# *Beyond organic vs. conventional system dichotomy: importance of management practices in driving agroecosystem multifunctionality*

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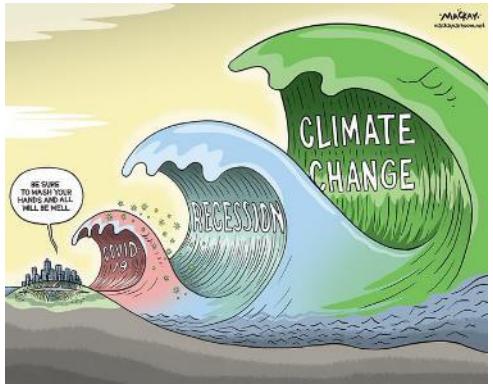
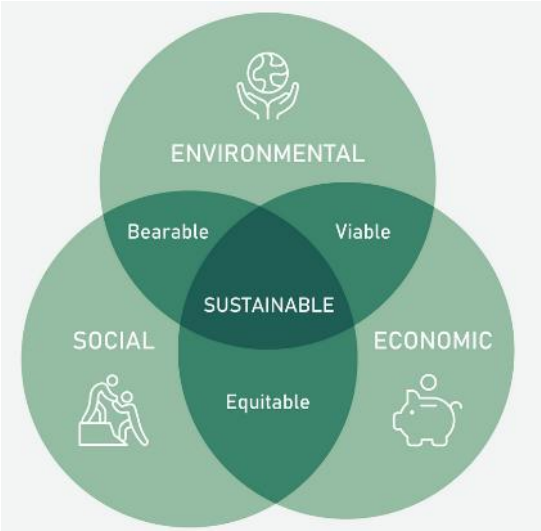
# Transition towards sustainable agriculture

Facing with **many challenges**, agriculture requires profound changes and the development of **innovative cropping systems** *(Doré 2011; Malézieux 2012; Gaba et al. 2015).*



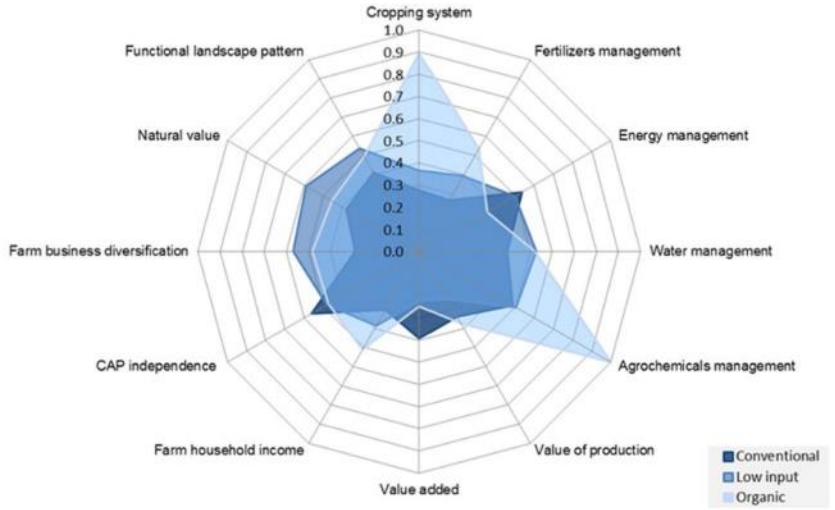




**Sustainable agriculture** implies :

- the production of sufficient **amounts of agricultural products** to feed the population
- without damaging the **environment**, preserving natural resources and biodiversity
- whilst maintaining the **income and quality of life** of farmers.

**Identifying the strengths and weaknesses of existing cropping systems**,
*i.e.* optimizing management practices and enhancing multiple functions,
is a key first step **before designing new, more sustainable cropping systems** *(Deytieux et al. 2016).*

# Assessing existing cropping systems



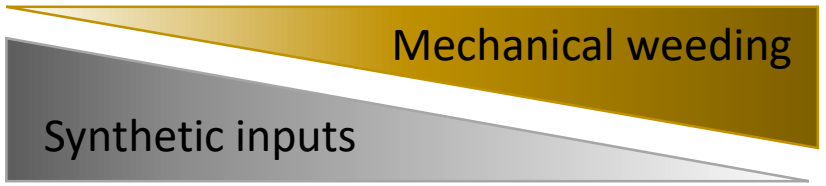

*Paracchini et al. (2015)*

The concept of **multifunctional agriculture (MFA)** can be a useful tool for cropping system assessment.

**Multifunctionality = simultaneous provision of multiple functions**, ensuring the delivery of diverse ecosystem services important for human well-being *(Stürck and Verburg, 2017)*

MFA studies typically compare conventional *vs.* organic farming *(Tuck et al. 2014; Ostandie et al. 2022; Couthouis et al. 2023)* and ignore **gradients of management practices**.

Conventional systems




Organic systems

# Our reseach question

How **annual cropping systems** affect **multifunctionality** and, **trade-offs and synergies** among agronomic, ecological, social and economic functions?

Can management practices, whether combined or on their be mobilized to foster synergies between crop production and other functions ?

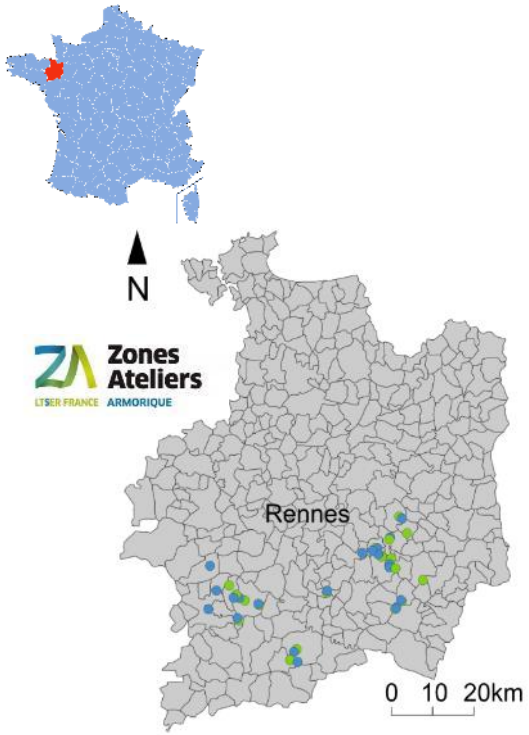
**3 levels** of
**management practices** description

