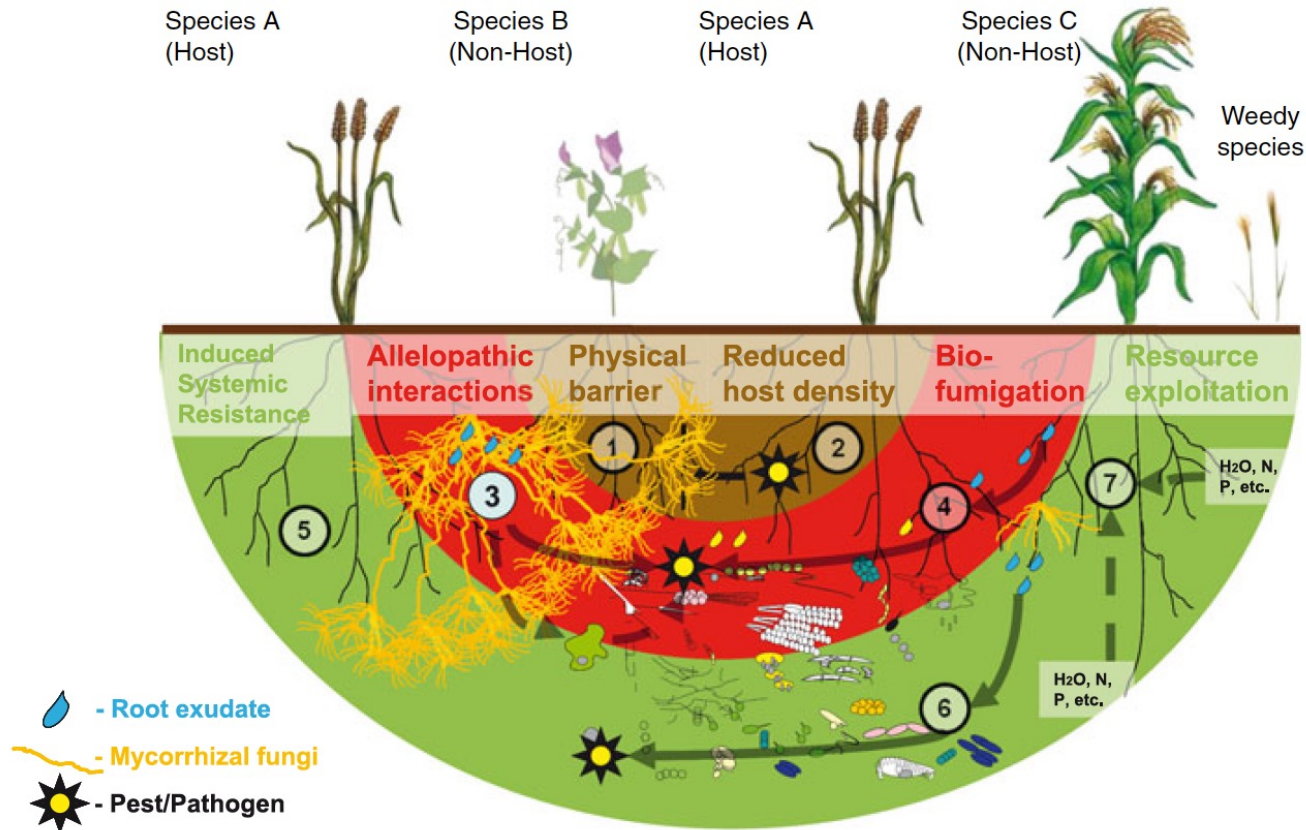
- Creating soil structure & soil porosity
- Limiting water & nutrient stresses
- Treating pest & disease (plants & animals)

### REGULATION of ECOLOGICAL PROCESSES for:

- creating soil structure & soil porosity
- Increasing water & nutrients availability
- Increasing pest & disease control
- Improving pollination
- Regulating microclimate

Duru *et al.* 2015

# ➤ Lock in to biodiversity-based agriculture ?



Ehrmann and Ritz, 2014

☘ Arable Crop diversification is accompanied by an increase in the complexity of cropping systems and interactions in the agroecosystem

