Sustainability assessment of agricultural systems: criteria, opportunities and challenges

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2022 EU CONFERENCE one

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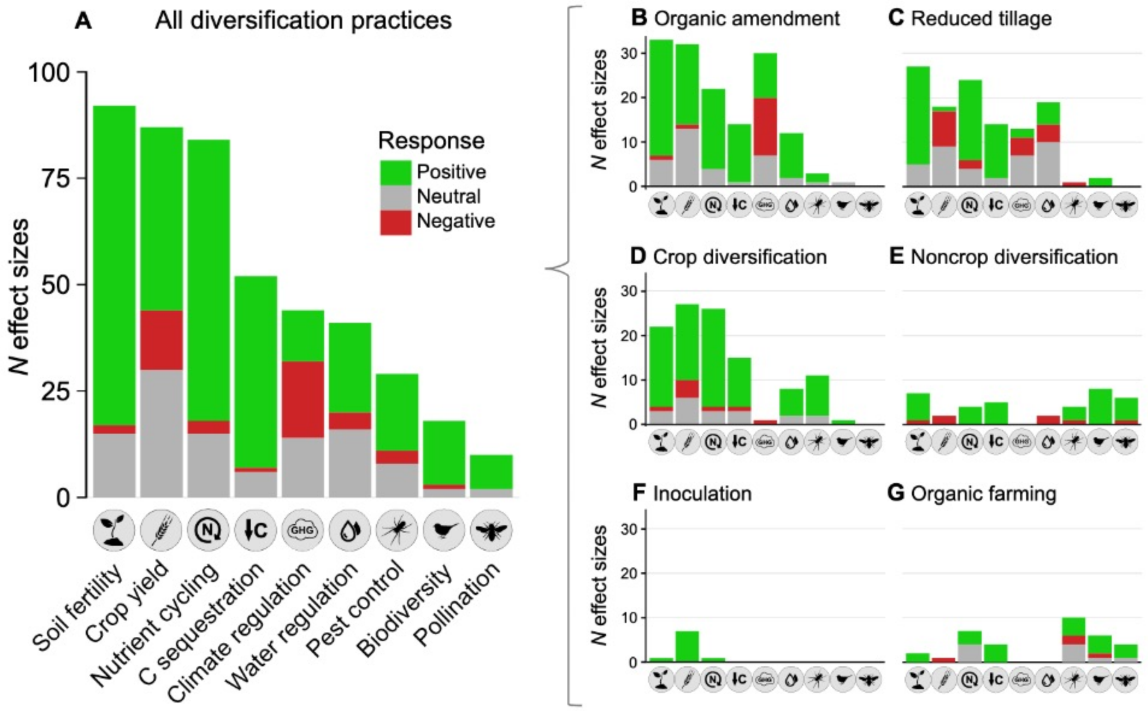
Agricultural diversification is a major lever of agroecological transition towards sustainable agrifood systems



Nature-based and/or technology-based innovations should be judiciously combined

SCIENCE ADVANCES | RESEARCH ARTICLE

ECOLOGY

Agricultural diversification promotes multiple ecosystem services without compromising yield

Giovanni Tamburini[1,2]*, Riccardo Bommarco[1], Thomas Cherico Wanger[1,3†], Claire Kremen[4,5], Marcel G. A. van der Heijden[6,7], Matt Liebman[8], Sara Hallin[9]

Positive but variable effects of crop diversification on biodiversity and ecosystem services