**Farming system**
organic *vs.* conventional

**Cropping system**
*i.e.* combination of management practices

**Individual management practices**

# Study design




40 winter wheat fields:
20 conventional + 20 organic

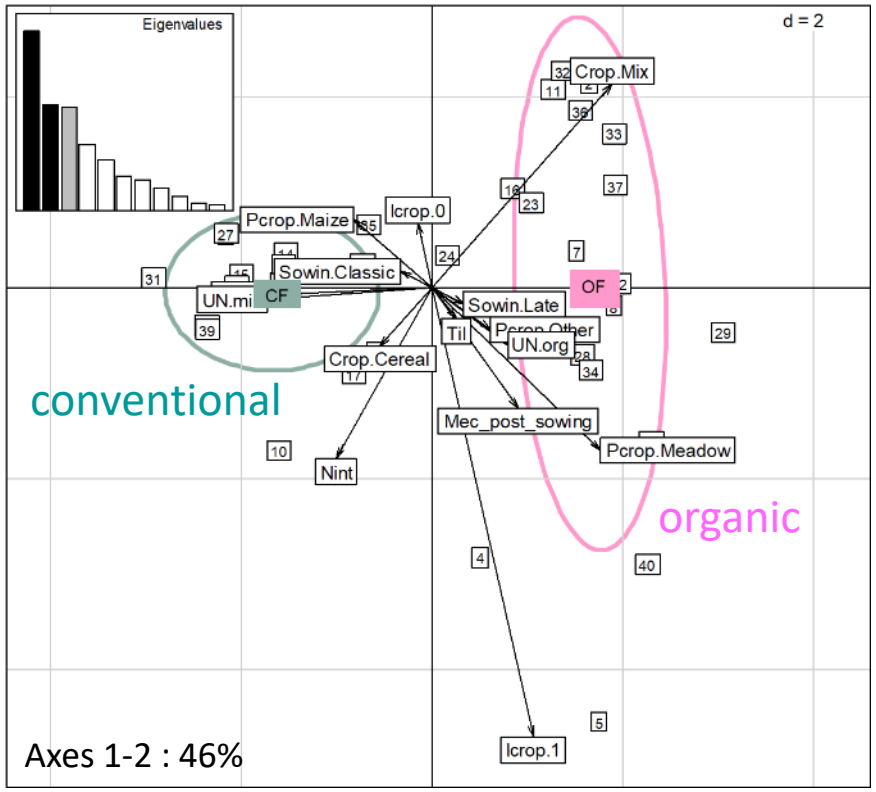
Field measurements

| Performances N = 4 | Functions N = 7 | Proxies N = 14 |
|---|---|---|
| Ecological | Biodiversity conservation | Sp. richness of plants, carabids and pollinating insects |
| | Pest predation | Abund. of carabids, spiders,staphylinids, aphidophagous syrphid, ladybird larvae |
| | Pest infestation | Abund. of aphids and weeds |
| | Pollination capacity | Abund. of pollinating insects |
| Agronomic | Food & feed production | Yield |
| Social | Labor time | Working hours |
| Economic | Income contribution | Semi-net margin |

Farmers' interviews

*Couthouis et al. (2023)*

# Cropping system characterization




Variables included in PCA : Sowing date, preceding crop, intermediary crop, organic fertilization,mineral fertilization, ploughing, mechanical operations post-sowing, pesticide use (Treatment Frequency Index), number of field interventions

Hierarchical Classification (CAH)

Organic farming

Group 1: low inputs, few field interventions

Group 2: late sowing, meadow as preceding crop, rather low inputs

Group 3: high organic input, many mechanical operations

Group 4: maize as preceding crop, systemic ploughing, moderate inputs, moderate TFI

Group 5: high mineral inputs, high TFI

Conventional farming

# Statistical analyses

| Performances N = 4 | Functions N = 7 | Proxies N = 14 |
|---|---|---|
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**Calculation of functions and multifunctionality index :**

Standardization (0-1) of each proxy by the min & max values, across all fields.

Averaging proxies values to obtain a value for each function (N =7).

Averaging function values to obtain a multifunctionality index.

