Planning the allocation of production intensity for reconciling livestock production and biodiversity

a model-based scenario approach

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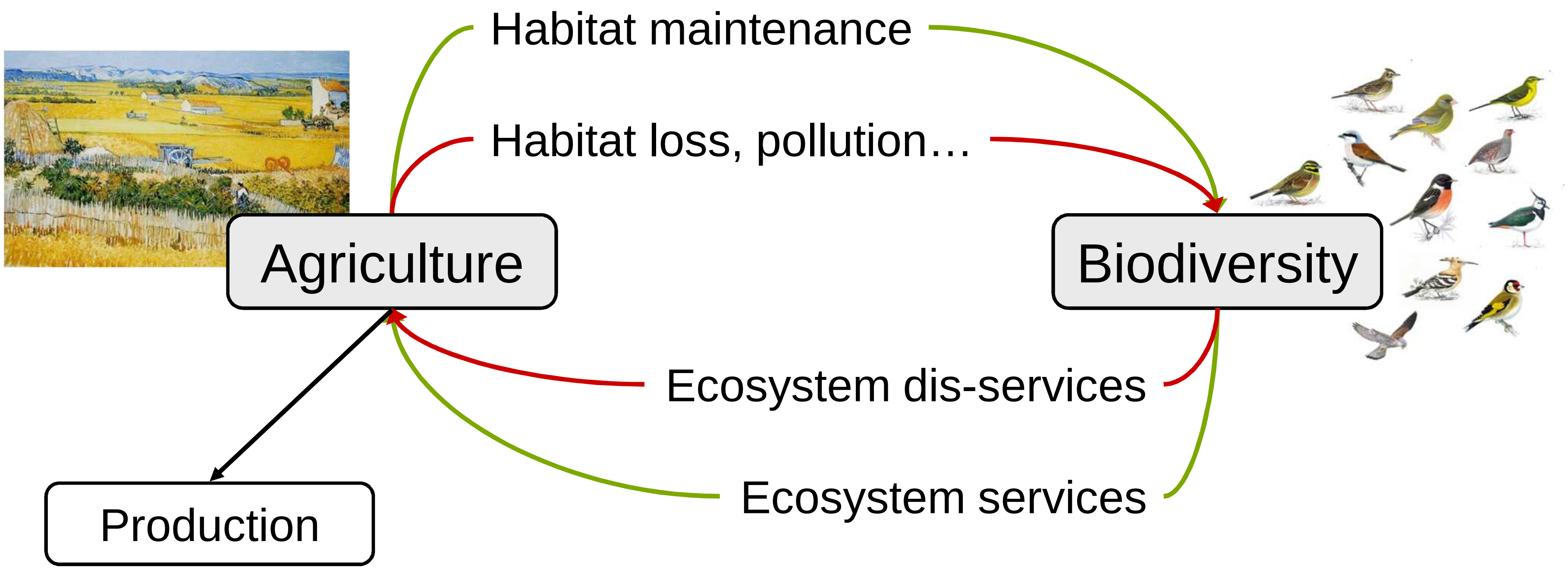
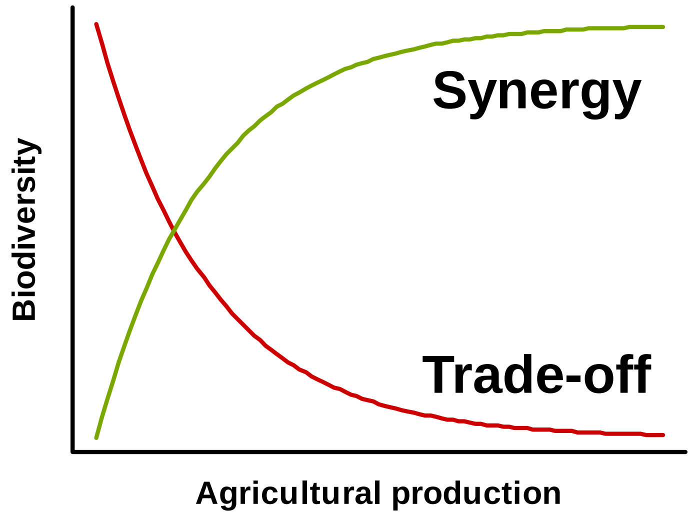
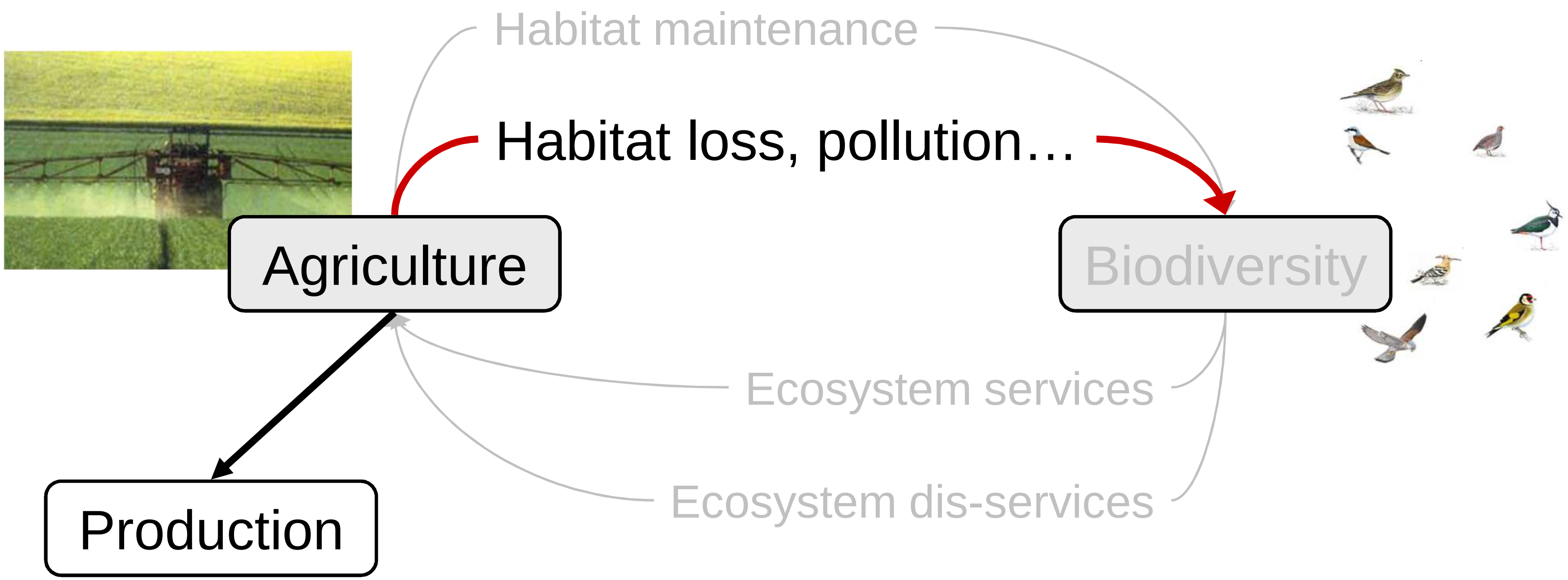
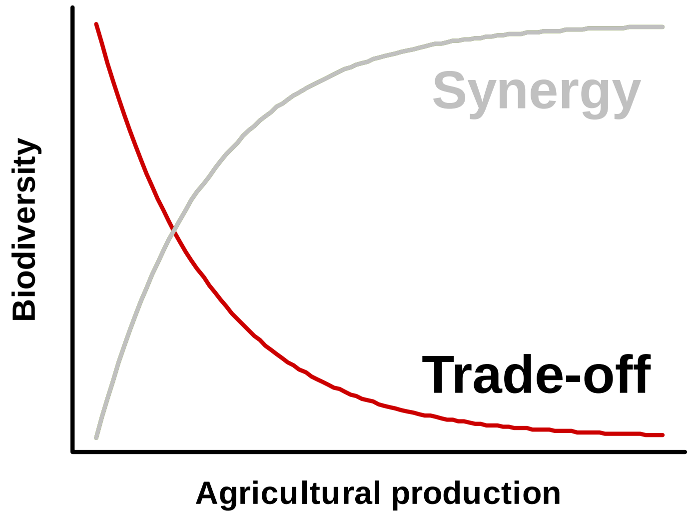
Introduction – Agriculture and biodiversity