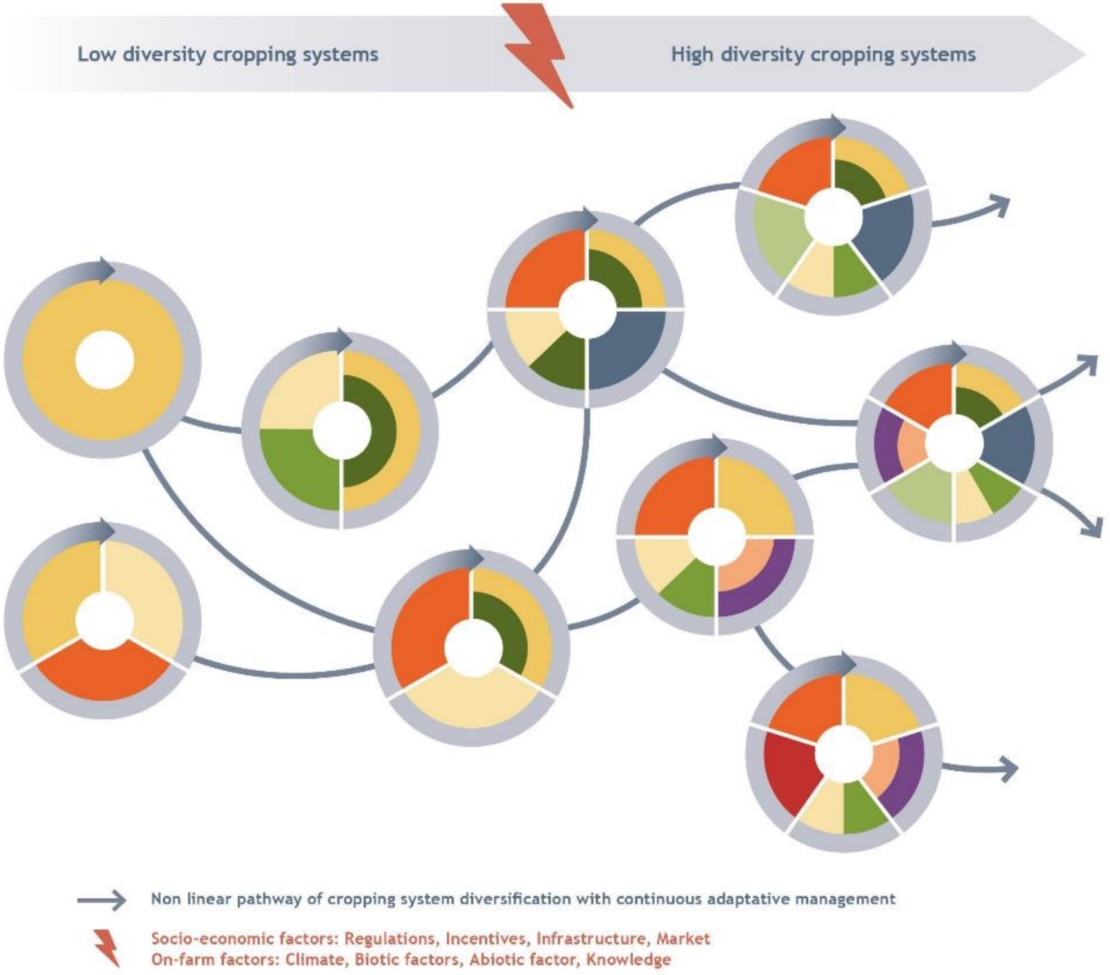
D. Beillouin, T. Ben-Ari, E. Malézieux, V. Seufert, D. Makowski

doi: https://doi.org/10.1101/2020.09.30.320309

But agroecological transition is a nonlinear and dynamic process

No “one size fits all” solution

- Solutions should be tailor-made to local contexts and needs
- Climate change and higher uncertainty require continuous adaptation of cropping systems



→ Assessment tools needed to help actors drive their pathway towards sustainable agrifood systems