**3 types of Generalized Linear Mixed effect Models (GLMMs)**

3 levels of management practices description

Mulifunctionality index
OR
Function values

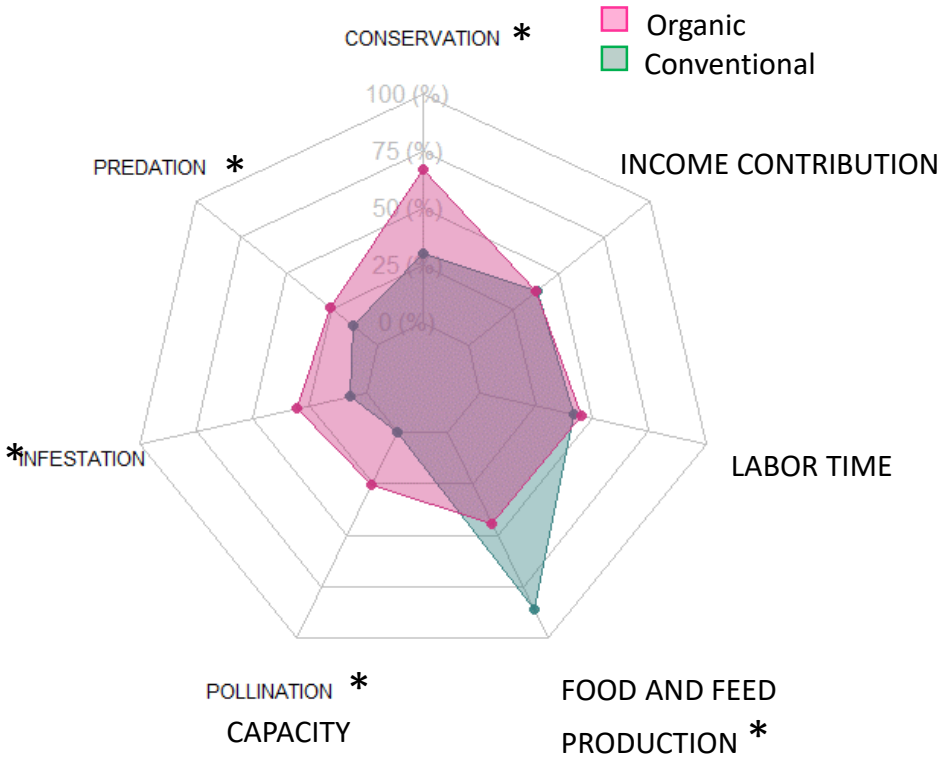
~ Farming system

Cropping system

Individual management practices

+ 1| Landscape

# Comparing organic vs. conventional




* indicates significant difference between OF and CF

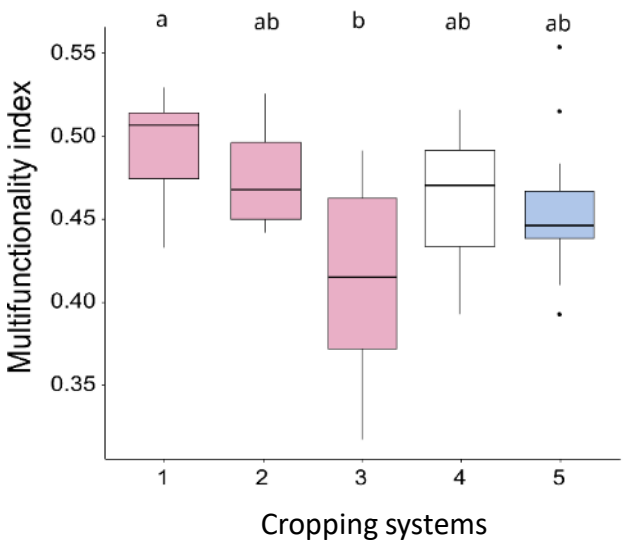
**No** significant **difference in multifunctionality** index
in line with Herzog et al. (2019) in annual and Ostandie et al. (2022) in perennial crops

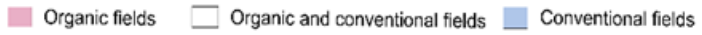
**Trade-off between biodiversity conservation and crop production**
in line with Wittwer et al. (2021) and Gong et al. (2022)

Higher values for biodiversity-based functions in organic systems

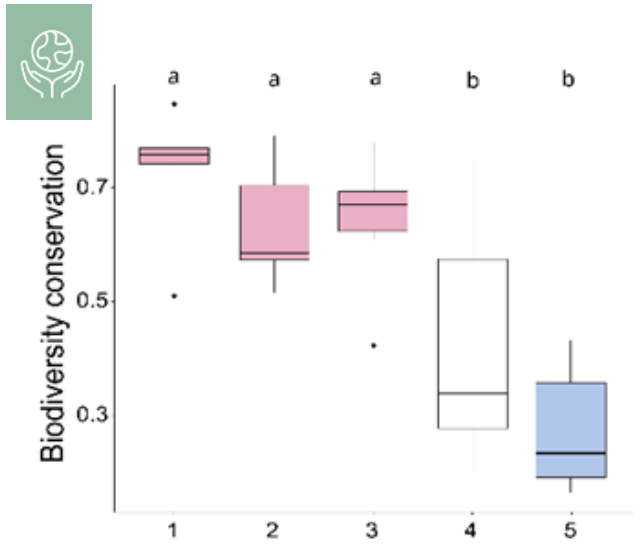
**Similar social and economic** performances
in line with Sutherland et al. (2012) and Seufert and Ramankutty (2017)

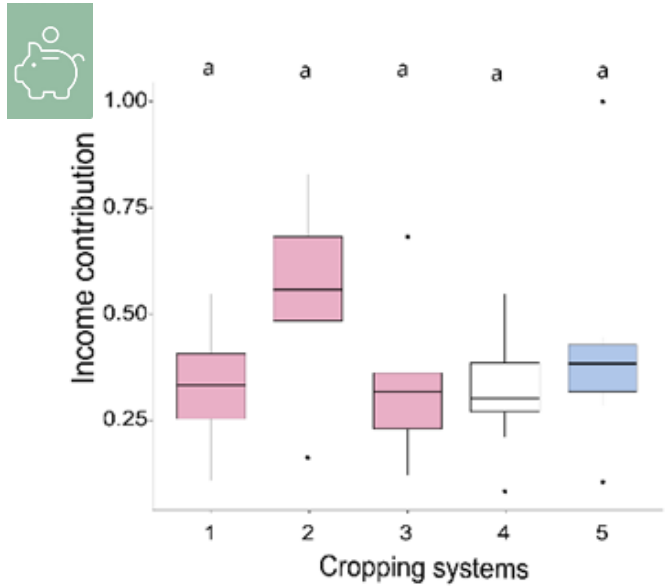
# Comparing cropping systems

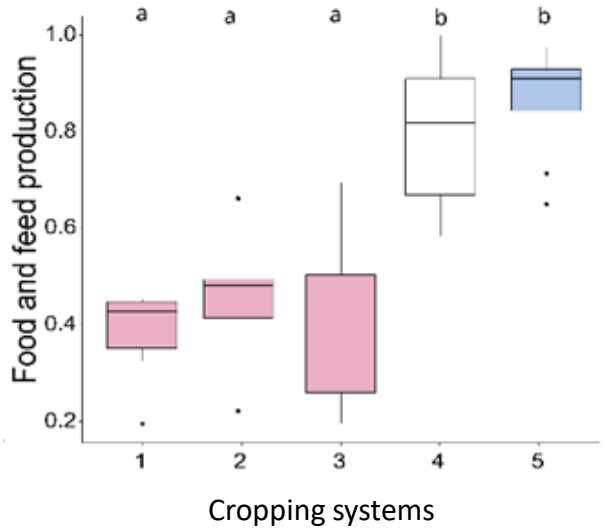


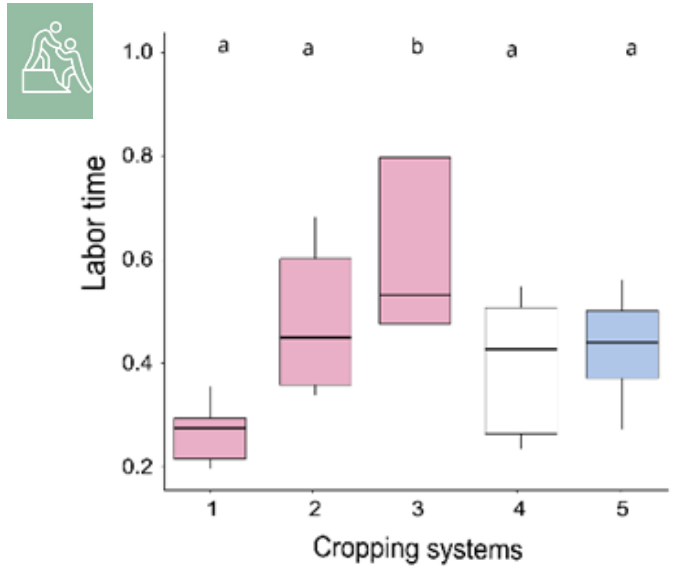




Rather similar multifunctionality
Group 1 with the highest value
Group 3 with the lowest value



