Assessing the impact of vegetables on biodiversity in life cycle assessment

Antonin Pépin, Maria Vittoria Guidoboni, Philippe Jeanneret, Hayo van Der Werf

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HEALTHY FOOD SYSTEMS FOR A HEALTHY PLANET

Assessing the impact of vegetables on biodiversity in life cycle assessment

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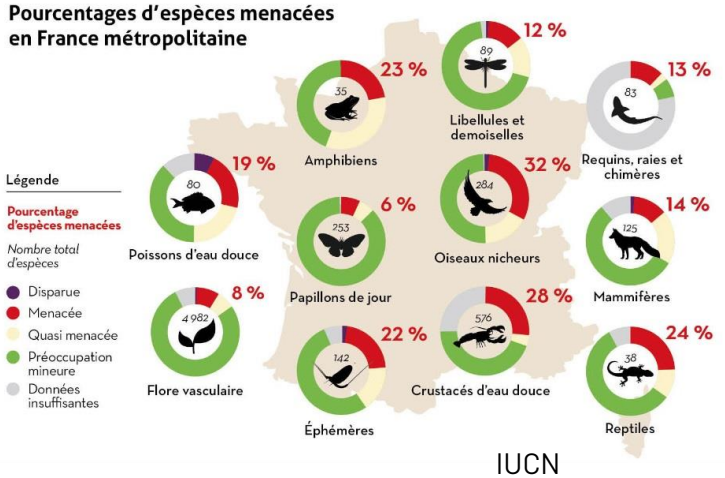
Introduction

- Biodiversity loss in agricultural landscapes
  - intensification of agriculture
  - degradation and loss of semi-natural habitats
  - LCA methods intend to address this issue
- An evolution of methods (e.g. de Baan et al., 2013; Mueller et al., 2014; Chaudhary et al., 2015; Knudsen et al., 2017; Chaudhary and Brooks, 2018)
  - Spacialisation, ecoregions
  - Land use (agriculture, pasture ; monocotyledon pasture, mixed pasture, arable crops, and hedge)
  - Intensity (organic, conventional)
  - Various taxonomic groups (vascular plants; mammals, birds, amphibians, reptiles, and plants)
- No current LCA method is able to assess and compare impacts on biodiversity of vegetable production systems as a function of farming practices and the local context.
- The expert system SALCA-BD (Swiss Agricultural LCA—Biodiversity) (Jeanneret et al., 2014) integrates biodiversity into agricultural LCA as an independent impact category.



IUCN

Introduction

SALCA-BD (Jeanneret et al., 2014)

- An expert system based on scientific literature
- Based on detailed inventory of farming practices
- 11 taxonomic groups
- Comparison of the “potential impact on biodiversity”
- For cropland and pasture
- Adapted to orchards by van der Meer et al. (2017)


Contents lists available at ScienceDirect

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An expert system for integrating biodiversity into agricultural life-cycle assessment