DiverIMPACTS

sustainability MDPI

Article

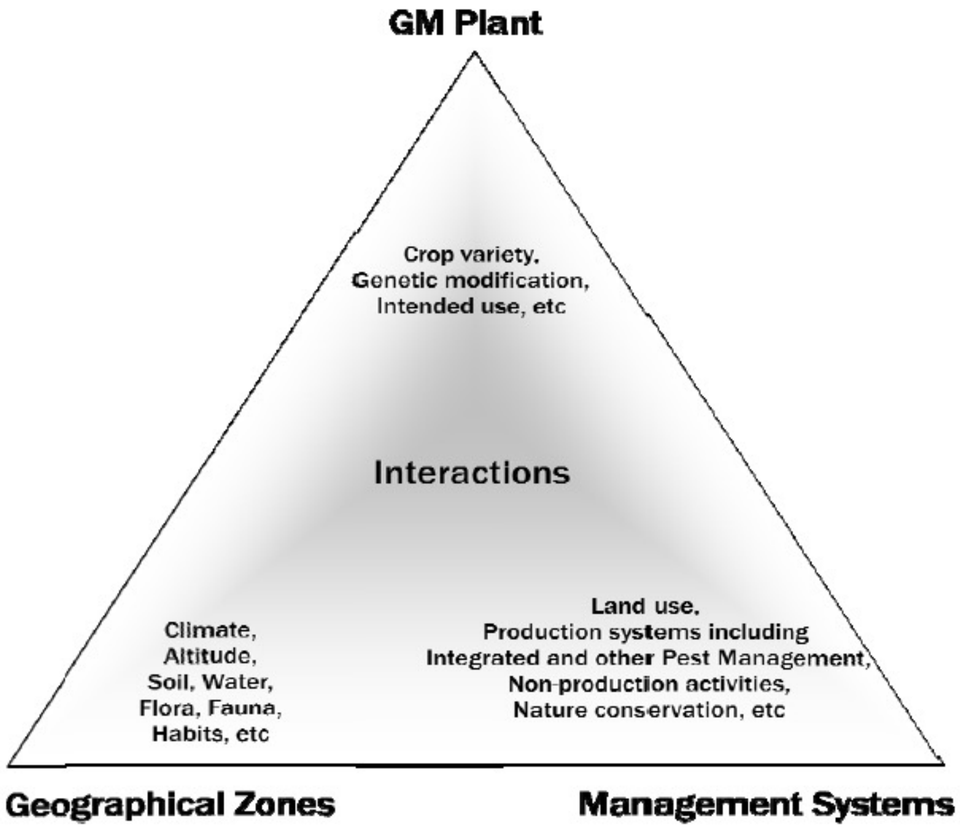
An Actor-Oriented Multi-Criteria Assessment Framework to Support a Transition towards Sustainable Agricultural Systems Based on Crop Diversification

Ileana Iocola [1,*], Frederique Angevin [2], Christian Bockstaller [3], Rui Catarino [3], Michael Curran [4], Antoine Messéan [2], Christian Schader [4], Didier Stilmant [5], Florence Van Stappen [5], Paul Vanhove [5], Hauke Ahnemann [6], Jérémy Berthomier [7], Luca Colombo [8], Giovanni Dara Guccione [8,9], Emmanuel Mérot [7], Massimo Palumbo [10], Nino Virzì [10] and Stefano Canali [1]

A systems perspective already foreseen for Environmental Risk Assessment (ERA)

"The objective of the ERA is […] to identify and evaluate potential adverse effects of the GM plant, **direct and indirect, immediate or delayed (including cumulative long-term effects) on the receiving environment(s)**"

« There is a requirement to assess the environmental **impact of the specific management and production systems** associated with the GM plant, including how the plant will be cultivated, …»



(EFSA ERA Guidance Document, 2010)