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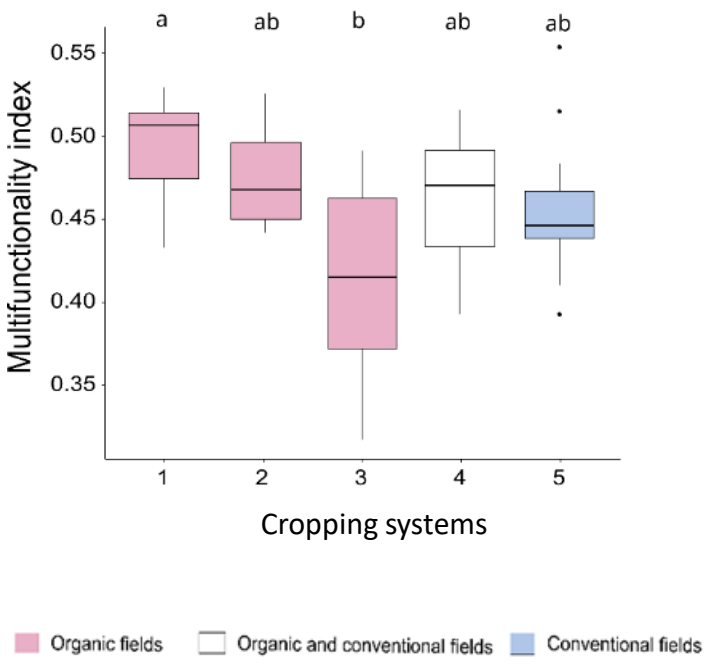
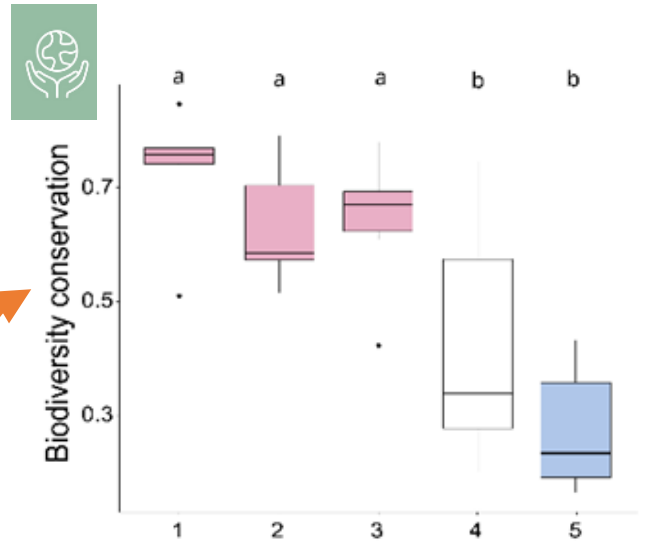
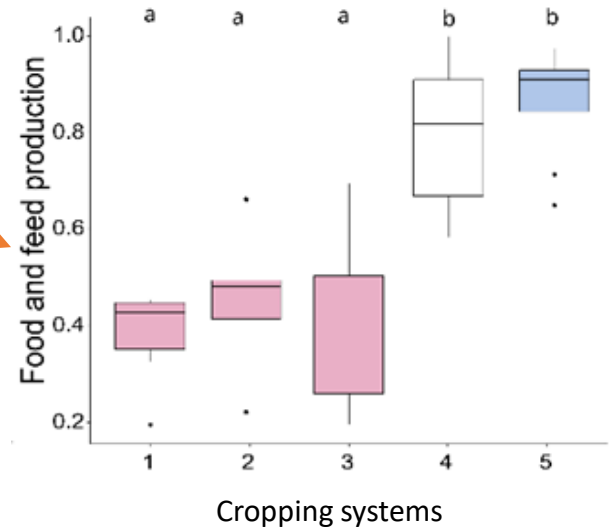


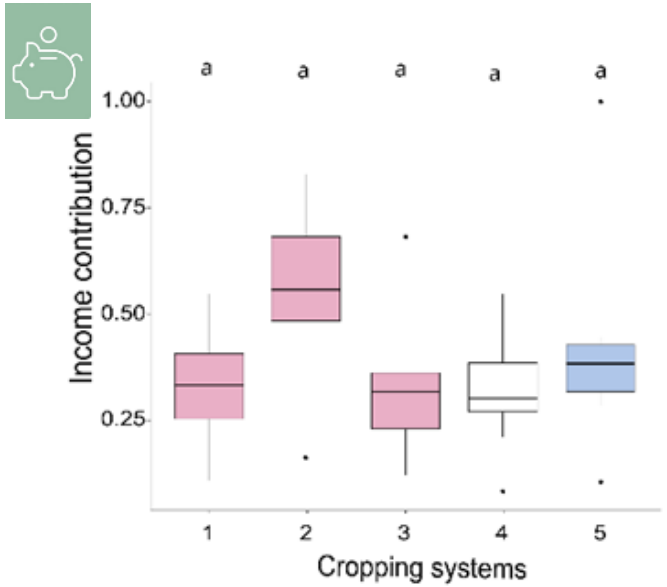

Rather similar multifunctionality values

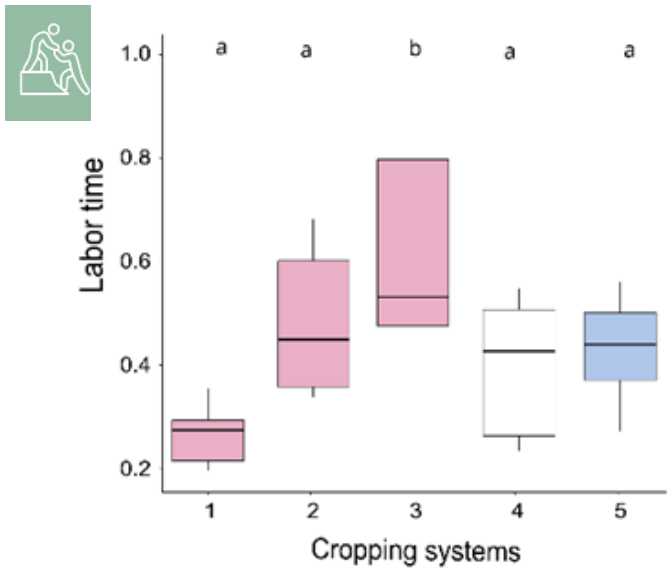
Trade-off between biodiversity conservation and crop production