Introduction – Agriculture and biodiversity



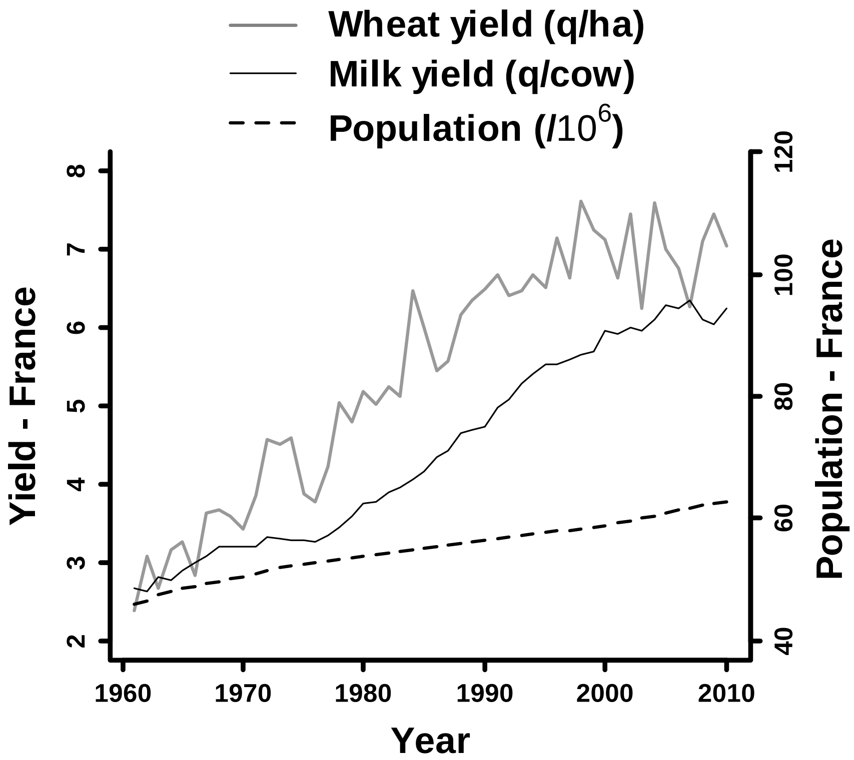


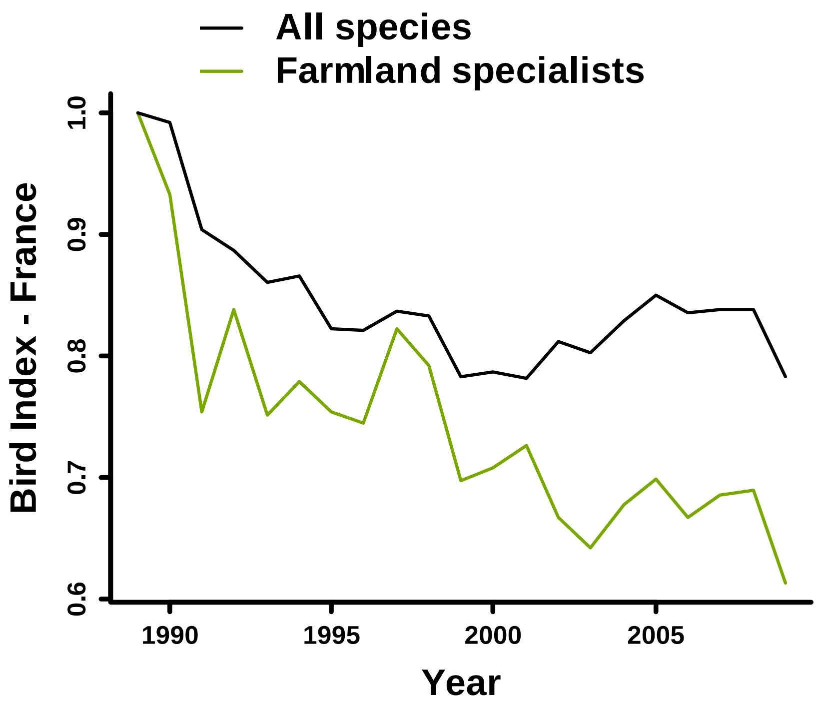
Introduction – Consequences of intensification

