



Redesigning European cropping systems  
based on species mixtures

## **Ecosystem services provided by Intercropping**

## **Intercropping and pesticide reduction**

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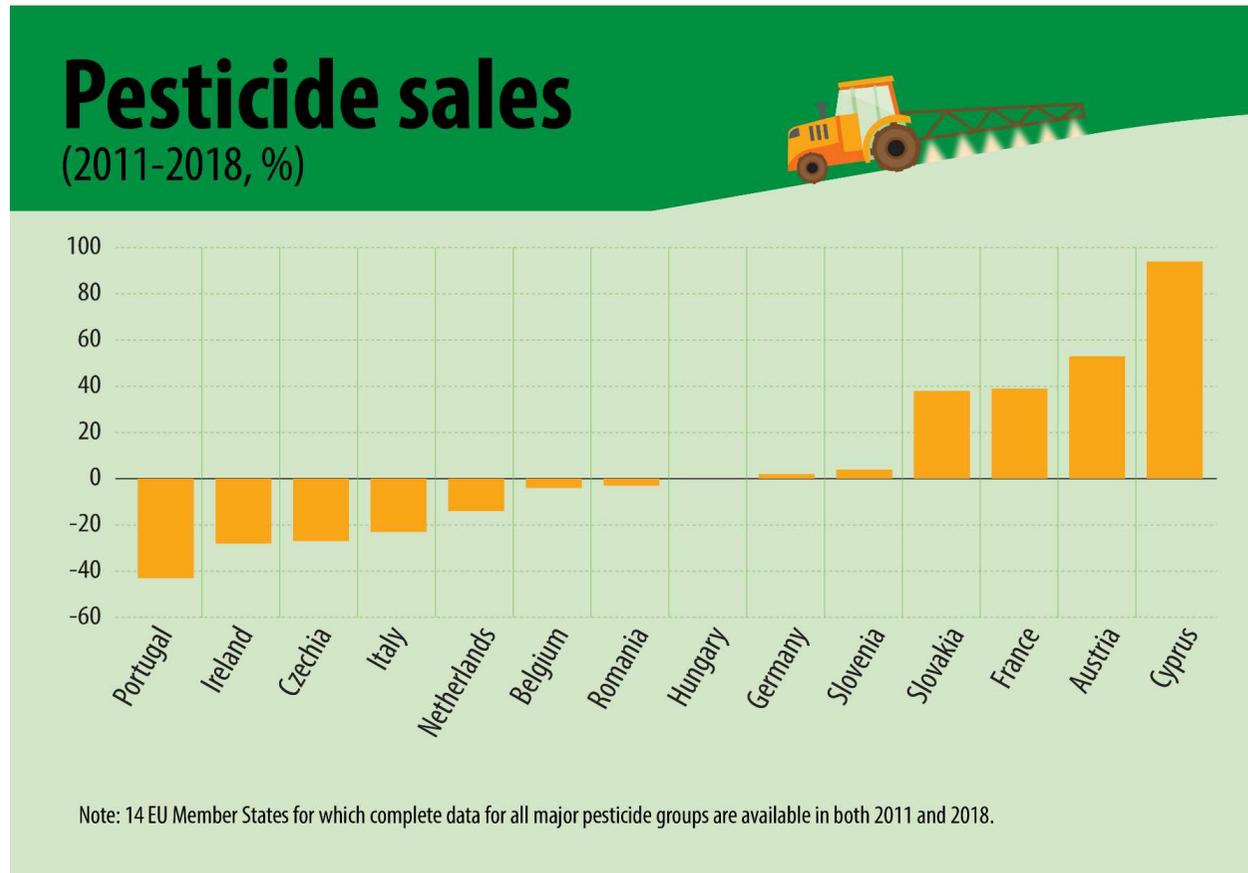