Antagonisms



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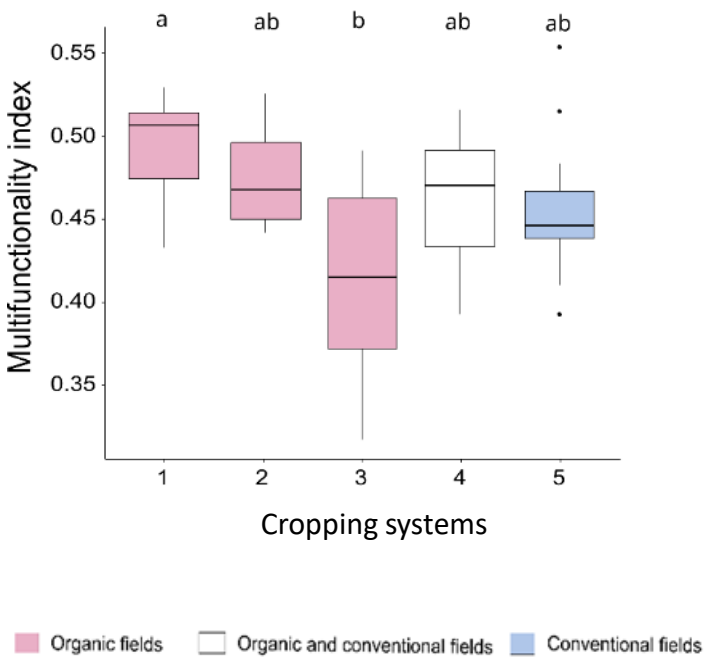
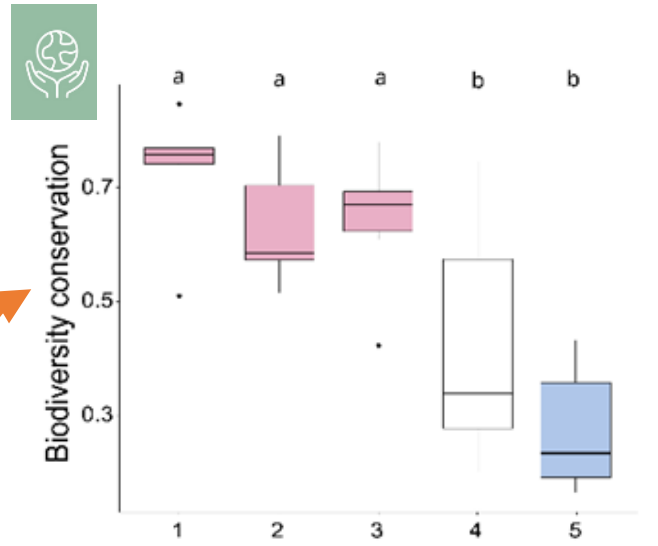


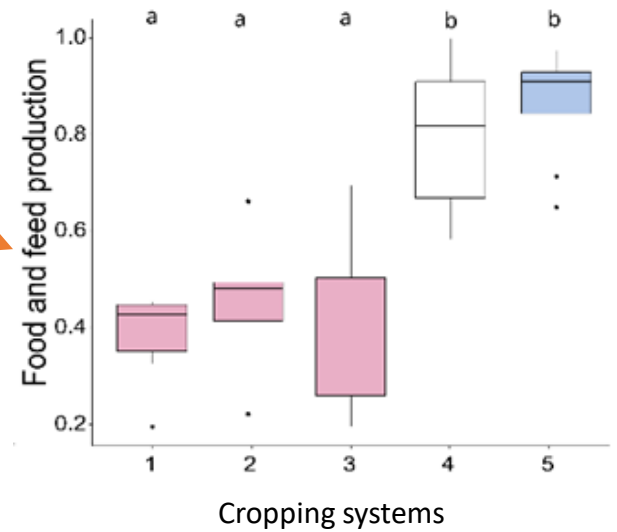

Rather similar multifunctionality values

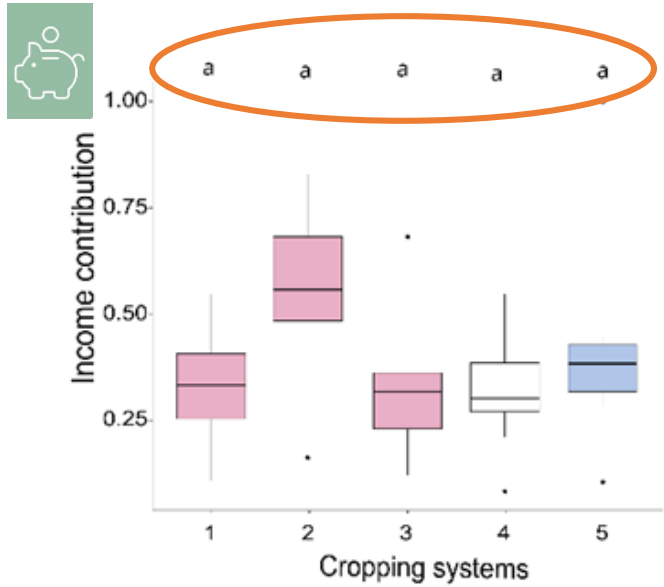
Trade-off between biodiversity conservation and crop production