Past agricultural intensification

(Input use, landscape simplification…)

has driven the production/biodiversity trade-off





Data: FAO, INSEE

Data: STOC

Introduction – Policies and intensity allocation

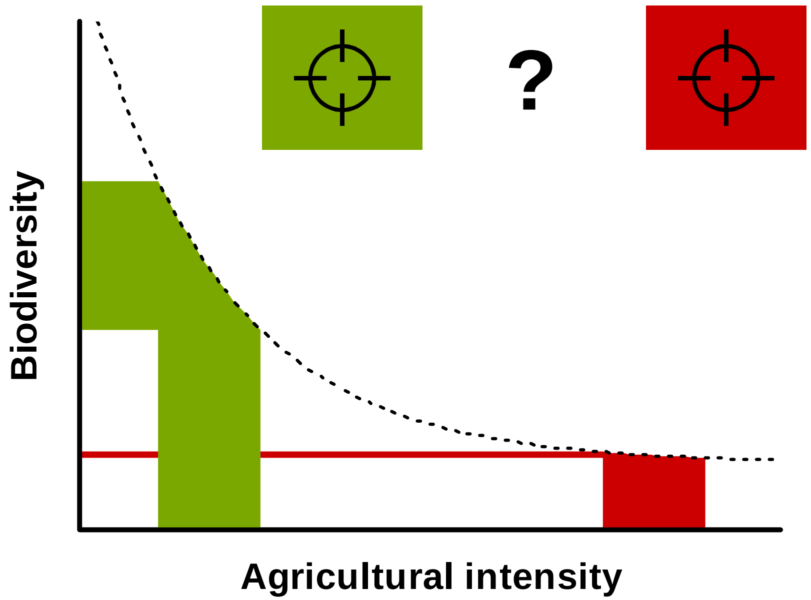
Current agricultural intensity:

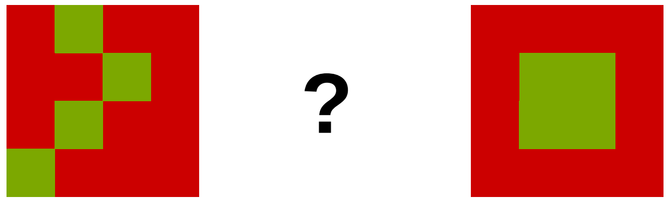
how to adjust its allocation to favor production and biodiv.?

- Current policies: random uptake, debated efficiency

- Targeting could be an efficiency lever

→ what targeting?





Kleijn 2003

Questions

Objective

Develop a model to evaluate the production and biodiversity perf. of several intensity allocations and scenarios

- What is the trade-off between production and biodiversity among allocations and scenarios?
- What optimal intensity allocation can overcome this trade-off?
- What role for the intensity of livestock production?

Questions

Outline

Introduction

Methods

Results

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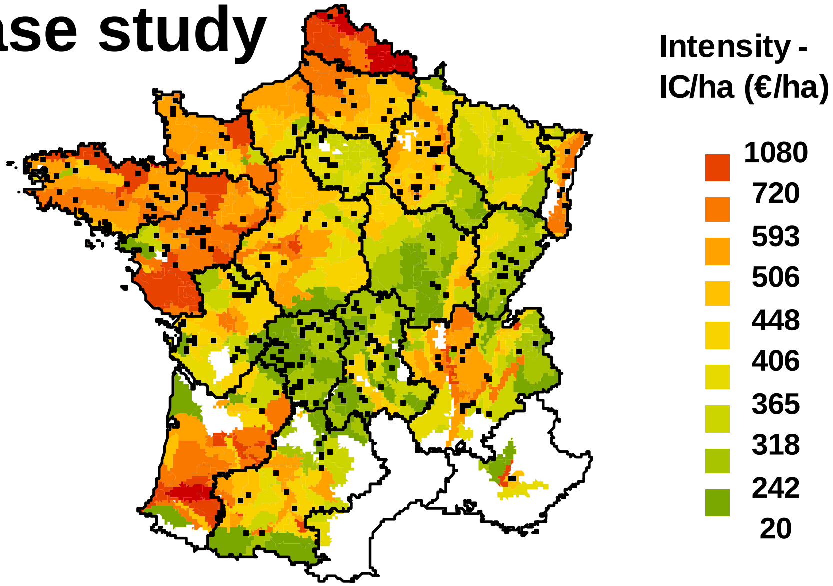
Methods – Case study

Case study

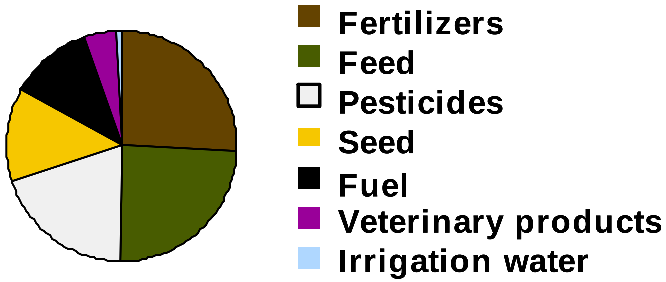


2006 Data. Teillard 2012 (AEE 149, 135–143)

- France scale
- Small Agricultural Regions resolution (“SARs”, mean width = 22.4 km)
- Production types: cereal/industrial crops, beef/dairy cattle, mixed crop-cattle

Decision variable

- Intensity: Input Cost/ha (“**IC/ha**”, in €/ha)