**ReMIX**

Species mixtures for redesigning  
European cropping systems



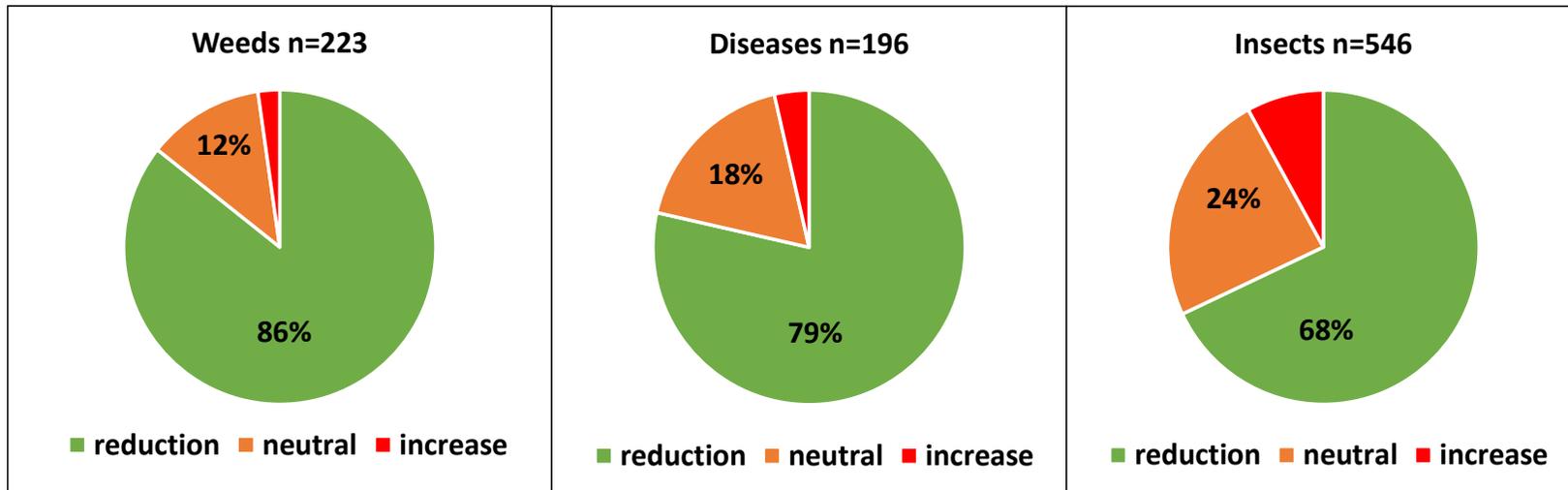
## Pesticide reduction is the goal but it still does not happen





## Mixtures are an important part of the solution

- ReMIX (WUR) analyzed existing data on pest, disease and weed control through species mixtures.



## Weed suppression through competition





## Disease reduction in mixtures: nothing new

1767: G. T. Tozzetti observed <sup>1</sup>

*„It is something worth pondering, that in this calamitous year, sowings of rye only, or of segalato, this is to say of **wheat and rye**, were immune from rust (...) the same happened in the Vecciati, that is to say, **wheat sown along with vetch** (...).*

*It is not so easy to render a reason, why wheat growing seeded with rye, or with vetch, was not damaged by the rust, **while a field of wheat along standing between one of rye, and one of vetch, yielded scarcely any seed, and that the most miserable.**“*

<sup>1</sup>: Tozzetti, T. G. (1767). *Phytopathol. Classics No. 9, 1952*). St. Paul, Minnesota, 1952: Am. Phytopathol. Soc.

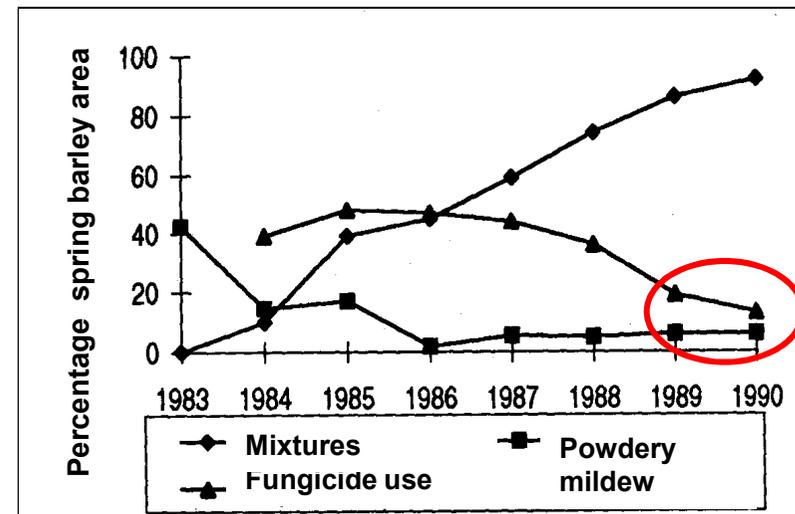


## Disease reduction in mixtures: nothing new

**1767: G. T. Tozzetti** observed that Wheat-Rye mixtures were mostly healthy while pure stands of wheat died of stem rust<sup>1</sup>.

**1980s:** German Democratic Republic  
**80% reduction of fungicide** use on  
spring **barley variety mixtures**<sup>2</sup>.

**Since 1984:** Colombian Coffee multiline  
Breeding program. **Yearly savings of  
>100 Mio \$ in fungicides**<sup>3</sup>.