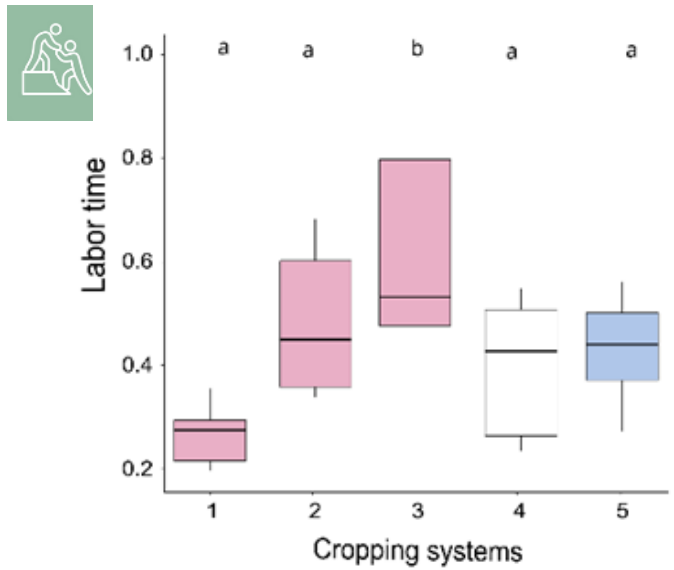
Similar income contribution

Antagonisms



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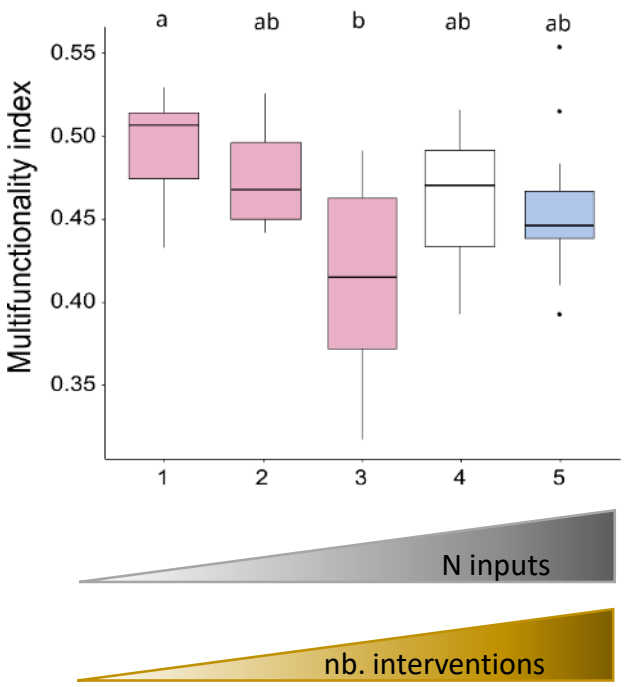
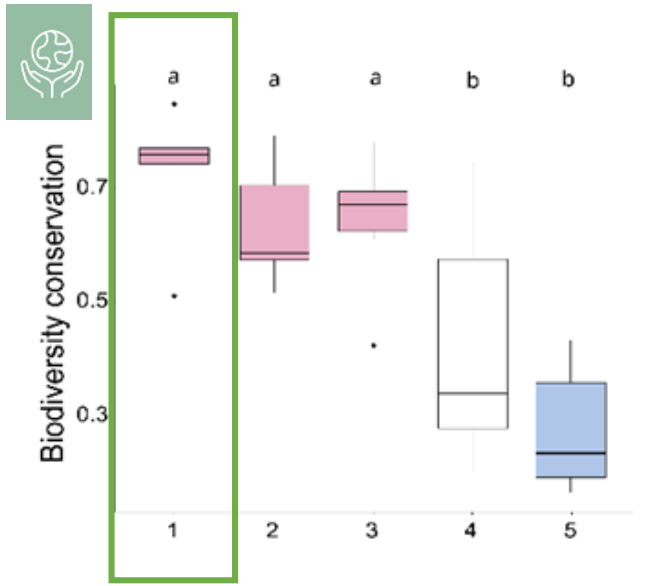
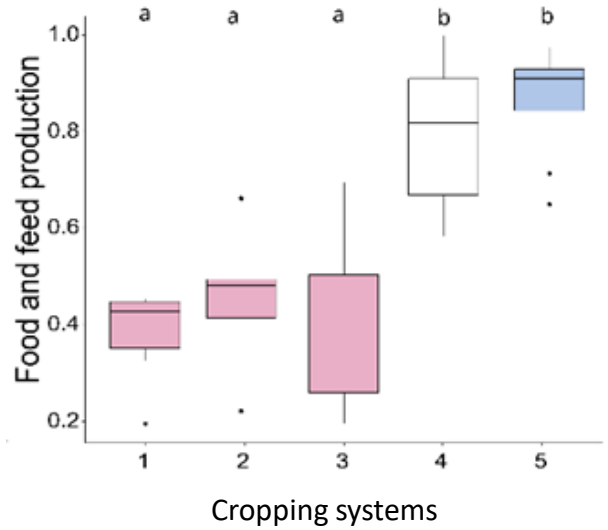
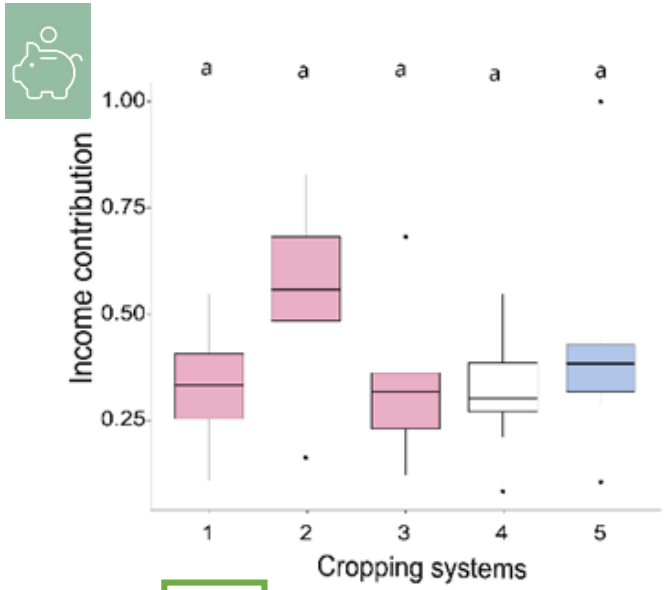
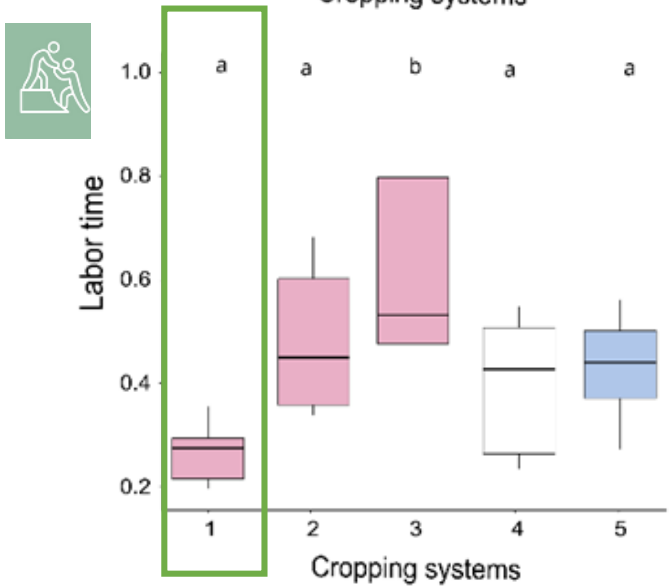



Group 1: « biodiversity-friendly »