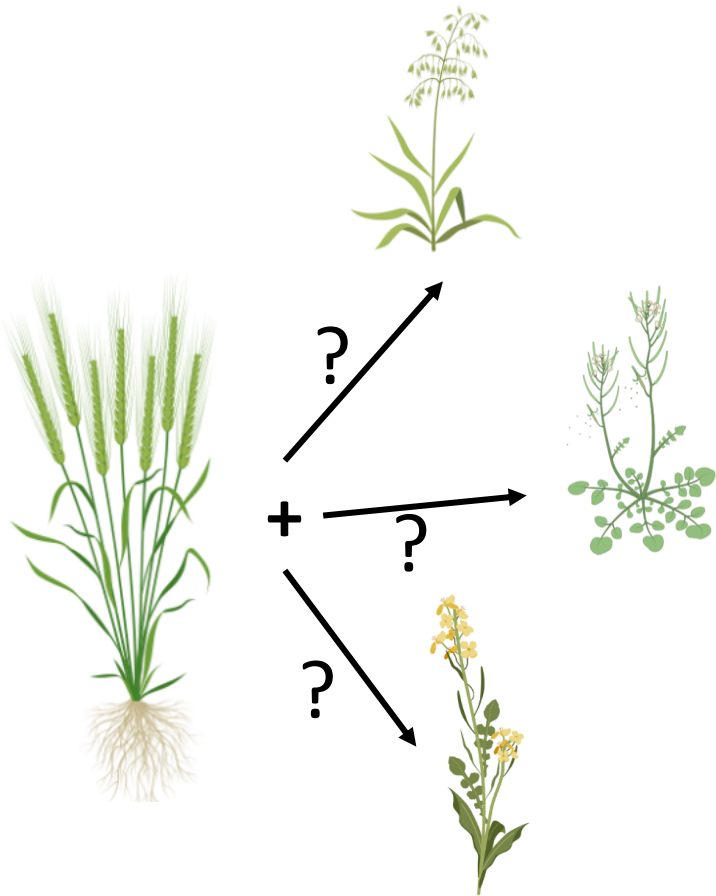
☘ Many combinations between species are possible (Verret *et al.*, 2020), the best combination is difficult to identify for local conditions

☘ And little is known about how to mix species (or varieties) to provide ecosystem services



## Two important issues to encourage the development of crop mixtures

 **Identify species assembly rules in crop mixtures to provide ecosystem services (here for weed regulation)**



 **Co-design a tool to assist in the design of mixtures**

**EcosysteMIX**, exploratory and didactic tool to help identify **mixtures of species** capable of providing one (or more) expected **ecosystem service(s)** under given **agro-environmental conditions**



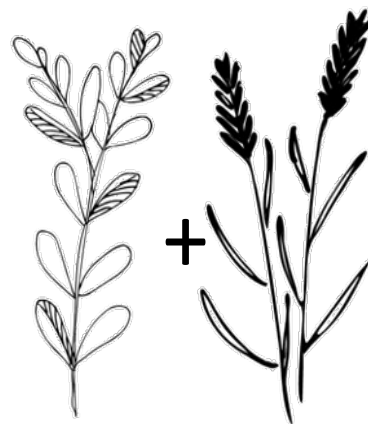
# ➤ A method based on knowledge hybridation and a functional ecology approach

## Knowledge gathering and hybridation



- Scientific Knowledge
- Empirical knowledge

Crops are described by their **functional traits**, these traits are involved in **biological functions**, that are providing **ecosystem services**