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Agroscope

→ Adapt SALCA-BD to vegetable production

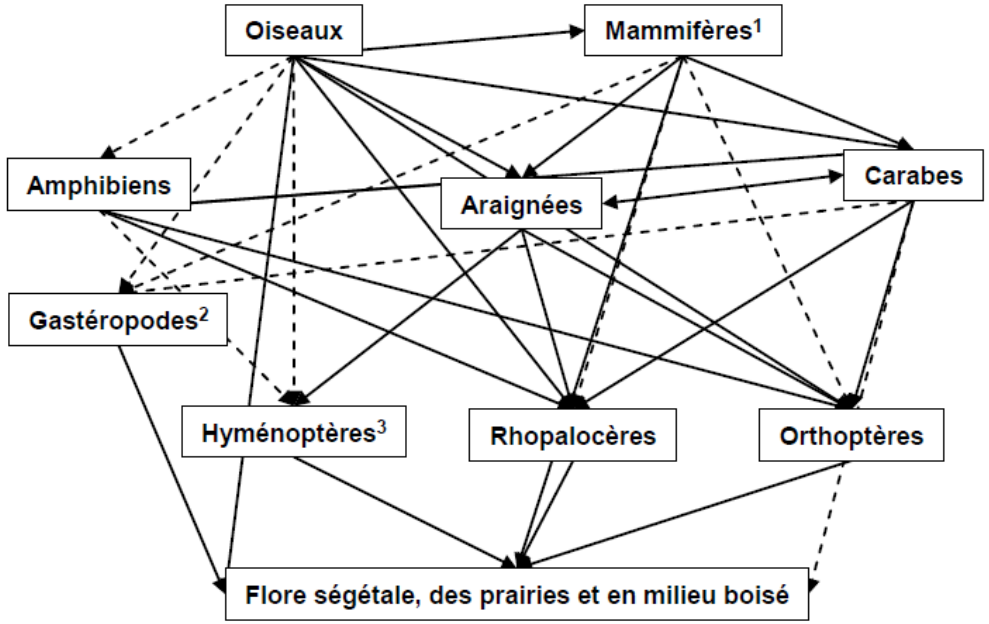
Adaptation of SALCA-BD

Habitats

- Crops
  - e.g. winter cereal, maize, pasture
- Semi-natural areas
  - e.g. hedgerows

Practices

- e.g. type & date o
- e.g. frequency &
  herbicide



Coefficients reflecting the ability to host biodiversity

X

Coefficients reflecting impact on biodiversity

=

Impact of 1 practice on 1 habitat on 1 species group

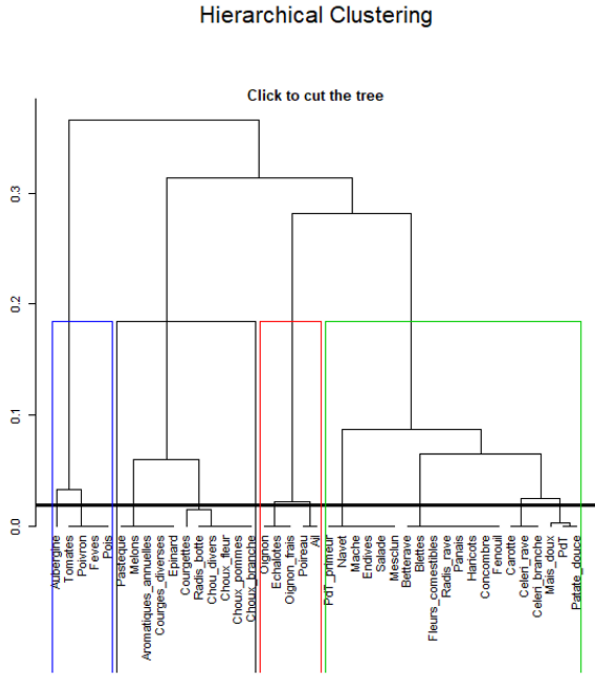
Habitats and practices of vegetable production

Aggregated → "**Biodiversity score**" at the field or farm level

Adaptation of SALCA-BD

Mavi Guidoboni

- 2 types of habitats : greenhouse and open field
- Group similar vegetables according to similar characteristics **height, soil cover, duration throughout the year, presence of flowers**



	VEGETABLES	CHARACTERISTICS
A	shallot, fresh onion, onion, leek, garlic	• medium height • low cover • no flowers
B	head cabbage (ex: Brussel cabbage), leafy cabbage (ex: kale), flower cabbage (ex: broccoli), other cabbage (ex: Chinese cabbage), annual aromatic plant,	• low-medium height • high cover • no flowers
C	beetroot, Swiss chard, bunch radish, carrot, celery, celery root, salad, mesclun, endive, fennel, corn salad, spinach, turnip, parsnip, radish	• low-medium height • medium cover • no flowers
D	eggplant, fava bean, pepper, potato, tomato, sweet potato	• high height • long duration • presence of flowers
E	pumpkin and squash, melon, watermelon, cucumber, courgette, bean, pea, early potato, edible flowers	• low-medium height • medium-high cover • presence of flowers
F	artichoke	perennial, medium soil cover
G	asparagus	perennial, low soil cover
H	strawberry	perennial
I	mixed vegetables	