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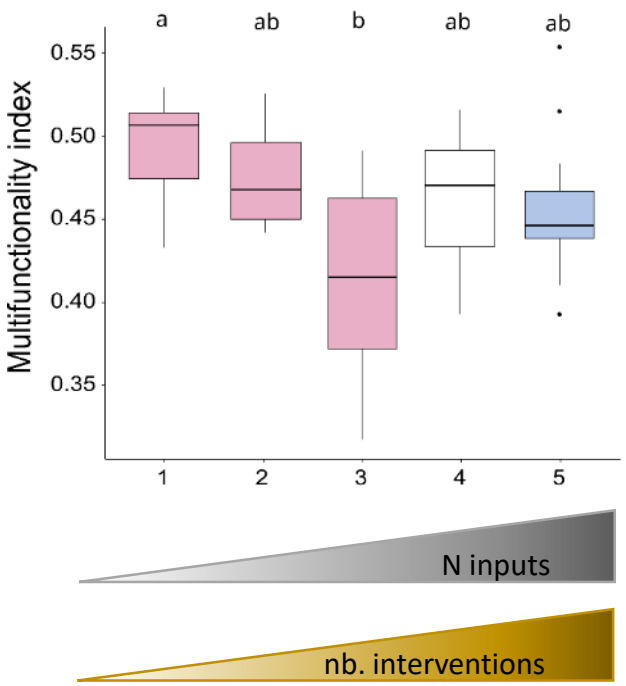
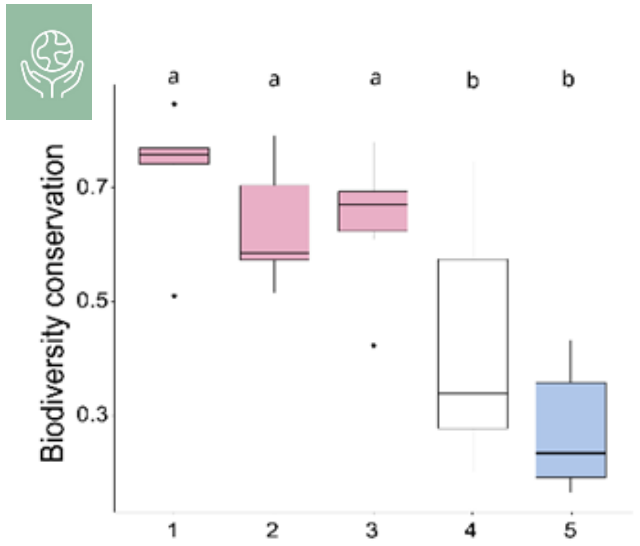
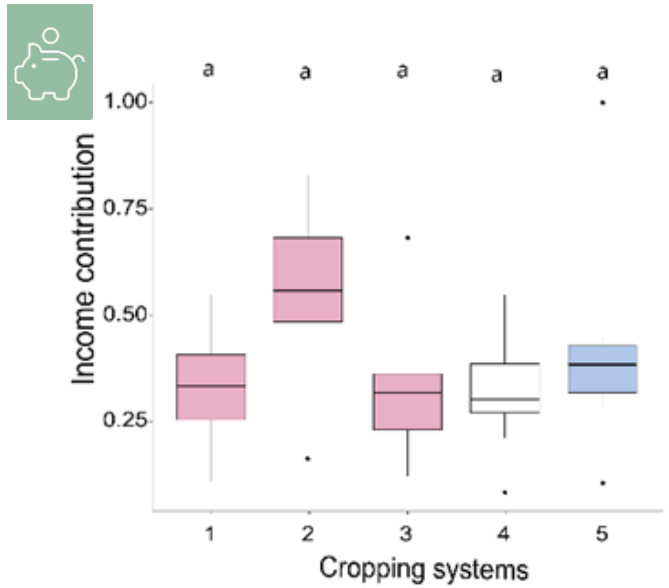
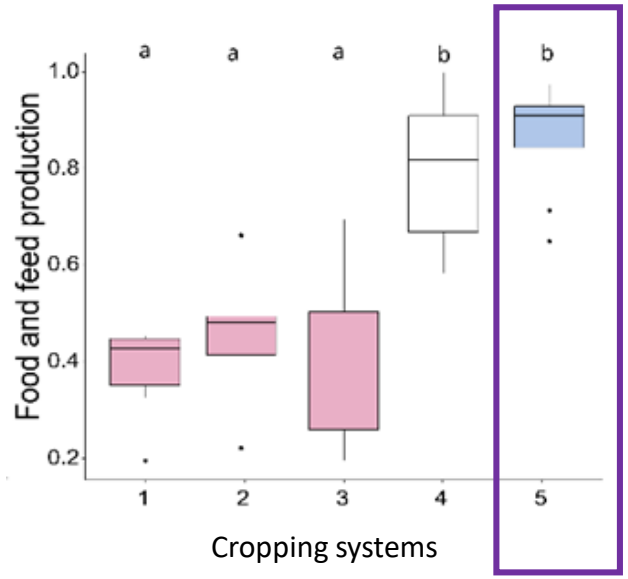
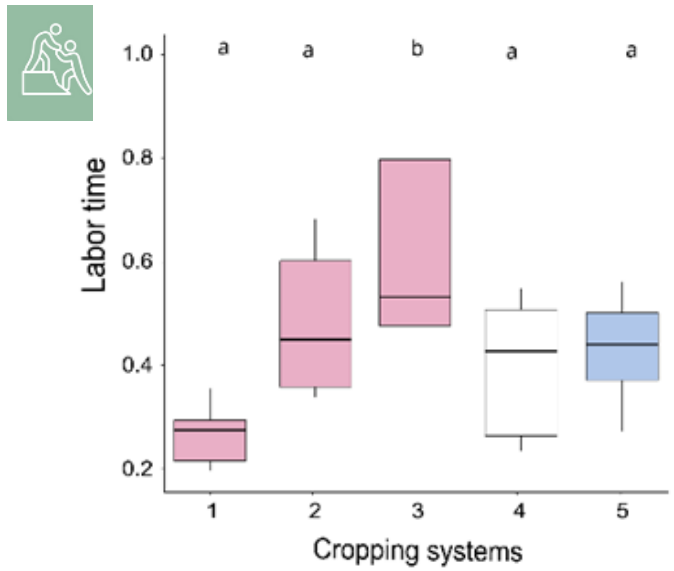