efsa European Food Safety Authority EFSA Journal 2010;8(11):1879

SCIENTIFIC OPINION

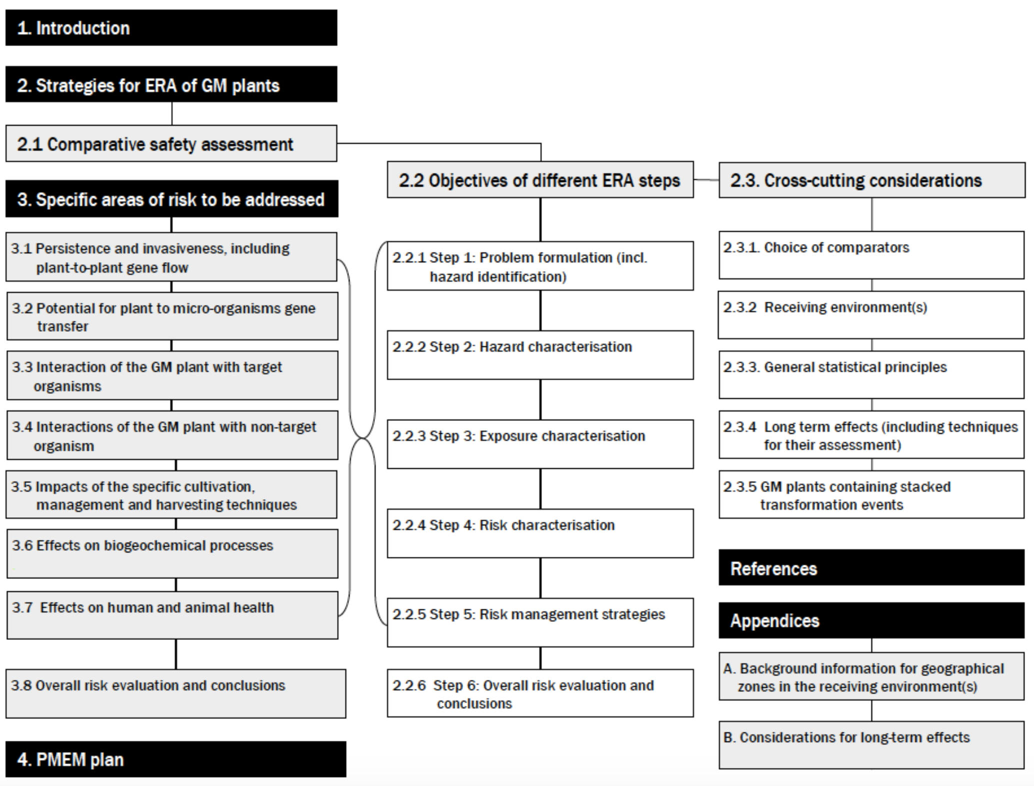
Guidance on the environmental risk assessment of genetically modified plants[1]

EFSA Panel on Genetically Modified Organisms (GMO)[2, 3]

European Food Safety Authority (EFSA), Parma, Italy

But a real challenge for the ERA of regulated products (pesticides, GMOs)

Currently still very much innovation-centered and based on small-scale experiments



(EFSA ERA Guidance Document of GM plants, 2010)

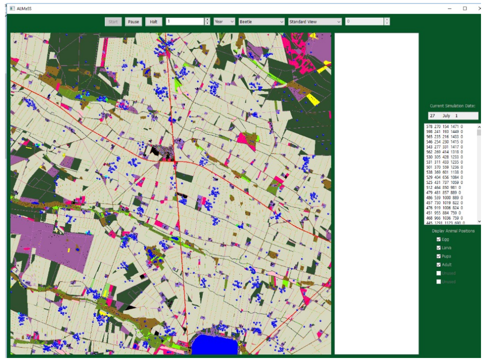
Typical conclusion of opinions on GM plants: "The GM event XYZ is as (un)safe as its conventional counterpart for the human and animal health and the environment"

Comparative assessment and substantial equivalence rely on the assumption that interactions with the receiving environment remain limited

This is generally not the case!

First, direct effects as measured during ERA lead to differential effects at the landscape level

Using 10 Danish landscapes and the same ERA outcome for hares (an endocrine disruptor).



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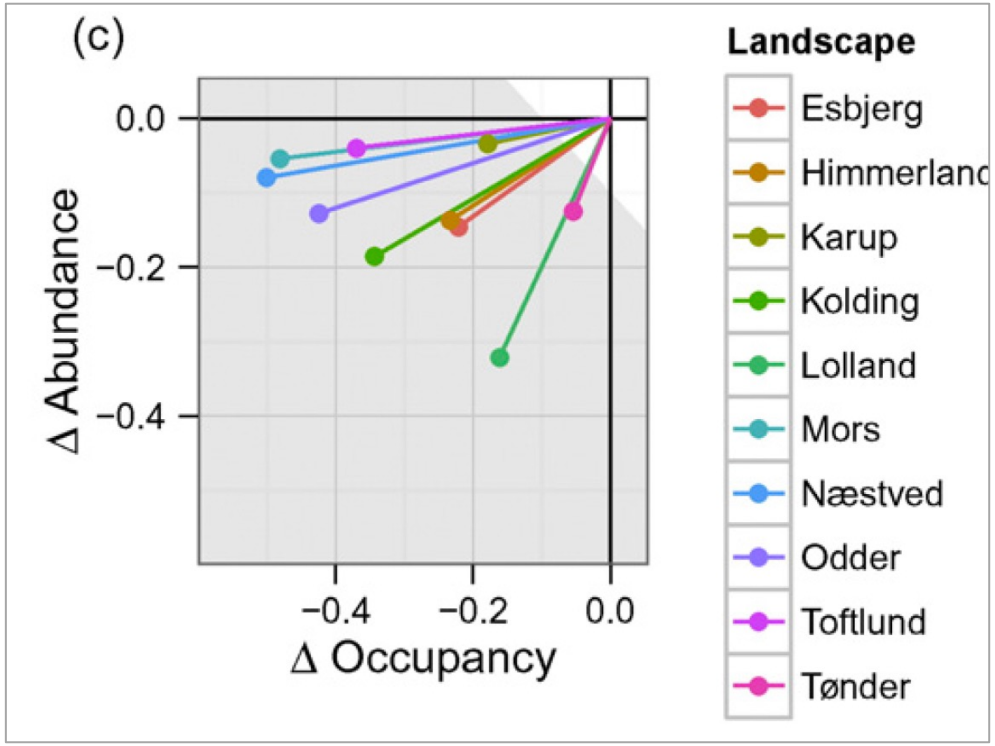
Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Landscape structure and management alter the outcome of a pesticide ERA: Evaluating impacts of endocrine disruption using the ALMaSS European Brown Hare model