Crop mixtures

Trait 1  
C/N

Trait 2  
Architecture

Trait 3  
Frost  
sensitiveness

Crop mixture traits

Function 1

Function 2

Agro-environmental conditions

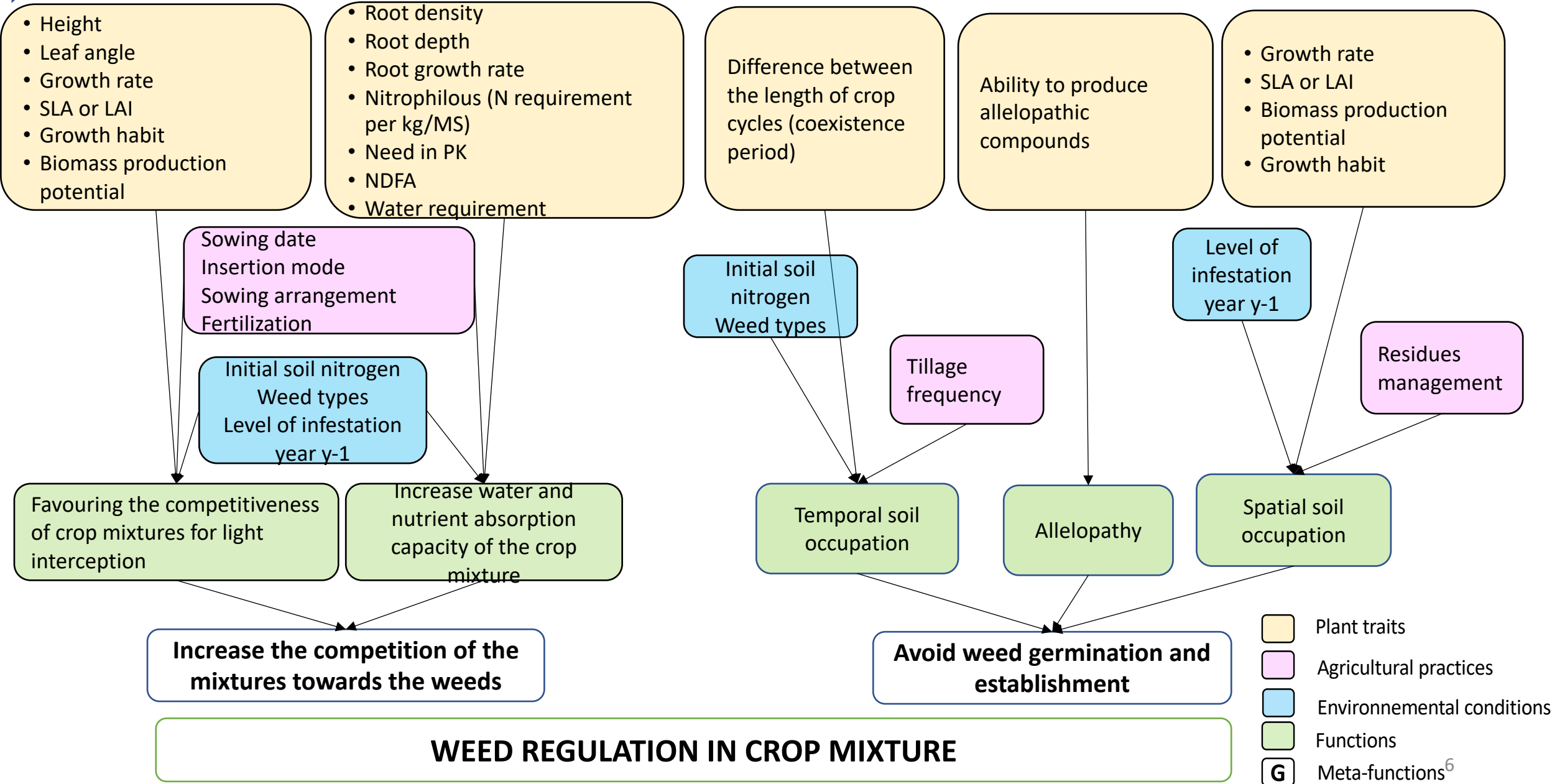
Weed regulation

Médiène *et al.*, 2016

Evaluation of services provided by species



# Functional representation of crop mixtures for weed regulation obtained after workshop



- Plant traits
- Agricultural practices
- Environmental conditions
- Functions
- G Meta-functions<sup>6</sup>



# Functional representation of crop mixtures for weed regulation obtained after workshop

- Height
  - Leaf angle
  - Growth rate
  - SLA or LAI
  - Growth habit
  - Biomass production potential
- Root density
  - Root depth
  - Root growth rate
  - Nitrophilous (N requirement per kg/MS)
  - Need in PK
  - NDFA
  - Water requirement