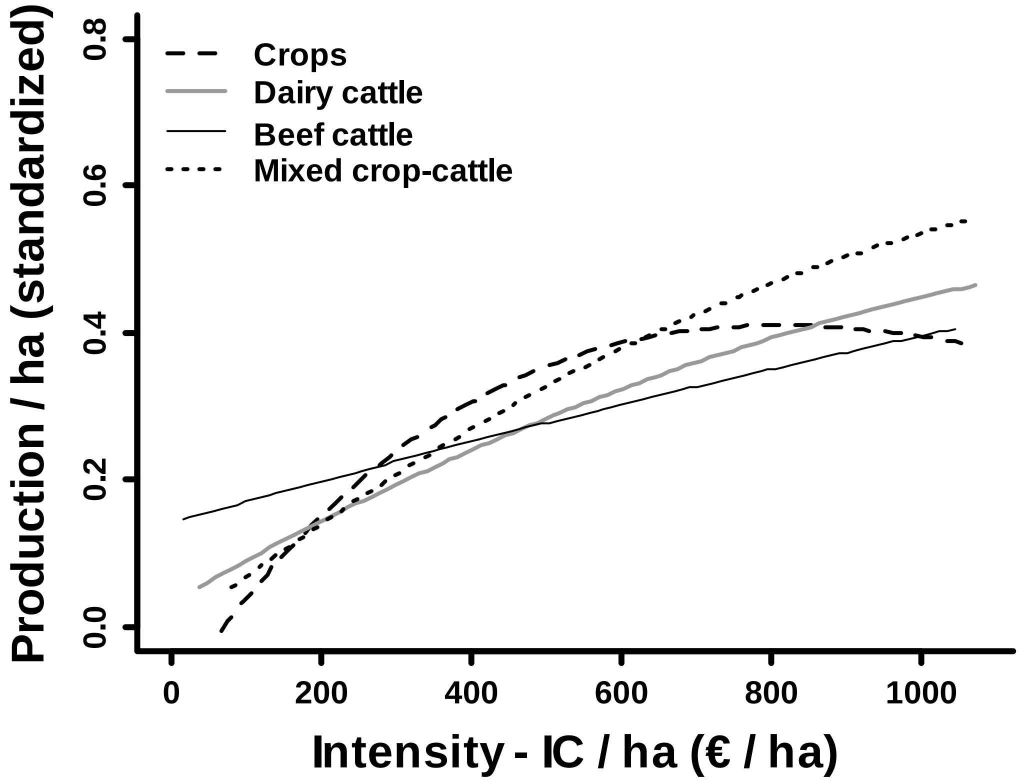


Performance criteria

- Production: volume of product/ha
- Biodiversity: community of common farmland birds (22 species)

Methods – Calibrations

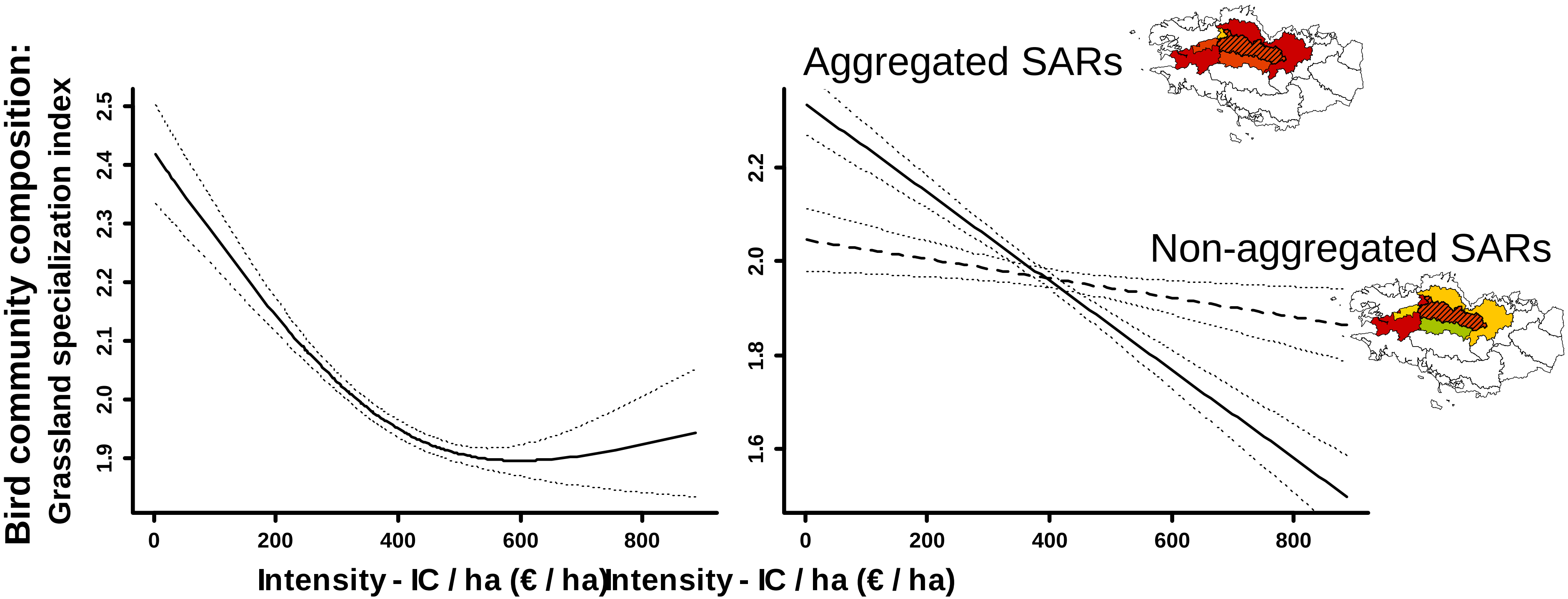
Strong relationship between intensity (IC/ha) and production



	n	F	P-value	% Deviance
Crops	1805	137.64	<0.001***	19
Bovine dairy	948	509.76	<0.001***	52
Bovine meat	570	39.28	<0.001***	12
Mixed crop-cattle	547	163.93	<0.001***	37

Methods – Calibrations

Effect of intensity on the composition of the bird community…
…strengthened by the spatial aggregation of intensity



	n	F	*P-value*	% Deviance
Intensity	330	59.49	<0.001***	18
Aggregation (intercept)	193/137	-5.39	<0.001***	6
Aggregation (slope)	193/137	5.99	<0.001***	7