(Topping et al., 2016)

Direct effects as measured during ERA lead to differential effects at the landscape level, another example

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Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

When the average hides the risk of Bt-corn pollen on non-target Lepidoptera: Application to *Aglais io* in Catalonia

Virgile Baudrot[a,*], Emily Walker[a], Andreas Lang[b,c], Constanti Stefanescu[d,e], Jean-François Rey[a], Samuel Soubeyrand[a], Antoine Messéan[f]

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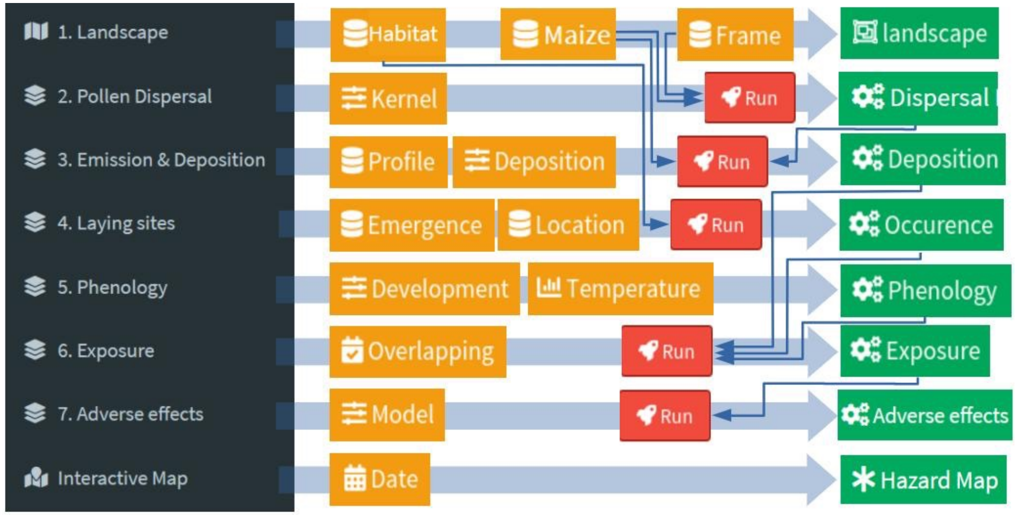
EXTERNAL SCIENTIFIC REPORT

APPROVED: 2 December 2020

doi:10.2903/sp.efsa.2021.EN-6443

Extension of the spatially- and temporally-explicit "briskaR-NTL" model to assess potential adverse effects of Bt-maize pollen on non-target Lepidoptera at landscape level