- Sowing date
- Insertion mode
- Sowing arrangement
- Fertilization






- Initial soil nitrogen
- Weed types
- Level of infestation year y-1

Favouring the competitiveness of crop mixtures for light interception

Increase water and nutrient absorption capacity of the crop mixture

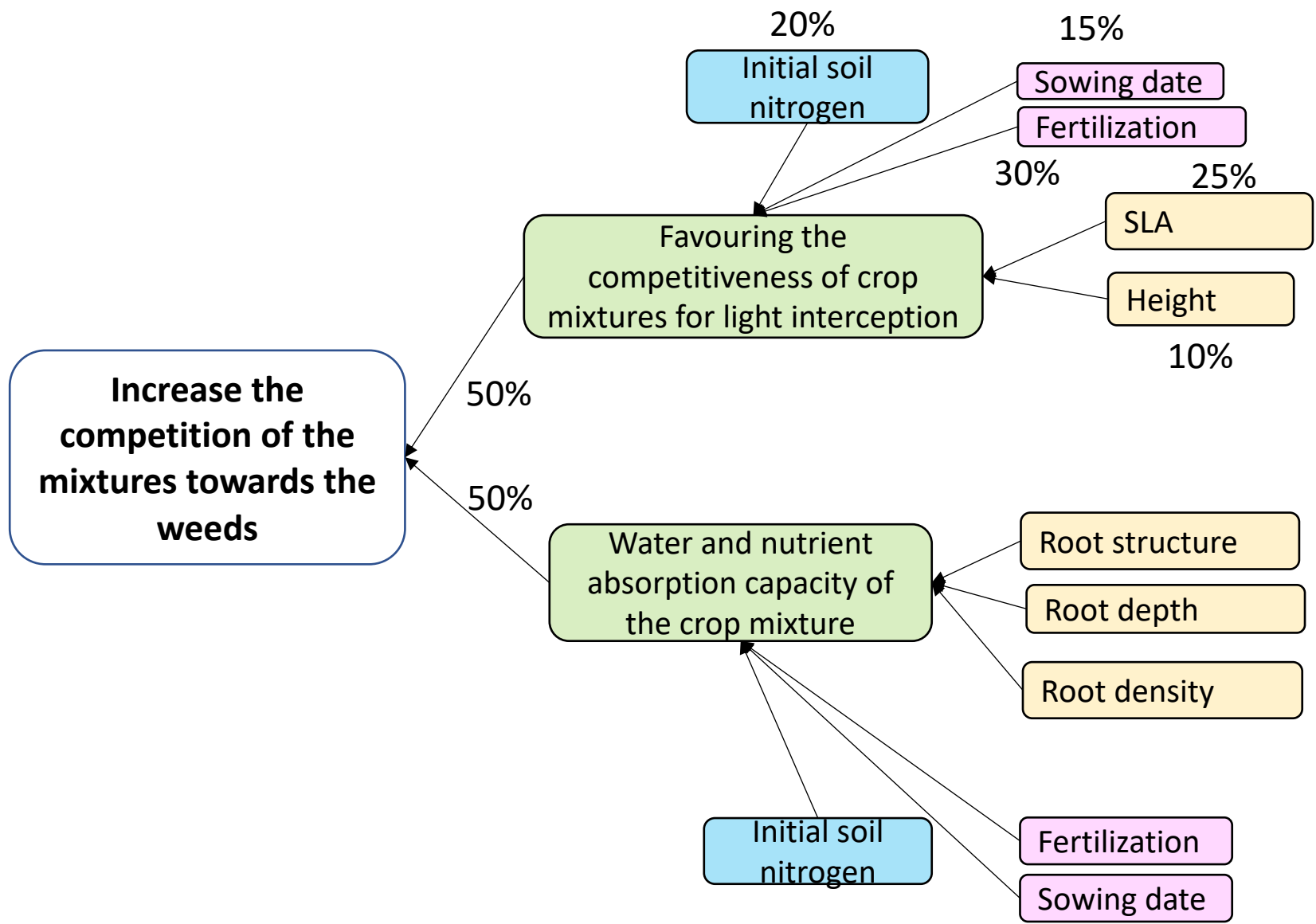
**Increase the competition of the mixtures towards the weeds**