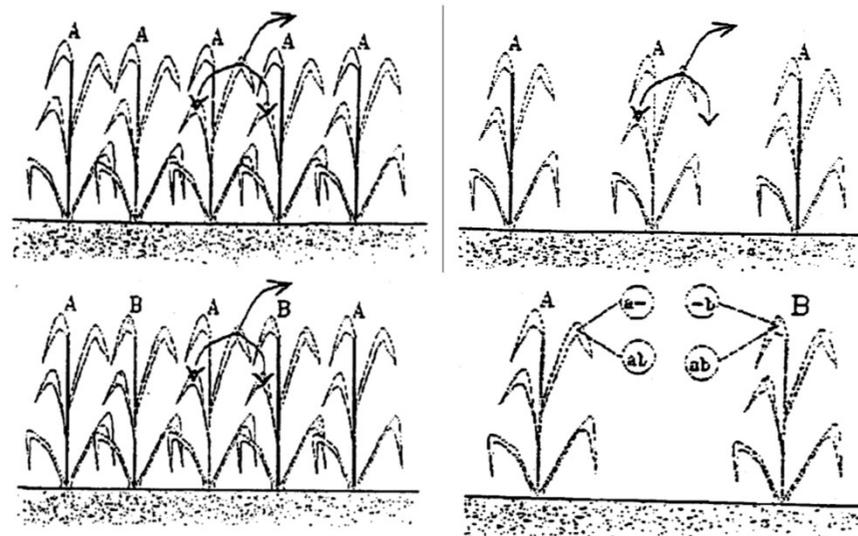
<sup>1</sup>: Tozzetti, T. G. (1767). *Phytopathol. Classics No. 9*, 1952). St. Paul, Minnesota, 1952: Am. Phytopathol. Soc.

<sup>2</sup>: Wolfe, M. S. (1992). In L. Munk (Ed.), *Barley Genetics VI* (pp. 1055-1067).

<sup>3</sup>: Finckh, M. R., & Wolfe, M. S. (2015). In M. R. Finckh et al (Eds.), *Plant Diseases And Their Management in Organic Agriculture* (pp. 153-174): APS Press.

## The Mechanisms work in cultivar and species mixtures

- **Distance and barrier effects**



- **Scale effects (GDR, Colombia)**

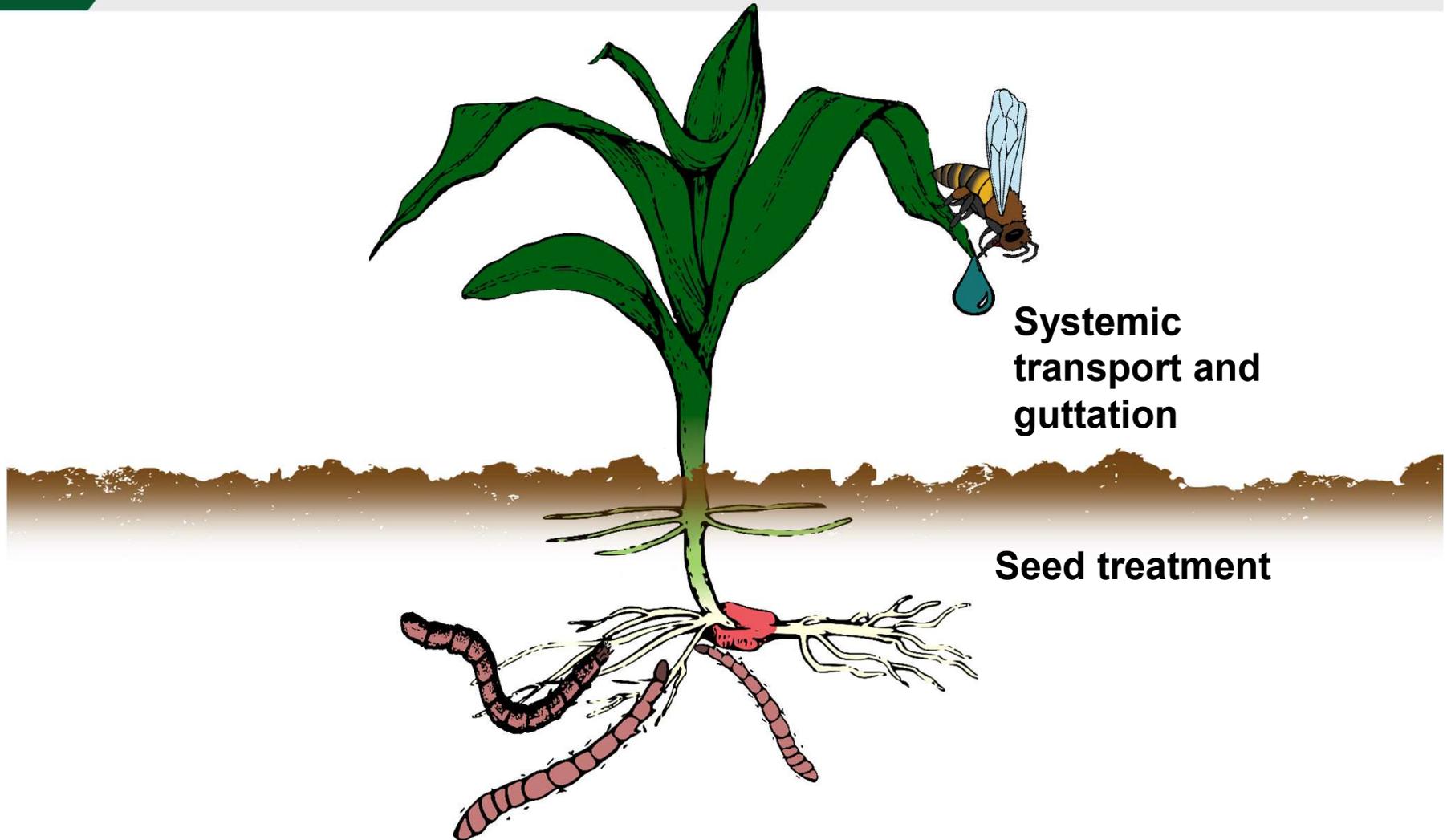
- **Induced resistance**, Similar to vaccine (but short term):