Adaptation of SALCA-BD

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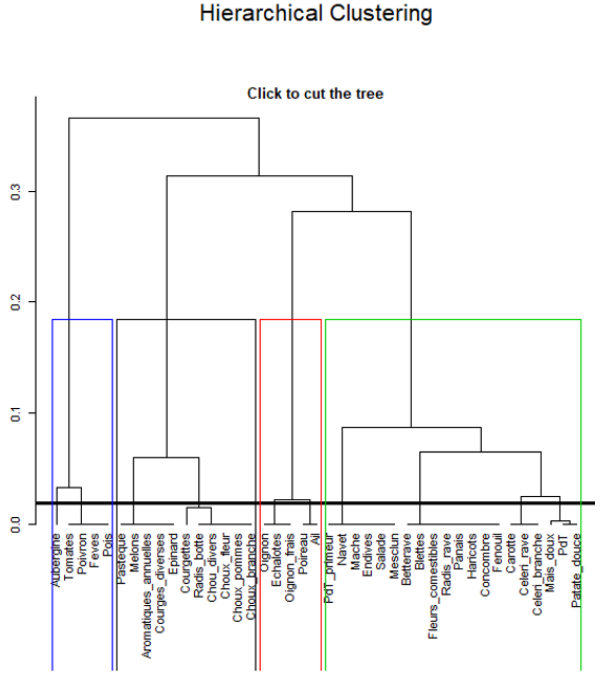

1 field, several crops, 1 margin

1 field, several crops, 1 margin

Adaptation of SALCA-BD

	Management Level I	Management Level II	Management Level III	crop flora				grassland flora				birds				small mammals				amphibians				snails and slugs				spiders				carabids				butterflies			
				H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG III	H II	MG I	MG II	MG II
A - OF	Plant protectio	Weed control without h	Cover	9	8	8	8	0	0	0	0	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	4	4	3	3	3	3	3	3	2	2	2	2
	Plant protectio	Weed control without h	Manual/mechanical hoeing	9	8	8	8	0	0	0	0	3	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1	4	4	3	3	3	3	3	3	2	2	2	2
	Plant protectio	Weed control without h	Thermic	9	8	8	8	0	0	0	0	3	2	2	1	2	2	1	1	1	1	1	1	1	1	1	1	4	4	3	3	3	3	3	3	2	2	2	2
A - GH	Plant protectio	Weed control without h	Cover	6	6	6	6	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	3	3	3	3	2	2	2	2	1	1	1	1
	Plant protectio	Weed control without h	Manual/mechanical hoeing	6	6	6	6	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	3	3	3	3	2	2	2	2	1	1	1	1
	Plant protectio	Weed control without h	Thermic	6	6	6	6	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	3	3	3	3	2	2	2	2	1	1	1	1
B - OF	Plant protectio	Weed control without h	Cover	7	7	7	7	0	0	0	0	4	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
	Plant protectio	Weed control without h	Manual/mechanical hoeing	7	7	7	7	0	0	0	0	4	2	2	1	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
	Plant protectio	Weed control without h	Thermic	7	7	7	7	0	0	0	0	4	2	2	1	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
B - GH	Plant protectio	Weed control without h	Cover	4	4	4	4	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	2	2	2	2	4	4	3	3	3	3	3	3	1	1	1	1
	Plant protectio	Weed control without h	Manual/mechanical hoeing	4	4	4	4	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	2	2	2	2	4	4	3	3	3	3	3	3	1	1	1	1
	Plant protectio	Weed control without h	Thermic	4	4	4	4	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	2	2	2	2	4	4	3	3	3	3	3	3	1	1	1	1
C - OF	Plant protectio	Weed control without h	Cover	7	7	7	7	0	0	0	0	4	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
	Plant protectio	Weed control without h	Manual/mechanical hoeing	7	7	7	7	0	0	0	0	4	2	2	1	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
	Plant protectio	Weed control without h	Thermic	7	7	7	7	0	0	0	0	4	2	2	1	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	4	4	3	3	2	2	2	2
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D - OF	Plant protectio	Weed control without h	Cover	9	8	8	8	0	0	0	0	5	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	5	4	3	3	3	3	3	3	3	3	2	2
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D - GH	Plant protectio	Weed control without h	Cover	6	6	6	6	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	4	4	3	3	2	2	2	2	2	2	2	2
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E - OF	Plant protectio	Weed control without h	Cover	7	7	7	7	0	0	0	0	5	3	3	2	2	2	1	1	1	1	1	1	2	2	2	2	5	4	3	3	3	3	3	3	3	3	2	2
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E - GH	Plant protectio	Weed control without h	Cover	4	4	4	4	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	2	2	2	2	4	4	3	3	2	2	2	2	2	2	2	2
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ARTICHOKE - OF	Plant protectio	Weed control without h	Cover	8	8	8	8	0	0	0	0	5	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	5	4	3	3	5	5	3	3	2	2	2	2
	Plant protectio	Weed control without h	Manual/mechanical hoeing	8	8	8	8	0	0	0	0	5	3	3	1	2	2	1	1	1	1	1	1	1	1	1	1	5	4	3	3	5	5	3	3	2	2	2	2
	Plant protectio	Weed control without h	Thermic	8	8	8	8	0	0	0	0	5	3	3	1	2	2	1	1	1	1	1	1	1	1	1	1	5	4	3	3	5	5	3	3	2	2	2	2
ARTICHOKE - GH	Plant protectio	Weed control without h	Cover	5	5	5	5	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	4	4	3	3	4	4	3	3	1	1	1	1
	Plant protectio	Weed control without h	Manual/mechanical hoeing	5	5	5	5	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	4	4	3	3	4	4	3	3	1	1	1	1