**WEED REGULATION IN CROP MIXTURE**

-  Plant traits
-  Agricultural practices
-  Environnemental conditions
-  Functions
-  Meta-functions<sup>7</sup>



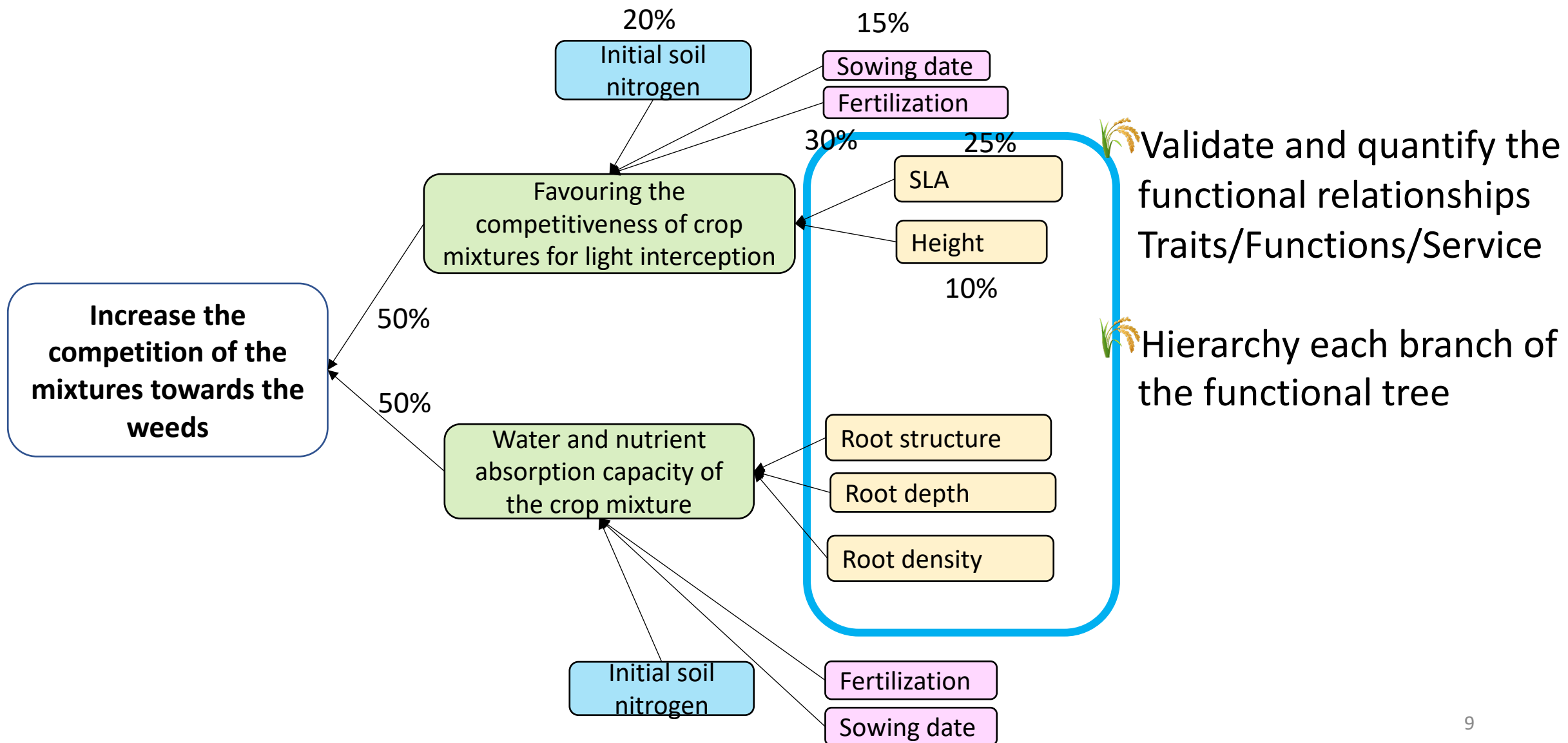
# ➤ Ongoing work: an example of hierarchical weighting