- ➔ If plants are confronted with an avirulent pathogen, defence mechanisms are triggered.
- ➔ The more diverse the pathogens the more defence mechanisms are triggered.

Finckh, M. R., & Wolfe, M. S. (2015). In M. R. Finckh et al (Eds.), *Plant Diseases And Their Management in Organic Agriculture* (pp. 153-174): APS Press.

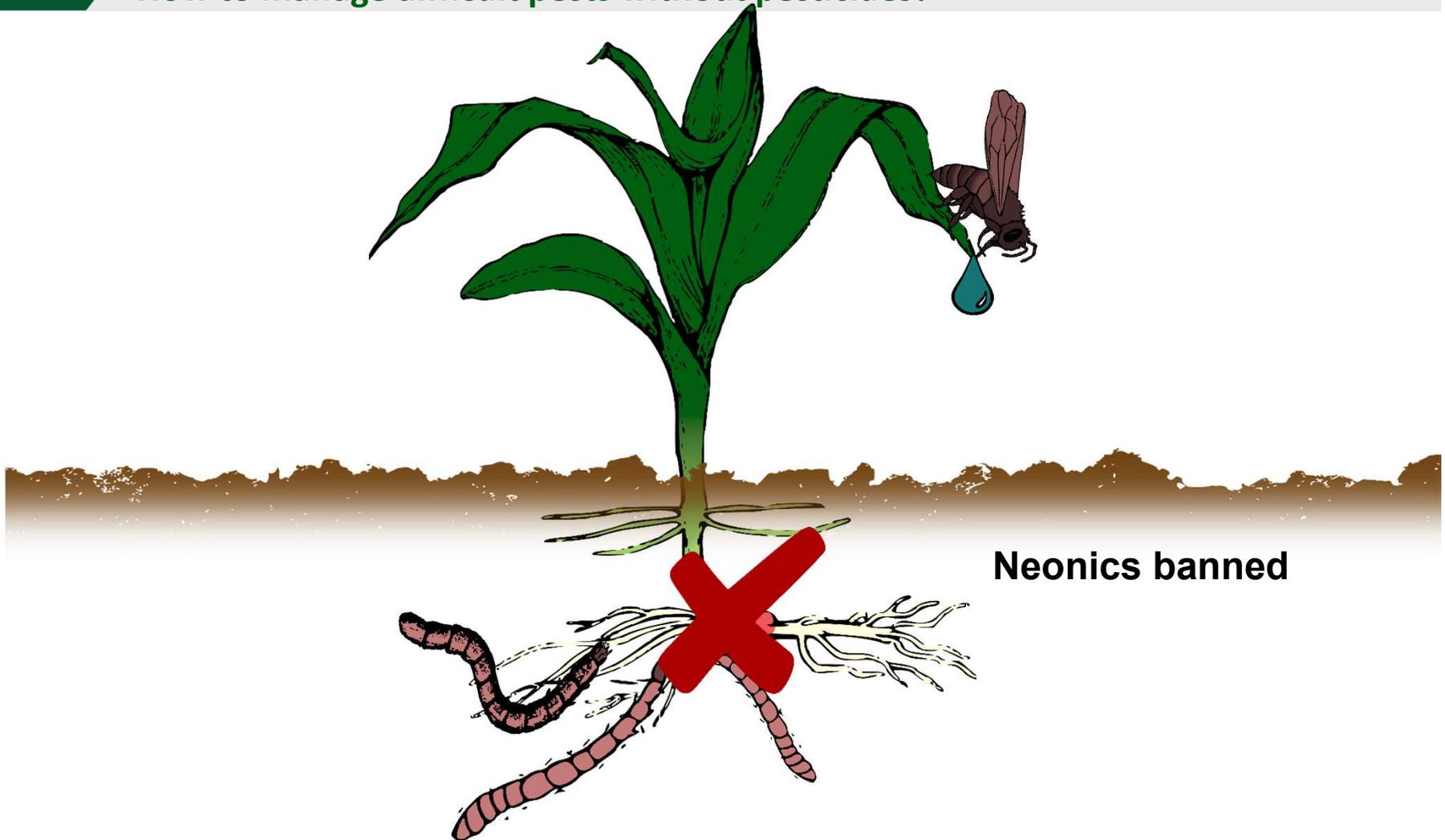