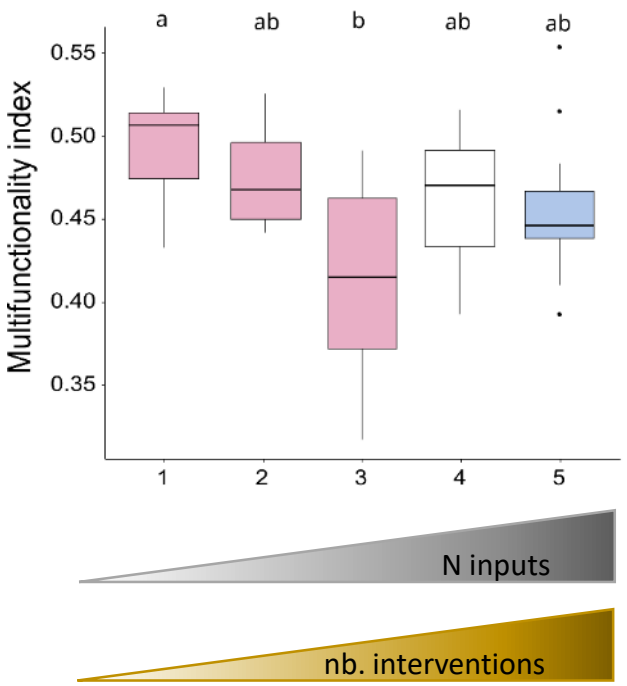



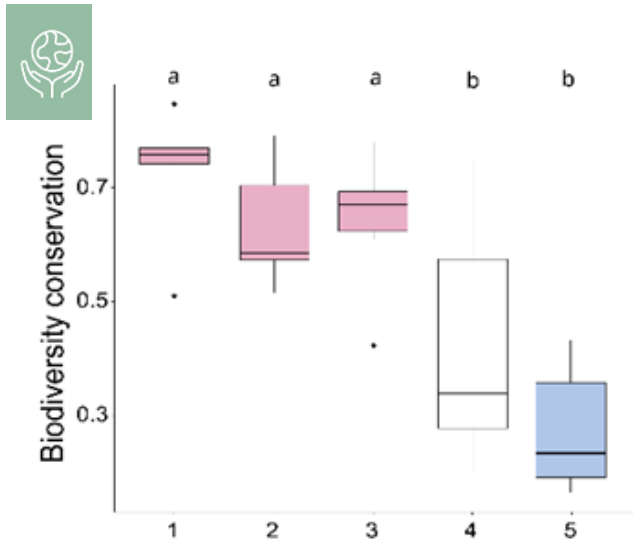



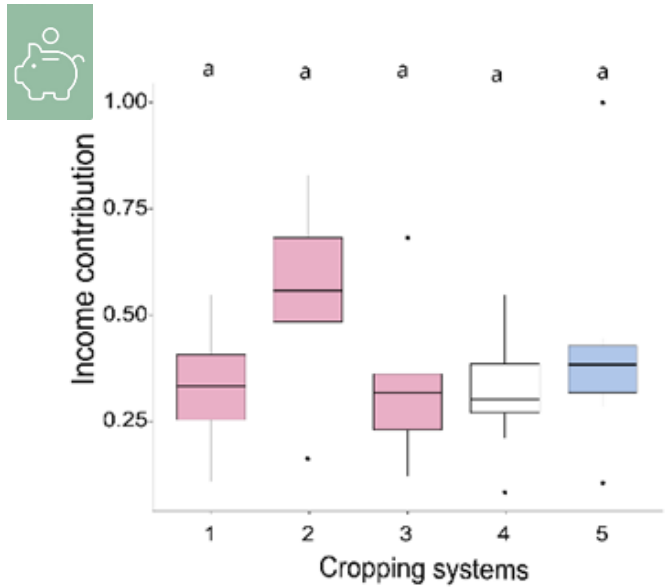

Group 1: « biodiversity-friendly »

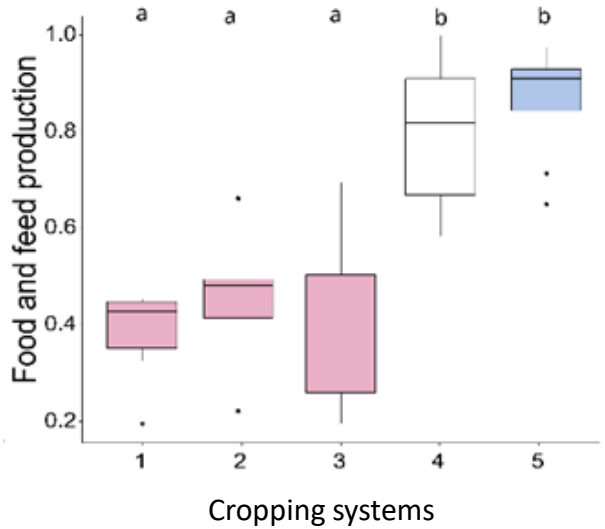
Group 5: « productivist »

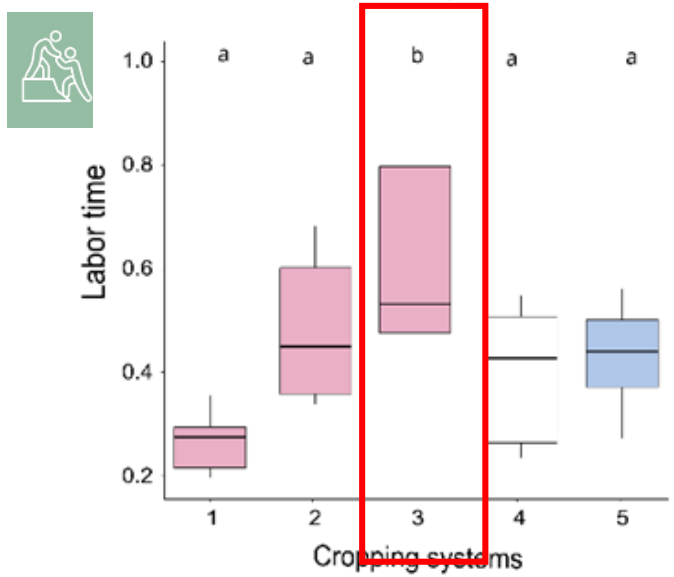
# Comparing cropping systems




Group 1: « biodiversity-friendly »
Group 5: « productivist »
Group 3: « labor intensive »

**Various strategies** for similar income

# Take-home messages

- Similar multifunctionality values can be achieved through different management paths.
- No cropping system reconciles crop production with biodiversity conservation suggesting current policies and incentives must be strenghtened
- Need to clarify farmers' strategic reasoning behind cropping system choices, which goes beyond cost–benefit considerations *i.e.* personal, social, technical, external factors

This calls for substantial **increases in knowledge and experience sharing** among scientists and farmers **about management practices**, combined or on their own, and their efficient use to enhance multiple performances underlying **sustainable agriculture**.



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