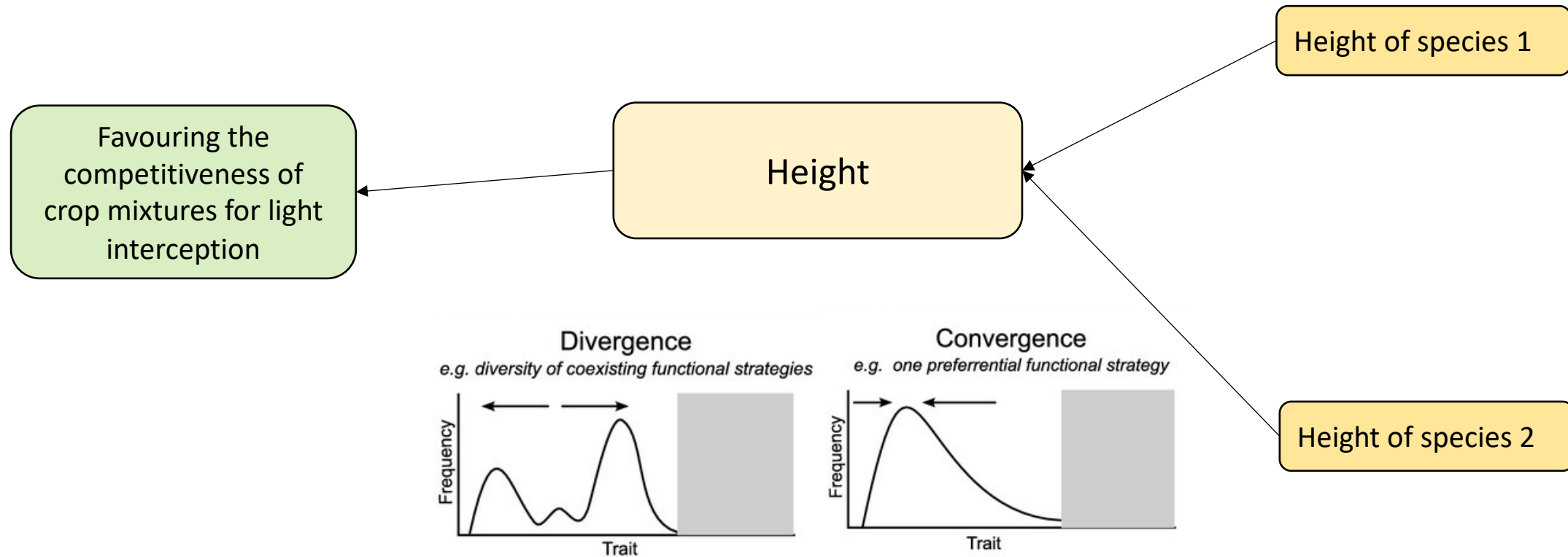
🌾 Validate and quantify the functional relationships  
Traits/Functions/Service