## How to manage difficult pests without pesticides?

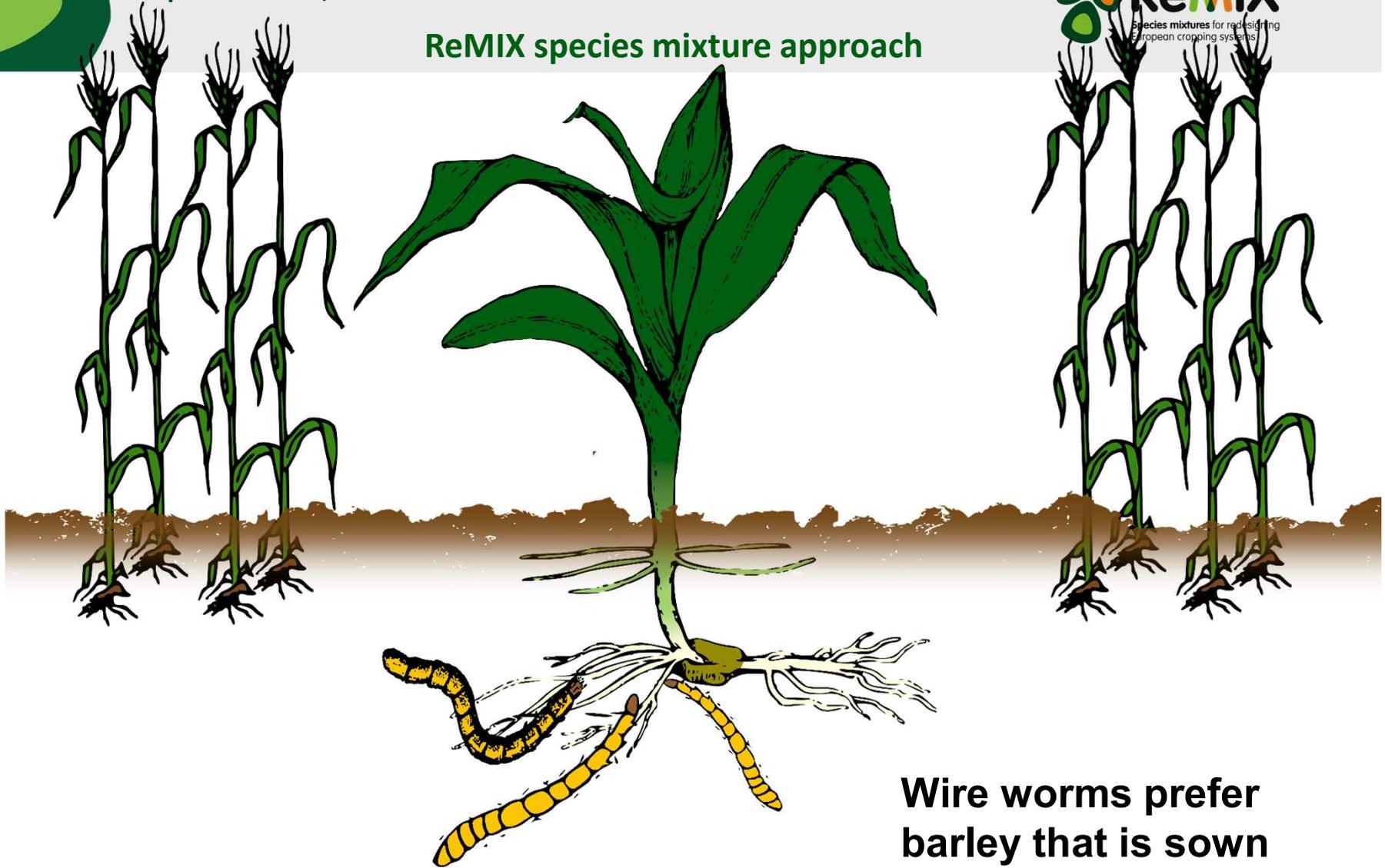




## How to manage difficult pests without pesticides?