Methods – Conceptual model

Optimizing the intensity allocation, 3 steps

3 intensity evolution scenarios
Intensification, Extensification, Reallocation

Random intensity allocations
N=1000

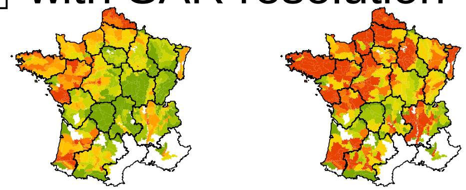
↓

2 criteria, f(intensity)
Production, Biodiversity

↓

Optimal intensity allocations

Generate
□ with SAR resolution



Assess
□ at national scale
- mean production volume
- bird community diversity

Select

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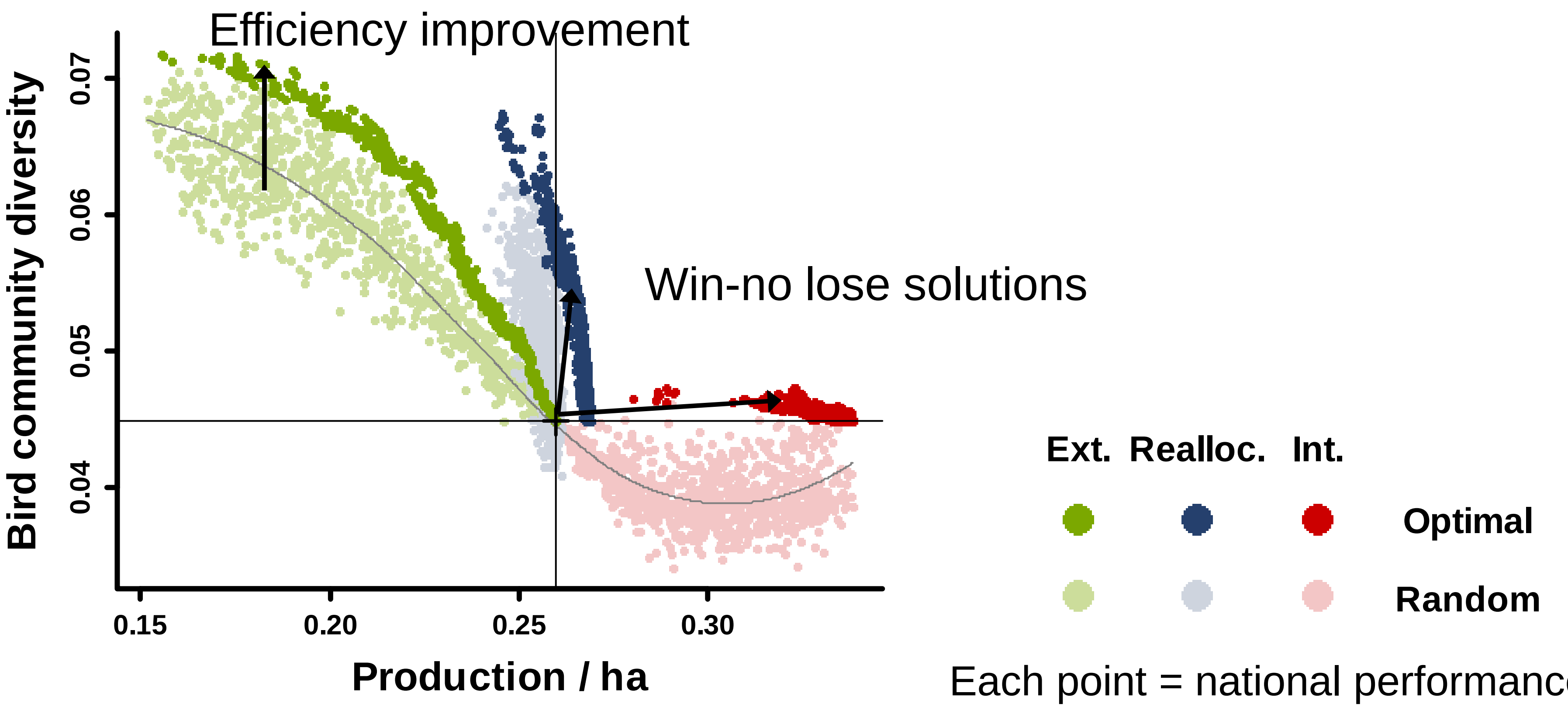
Results – Trade-off among allocations

Optimal allocations improve the trade-off, and reveal win-no lose solutions



Each point = national performances of one simulated allocation

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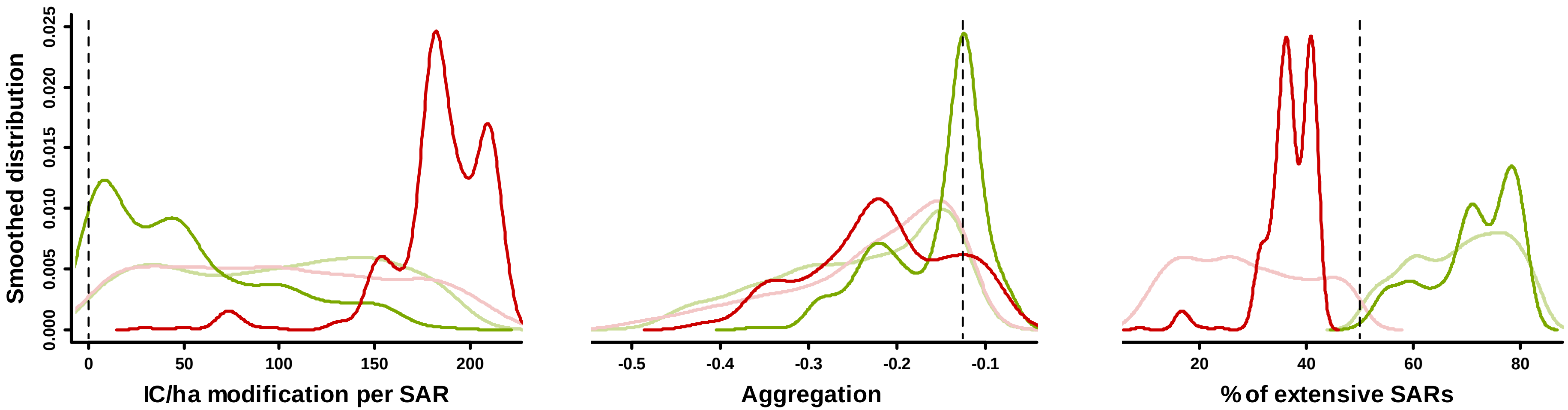
Results – The optimal allocations

What are the properties of the optimal allocations?