🌾 Hierarchy each branch of the functional tree

# ➤ Ongoing work: an example of hierarchical weighting



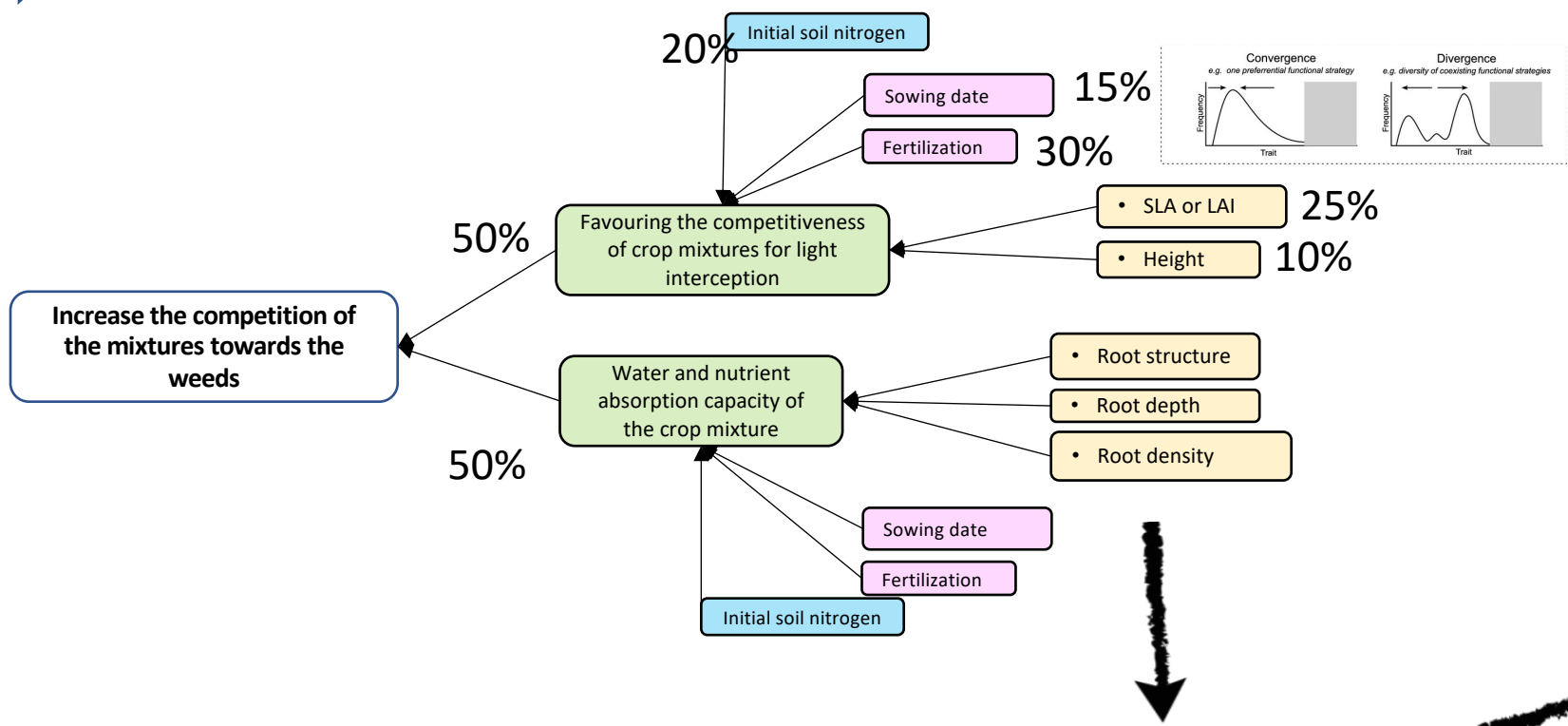
# ➤ Ongoing work: defining the assembly rules of traits in crop mixtures



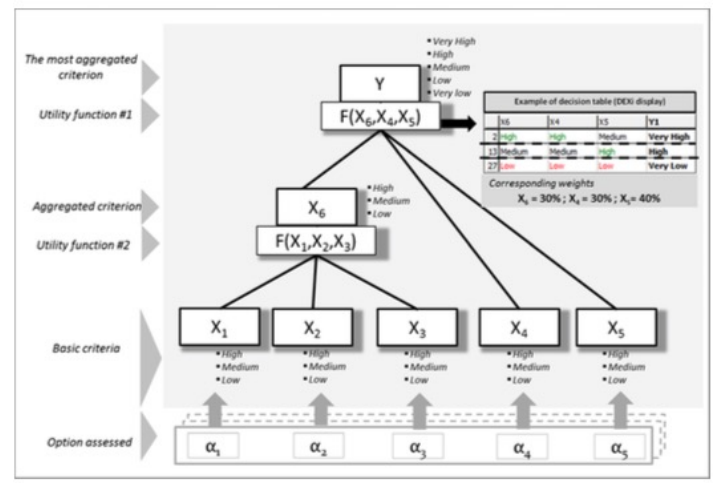
Bernard-Verdier *et al.* 2012

For example, to promote the competitiveness of the mixture against weeds, it is necessary that the two species have a high height, i.e. convergent or high for one and low for the second i.e. divergence