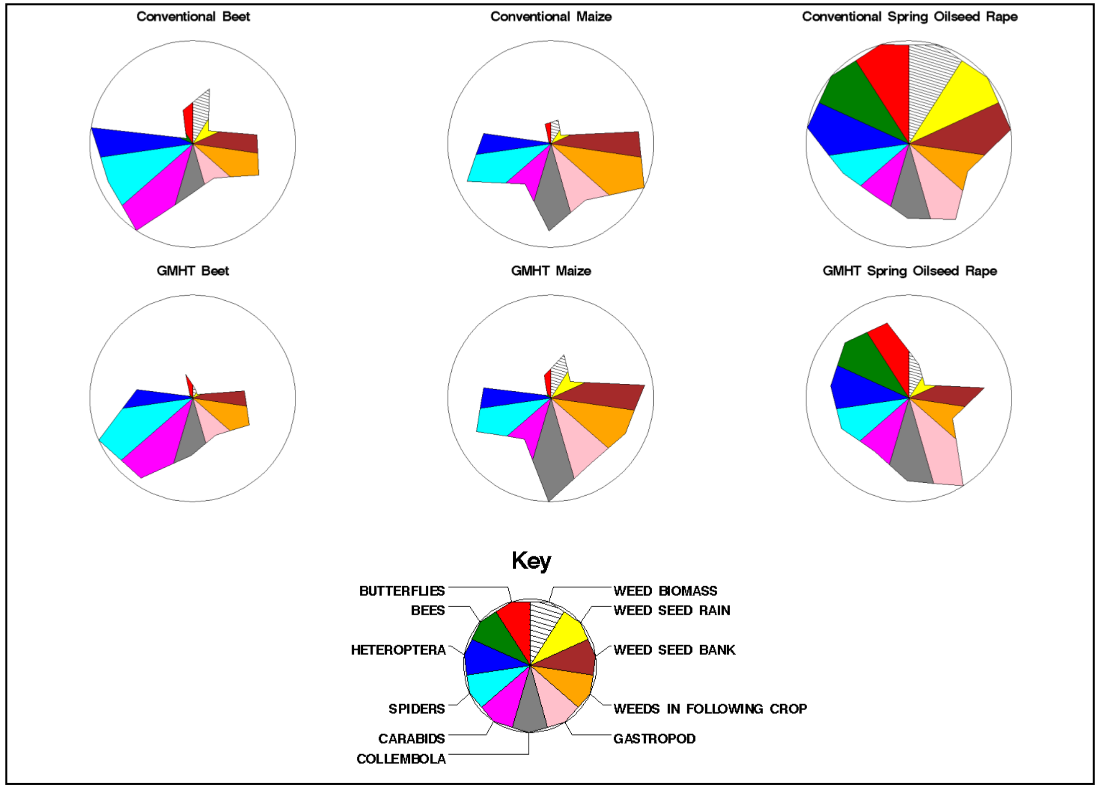
Virgile Baudrot[1], Andreas Lang[2], Constanti Stefanescu[3], Samuel Soubeyrand[1] and Antoine Messéan[1]



Structure of BriskaR-NTL landscape model

Also, indirect effects at large scale are likely to outweigh direct and local effects

→ Herbicide tolerant crops lead to changes in herbicide regime but also soil tillage and crop rotation



Farm Scale Evaluation, Firbank et al., 2003

Multi-criteria evaluation of cropping systems

Anova comparison of means

Cropping system	Species richness	Bee food	Yield loss	Harvest pollution	Years to resistance
Soya/Maize/Wheat/Maize	15.62 B	1.46 D	41.53 CB	2.72 BA	7.02 BC
Soya/HTmaize/Wheat/HTmaize	16.49 A	1.58 DC	43.62 B	2.65 B	8.45 BC
+ no mouldboard plough	9.34 H	0.59 F	19.76 D	1.04 D	17.4 A
Wheat/HTmaize	10.42 G	1.18 E	20.3 D	1.63 C	10.9 BA
+ no mouldboard plough	14.16 C	1.63 C	60.16 A	2.92 A	2.61 DC
HTmaize monoculture	11.17 F	1.11 E	1.08 E	0.32 E	20.6 A
+ early sowing	10.56 GF	0.51 F	1.86 E	0.89 D	9.67 BA
+ late sowing	12.89 E	1.52 DC	0.26 E	0.18 FE	8.71 BC
+ no mouldboard plough	8.09 I	0.16 G	0 E	0.02 F	11.4 BA
+ no plough + early sowing	6.32 J	0.04 G	-7.2 F	0 F	> 28
+ no till	13.78 DC	2.29 A	39.48 CB	2.76 BA	1 D
+ no till + 2nd glyphosate	14.05 DC	2.09 B	37.59 C	2.83 BA	1 D
+ no till + 2nd gly. + early sow.	13.48 DE	2.21 BA	38.15 C	2.84 BA	1 D
+ catch crop killed with glyph.	4.37 K	0.11 G	-0.12 E	0.01 F	> 28
+ catch crop killed with tillage	4.84 K	0.04 G	-0.28 E	0.06 F	2.25 DC

GM HT maize

→ HT maize and glyphosate are not the main drivers

...phosate-resistant maize. I Effects on weeds. Environmental Science and Pollution Research 24, 11582-11600.