→ Optimal allocations corresponds to targeted intensity changes



- Small changes in many SARs
- Large changes in fewer SARs

- Promote intensity aggregation
- Promote intensity heterogeneity

- Spare many extensive SARs
- Spare many extensive SARs

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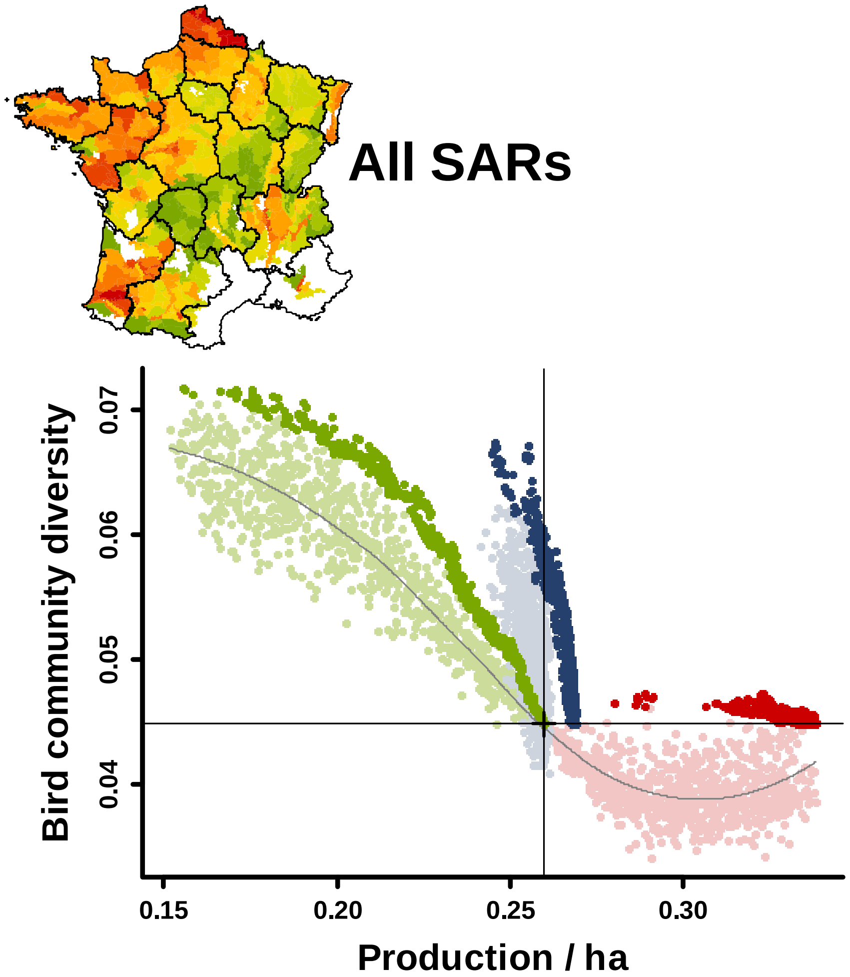
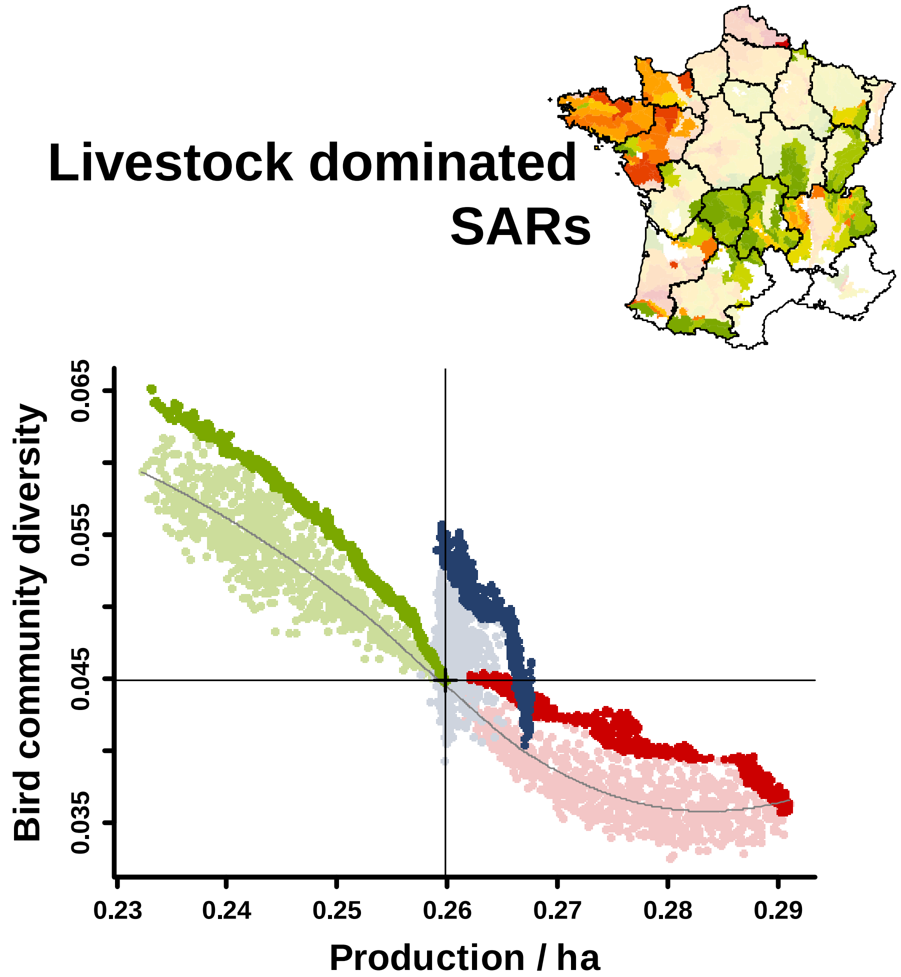
Results – The role of livestock farming