# Finalized goal: A tool to assist in designing of species mixtures

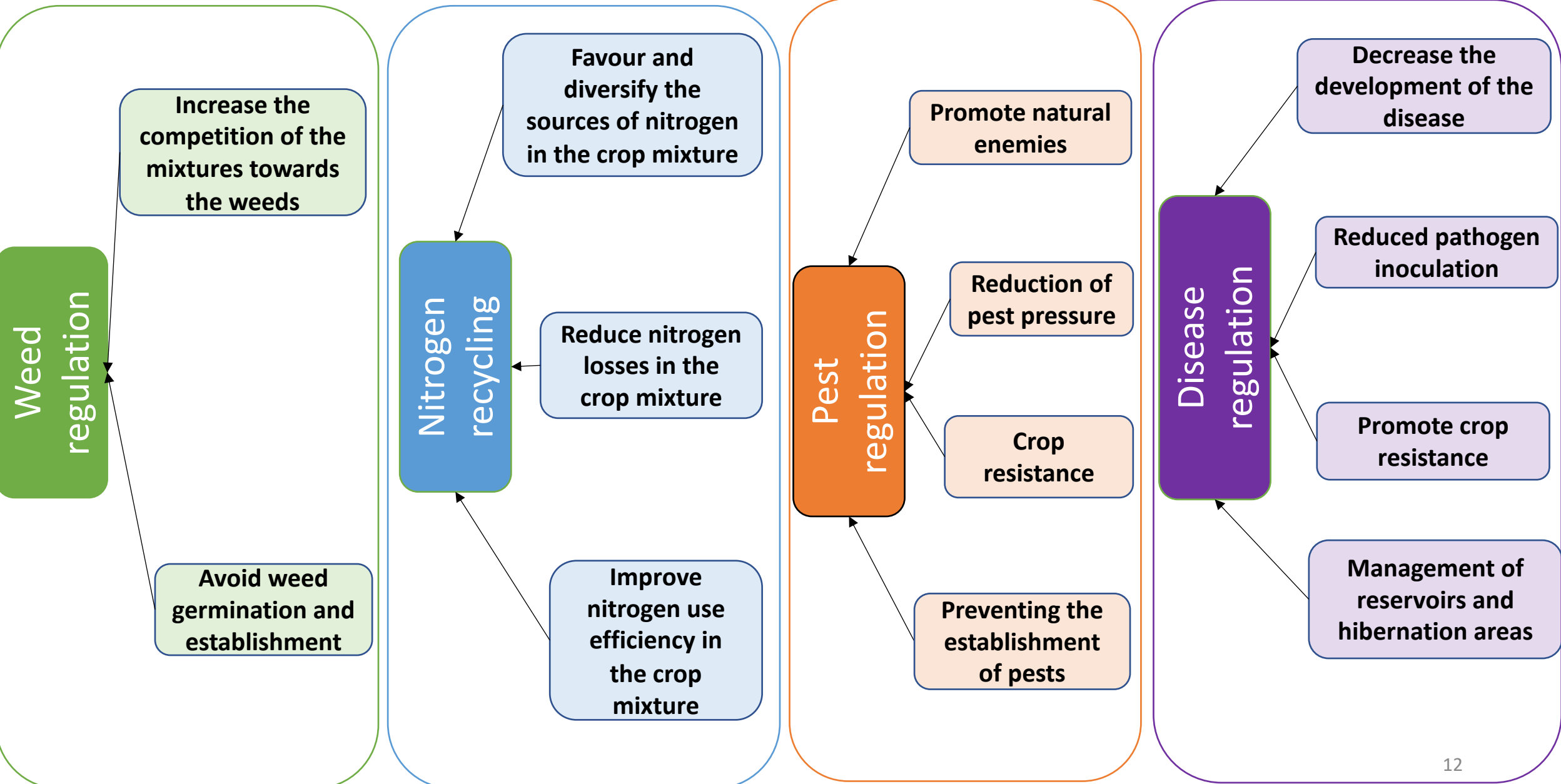


Qualitative hierarchical multi-attribute model (ex. Dexi) for each service to made **decision rules**



Classification of **species mixtures** according to their capacity to provide the expected **services** in the local production context

# ➤ Meta-functions involved in 4 ecosystem services



**THANK YOU FOR YOUR ATTENTION!**

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