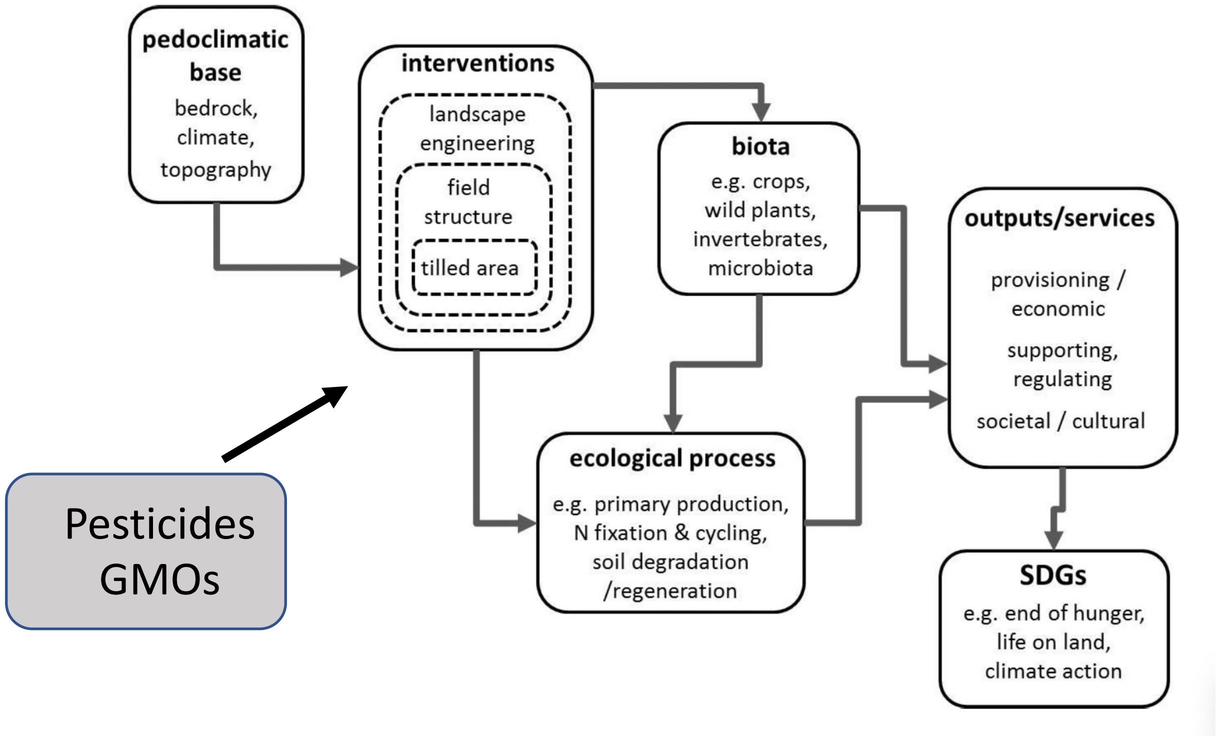
Colbach, N., Darmency, H., Fernier, A., Granger, S., Le Corre, V., Messéan, A., 2017. Simulating changes in cropping practices in conventional and glyphosate-resistant maize. II. Effect on weed impacts on crop production and biodiversity. Environmental Science and Pollution Research 24, 13121-13135.