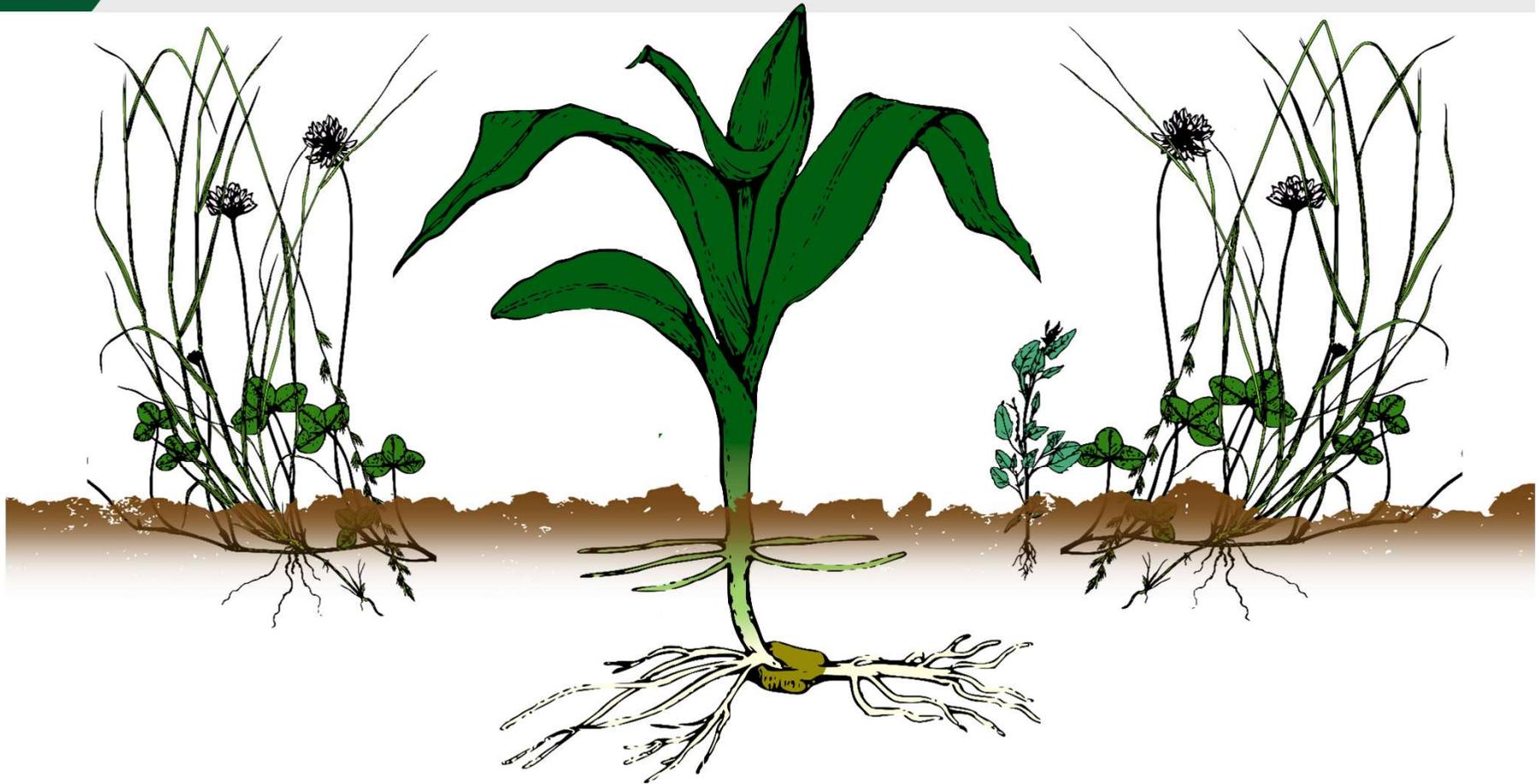


## ReMIX species mixture approach



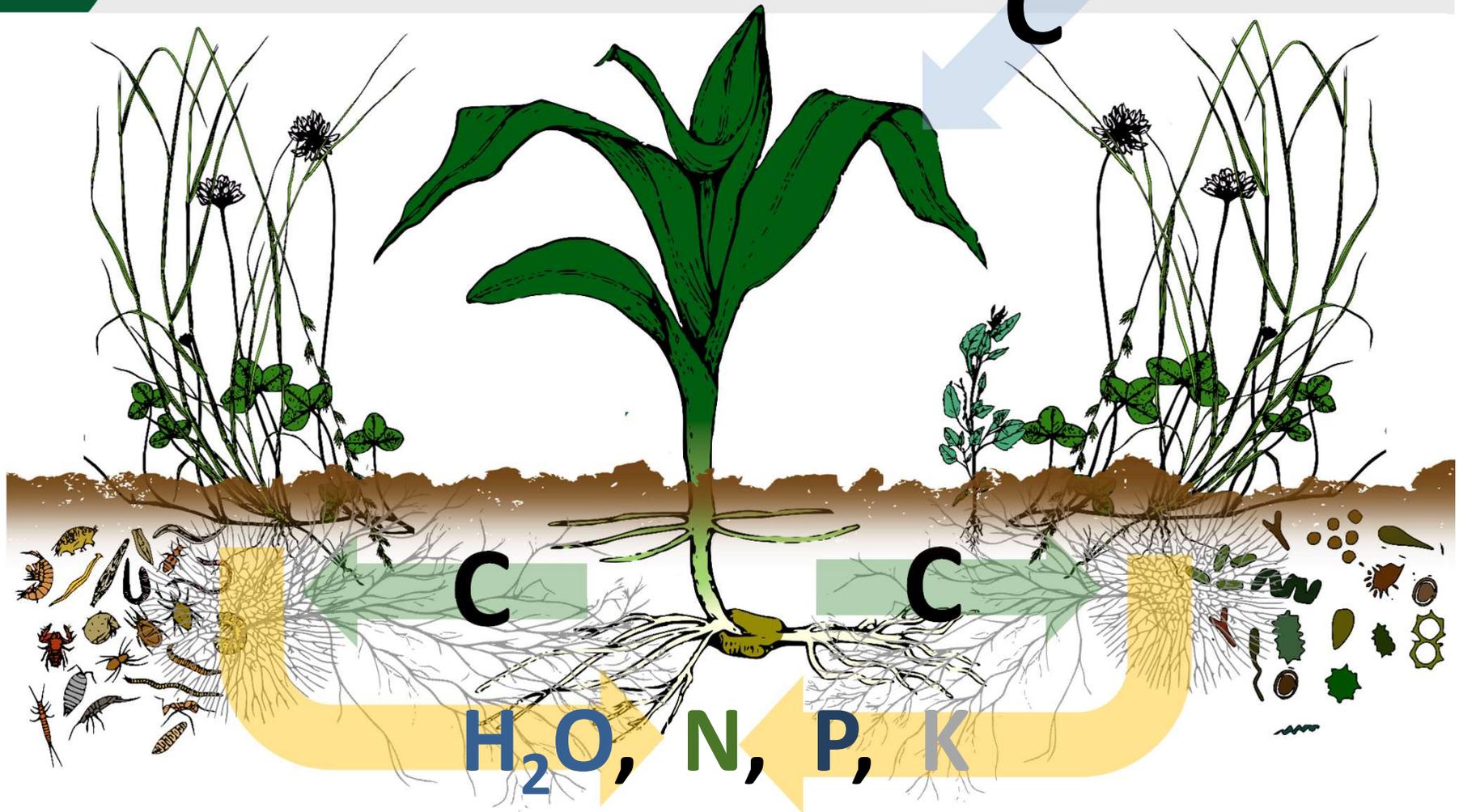
**Wire worms prefer  
barley that is sown  
less deeply**