Intensity modification of livestock dominated SARs

→ Less efficient intensification and reallocation

→ Still efficient extensification





Results – The role of livestock farming

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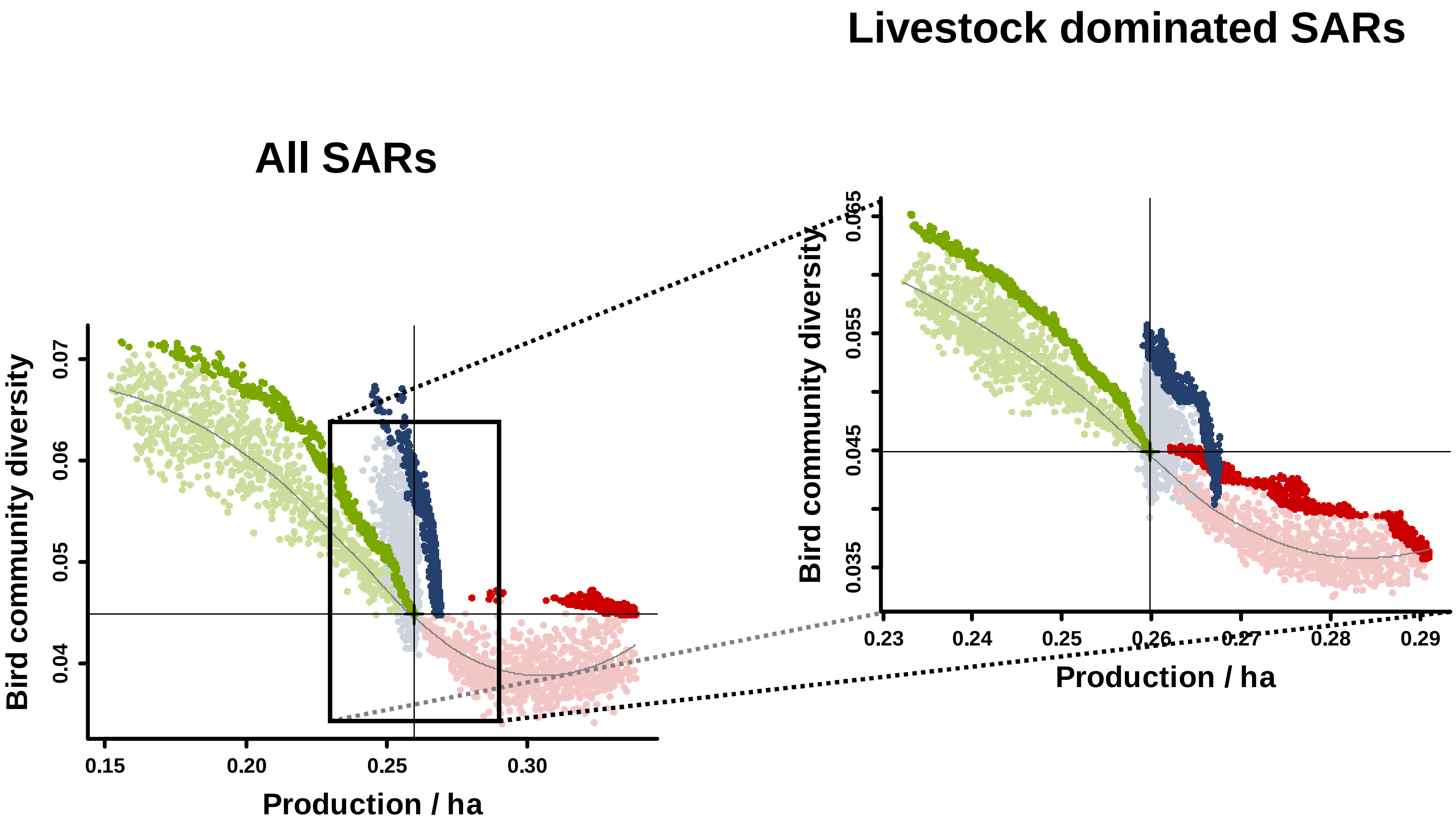
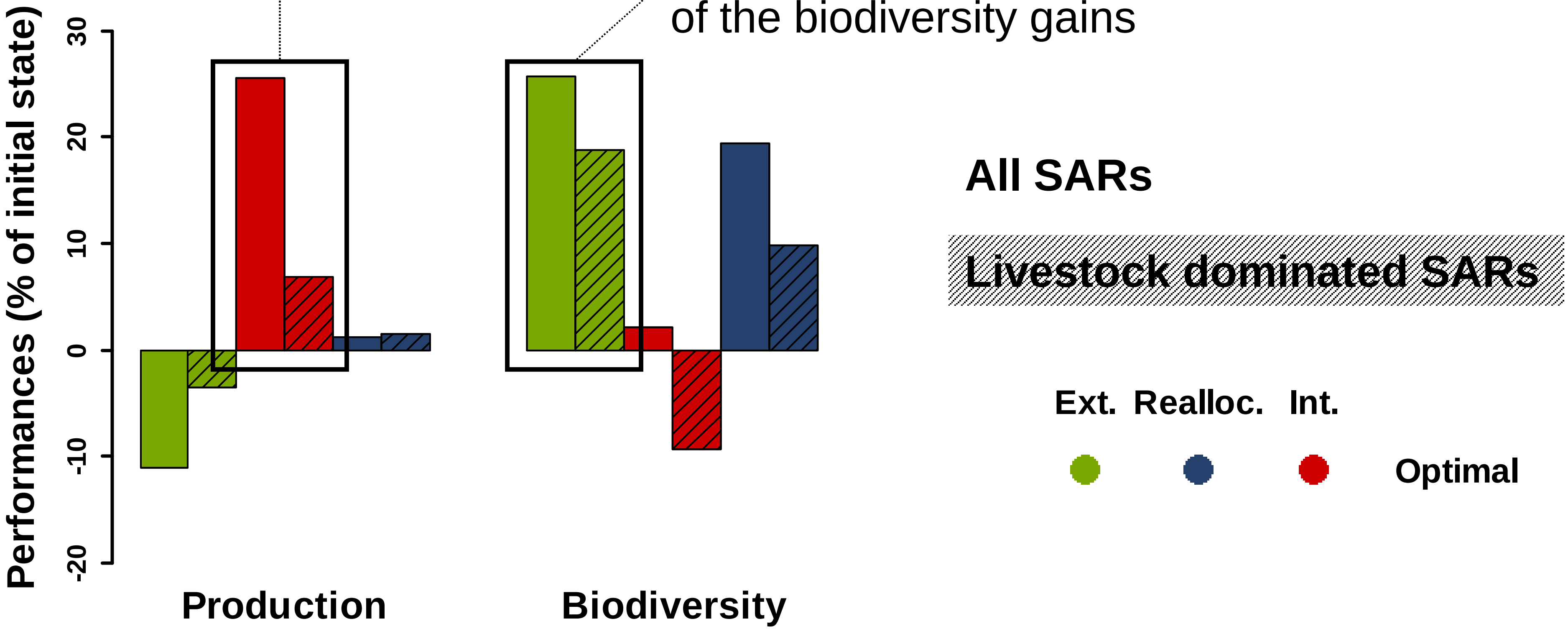