Test of SALCA BD

At field level

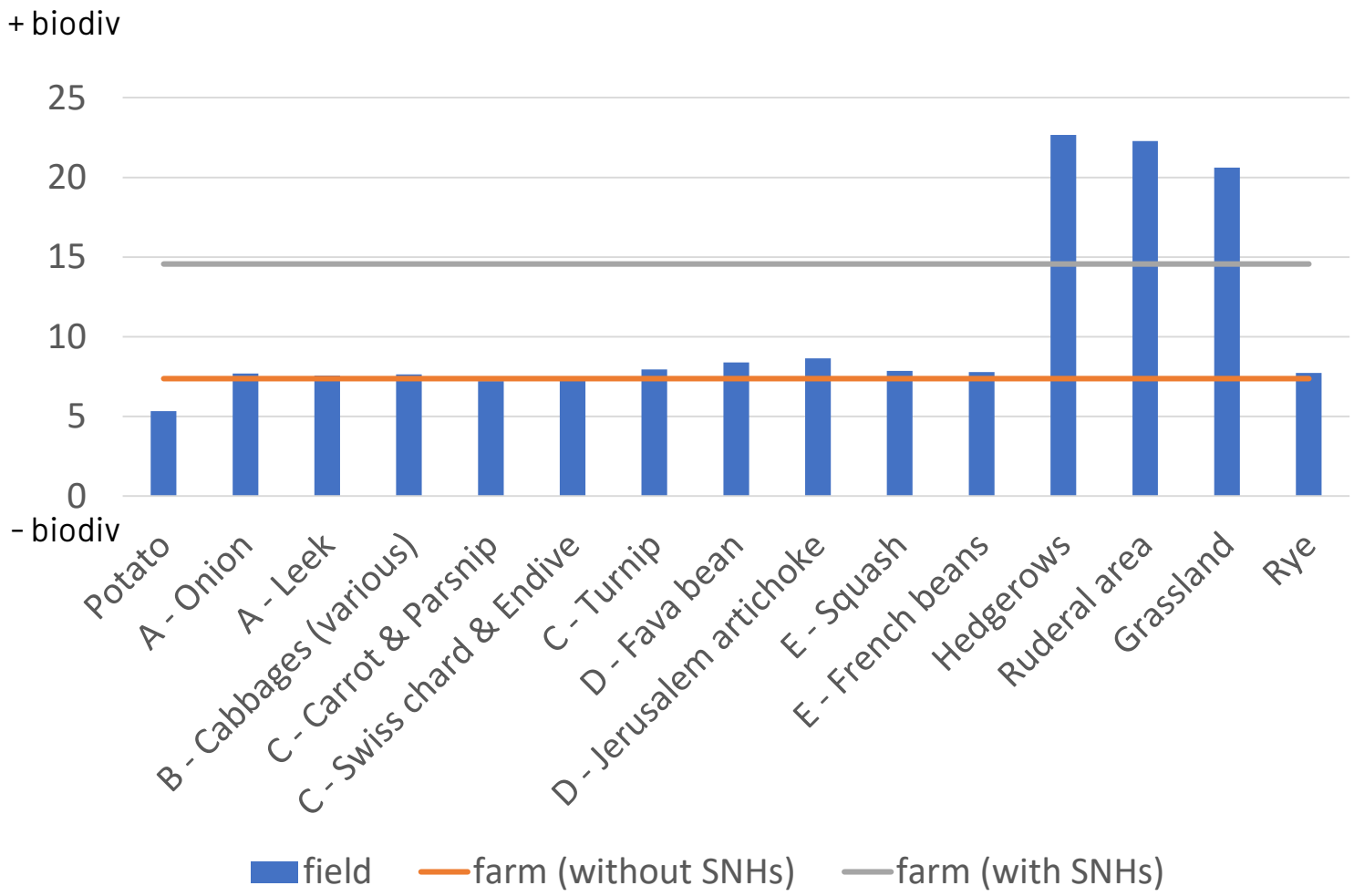
- Changes to practice intensities at the field level on biodiversity using a **field of onions**
  - Low : the lowest intensity of each practice
  - High : the highest intensity of each practice