## Multiple benefits from associated plants



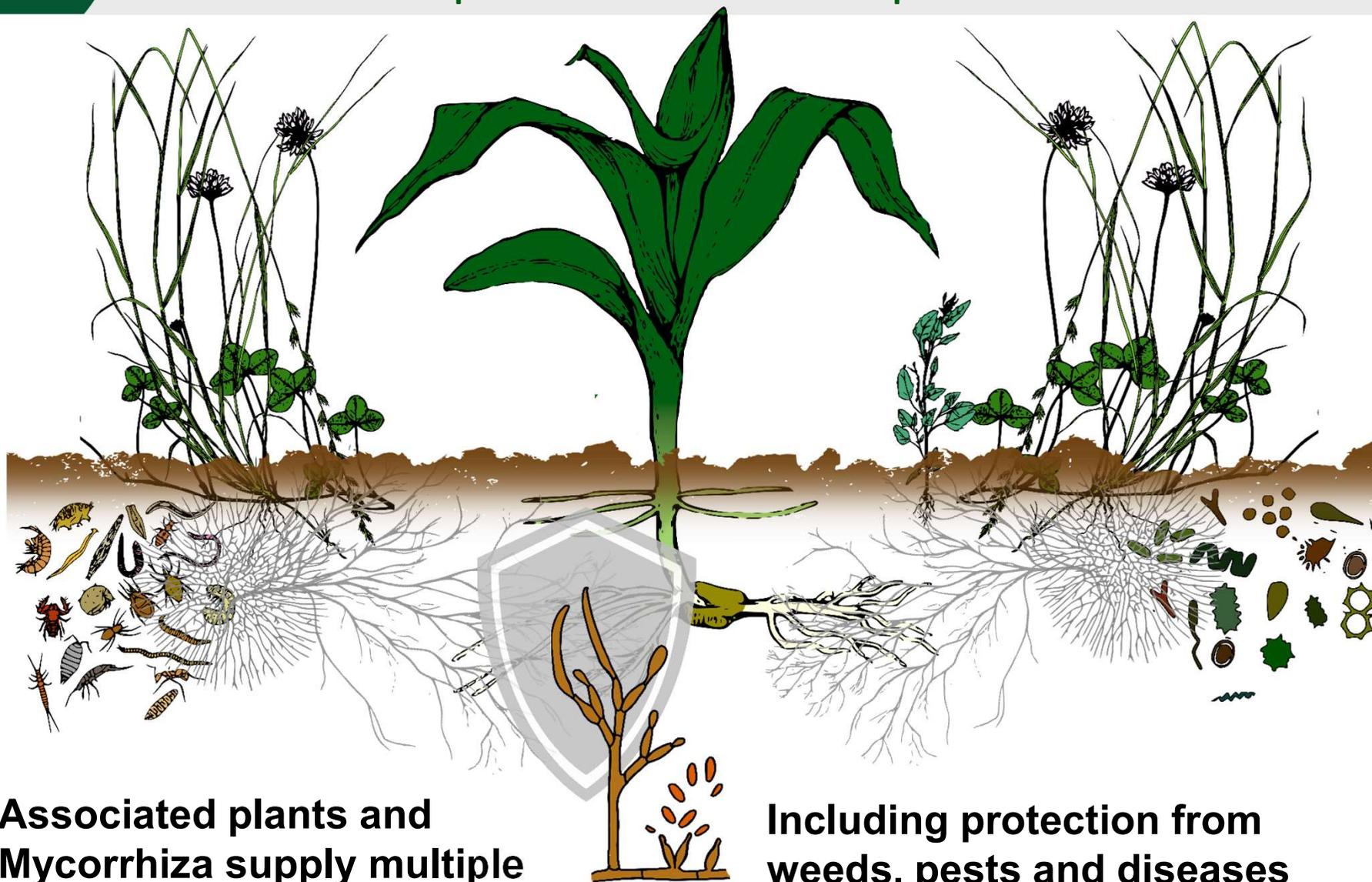
**Associated plants suppress weeds**

## Multiple benefits from associated plants



**Associated plants and Mycorrhiza supply multiple ecological services**

## Multiple benefits from associated plants



**Associated plants and Mycorrhiza supply multiple ecological services**

**Including protection from weeds, pests and diseases**

## Conclusions

- **Pesticide saving potential** through mixtures is **very high**
- **Mixtures deal with weeds and insects and diseases** simultaneously
  - ➔ **Less need for pesticides** through mixtures
  - ➔ **Enhanced pesticide reductions** as many pesticides are incompatible with different mixture partners.
  - ➔ **Beneficials** may be **enhanced** by more flowers in the crop stands





## Policy recommendations

### ➤ Focused advise for farmers

➔ Adjust Curricula for vocational trainings

➔ Continuous support for the **development of training materials**, e.g. serious games, on-line tools

### ➤ Support **breeding for mixed cropping**

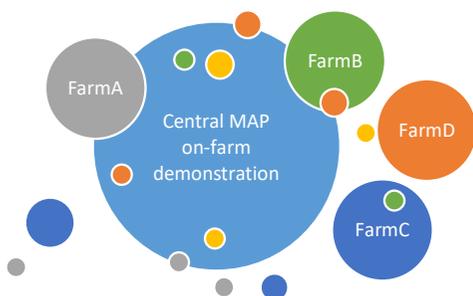
### ➤ Support **development of mixture logistics:**

➔ Harvesting methods

➔ **Separation of products** needs to be organized

➔ Support of **mixture products in human nutrition**

➔ Support **participatory approaches** with stakeholders



Thank you

ReMIX Team

Stephan Junge  
design





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