Results – The role of livestock farming

Intensity modification of livestock dominated SARs

- Low increase in production: livestock dominated SARs represent less area

- Livestock dominated SARs fulfill a large part of the biodiversity gains



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Discussion – Implications

- Policy implications

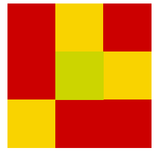
→ Targeted intensity changes are more efficient

→ Livestock production is essential to biodiversity objectives

→ Opposite targeting is necessary for:

$$\begin{cases} \max \mathit{Biodiv} \\ \min \mathit{Production} \text{ loss} \end{cases}$$

$$\begin{cases} \max \mathit{Production} \\ \min \mathit{Biodiversity} \text{ harm} \end{cases}$$

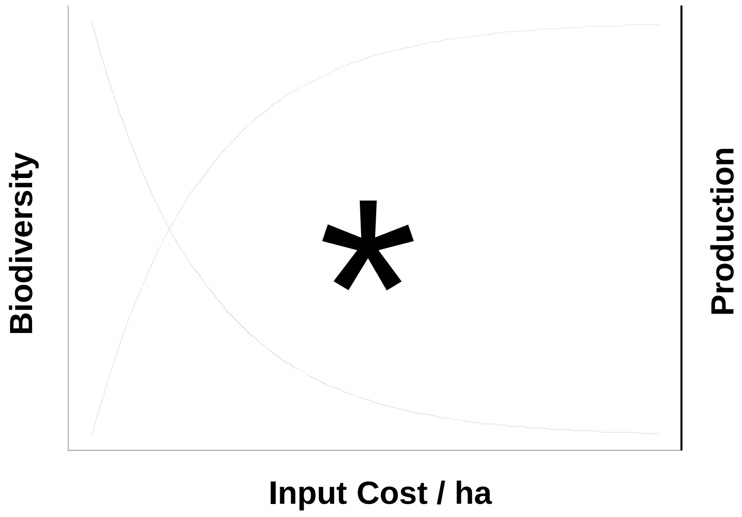


Promote large, homogeneous clusters of extensive SARs

Concentrate intensity in certain SARs and promote heterogeneity

Discussion – Limitations

- Factors influencing the correlations



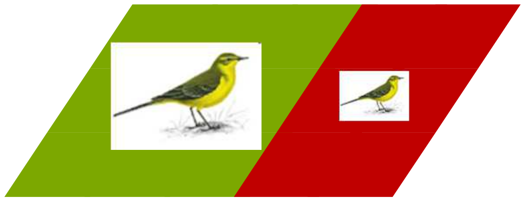
* Input prices
* Input categories
* Input products

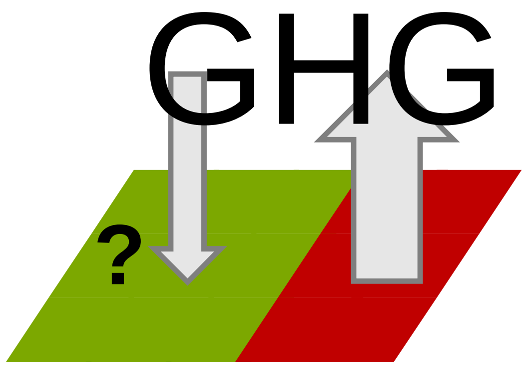
- Generalization restriction to other taxa

Discussion – Perspectives

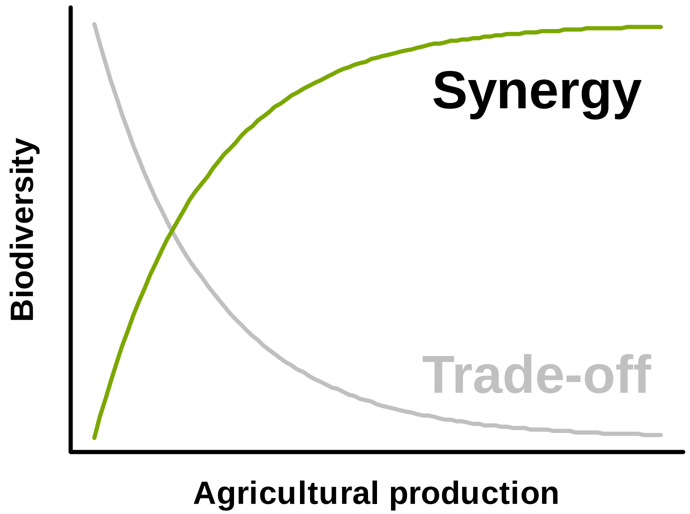
- Accounting for other environmental criteria

Segregating objectives was partially possible for biodiversity, what about other criteria?





- Quantifying ecosystem services



Thank you

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“Coviability models of FARMing and BIRD biodiversity”