Indicator species group	Open field			Greenhouse		
	Low	High	Δ	Low	High	Δ
Field level	7.47	4.71	-37%	5.24	3.30	-37%
Crop flora	24.13	16.41	-32%	16.08	10.61	-34%
Grassland flora	0.00	0.00	-	0.00	0.00	-
Birds	9.06	4.13	-54%	3.75	1.75	-53%
Mammals	4.29	4.03	-6%	2.92	2.75	-6%
Amphibians	2.56	1.55	-40%	0.00	0.00	-
Snails	2.92	2.17	-26%	2.92	2.17	-26%
Spiders	9.85	4.92	-50%	8.10	4.03	-50%
Carabid beetles	7.95	4.66	-41%	7.25	4.39	-39%
Butterflies	5.44	3.12	-43%	3.44	2.00	-42%
Wild bees	3.00	2.21	-26%	3.00	2.21	-26%
Grasshoppers	0.00	0.00	-	0.00	0.00	-

Test of SALCA BD

At farm level

- Case study at farm scale in an organic vegetable farm in Brittany
- Biodiversity scores
  - for crops and semi natural habitats (SNHs)
  - for the whole-farm with and without the inclusion of SNHs
- Importance of semi-natural areas (hedges, extensive grassland, etc.) for biodiversity
- Lower-impact practices cannot entirely compensate for a lack of SNHs (Nemecek et al., 2011)
- Combining low-intensity farming with the presence of SNHs enhances the biodiversity of farming landscapes



Conclusion

- For preserving biodiversity:
  - Low intensity practices
  - Importance of semi natural areas
- Because it considers habitats and practices in detail, SALCA-BD is useful:
  - for assessing biodiversity at field and farm levels
  - for comparing farming systems with similar land uses and management types (organic or conventional)
- Does not consider impacts of the background system
  - Combining SALCA-BD with comprehensive methods for assessing impacts on biodiversity ?

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Using an expert system to assess biodiversity in life cycle assessment of vegetable crops

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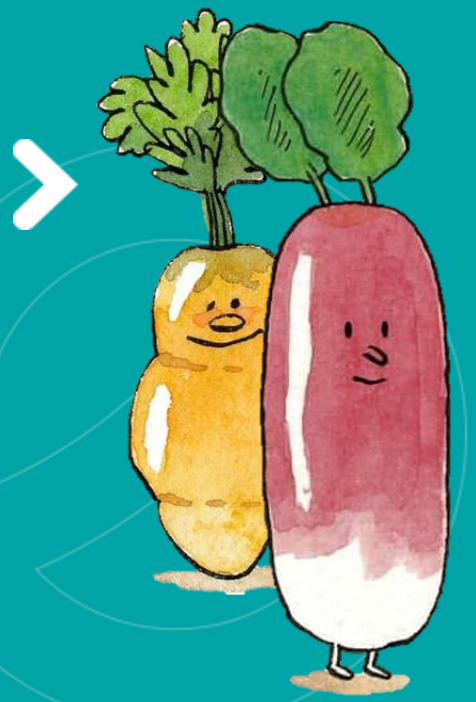

Thank you !

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