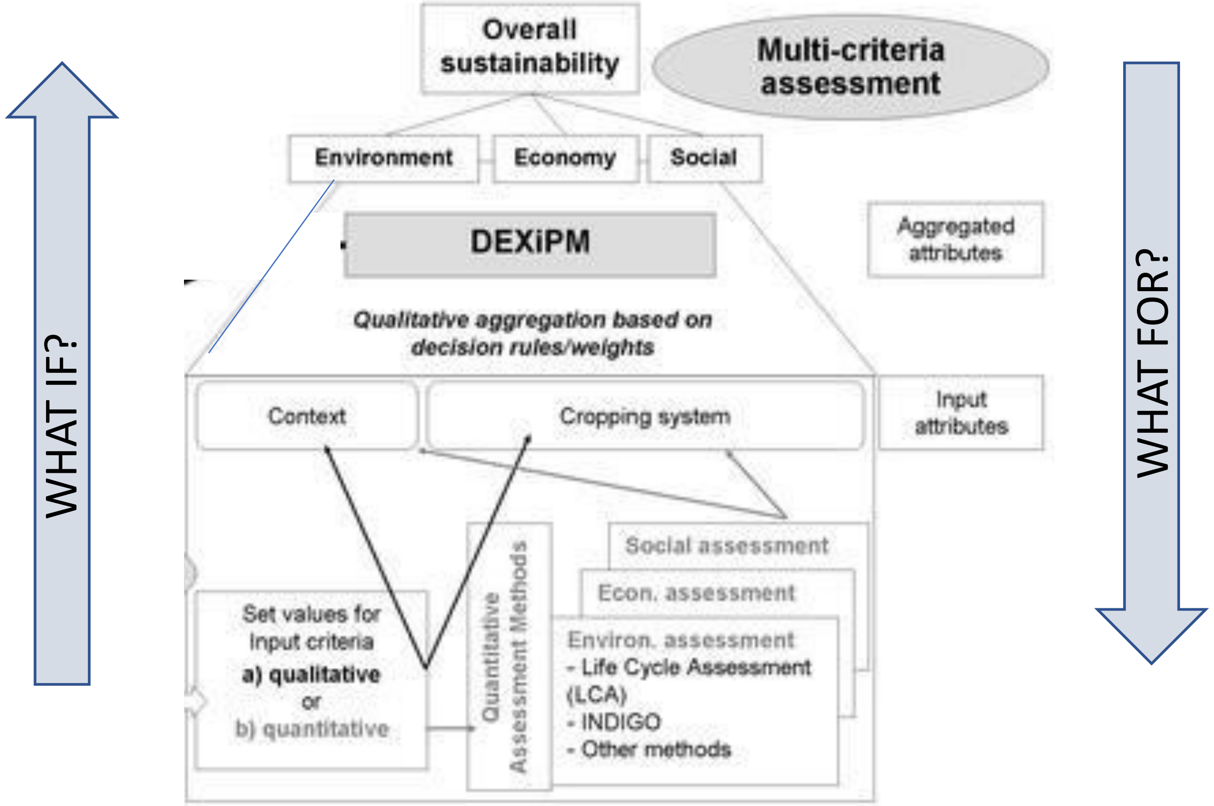
Environ Sci Pollut Res (2017) 24:13121–13135
DOI 10.1007/s11356-017-8796-9
RESEARCH ARTICLE

Simulating changes in cropping practices in conventional and glyphosate-resistant maize. II. Weed impacts on crop production and biodiversity

Nathalie Colbach[1,2] · Henri Darmency[1] · Alice Fernier[1] · Sylvie Granger[1] · Valérie Le Corre[1] · Antoine Messéan[3]

Framework and tools to articulate prospective ERA with global sustainability assessment





amiga (Squire, 2017)

Ecological Indicators 18 (2012) 171–182
Contents lists available at SciVerse ScienceDirect
Ecological Indicators
journal homepage: www.elsevier.com/locate/ecolind

Assessing innovative cropping systems with DEXiPM, a qualitative multi-criteria assessment tool derived from DEXi

Elise Pelzer[a,b,c,*], Gabriele Fortino[a], Christian Bockstaller[d,e], Frédérique Angevin[a], Claire Lamine[a], Camilla Moonen[f], Vasileios Vasileiadis[g], Daniel Guérin[a], Laurence Guichard[b,c], Raymond Reau[b,c], Antoine Messéan[a]

Agron. Sustain. Dev. 29 (2009) 447–461
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DOI: 10.1051/agro/2009006
Available online at: www.agronomy-journal.org
Agronomy for Sustainable Development

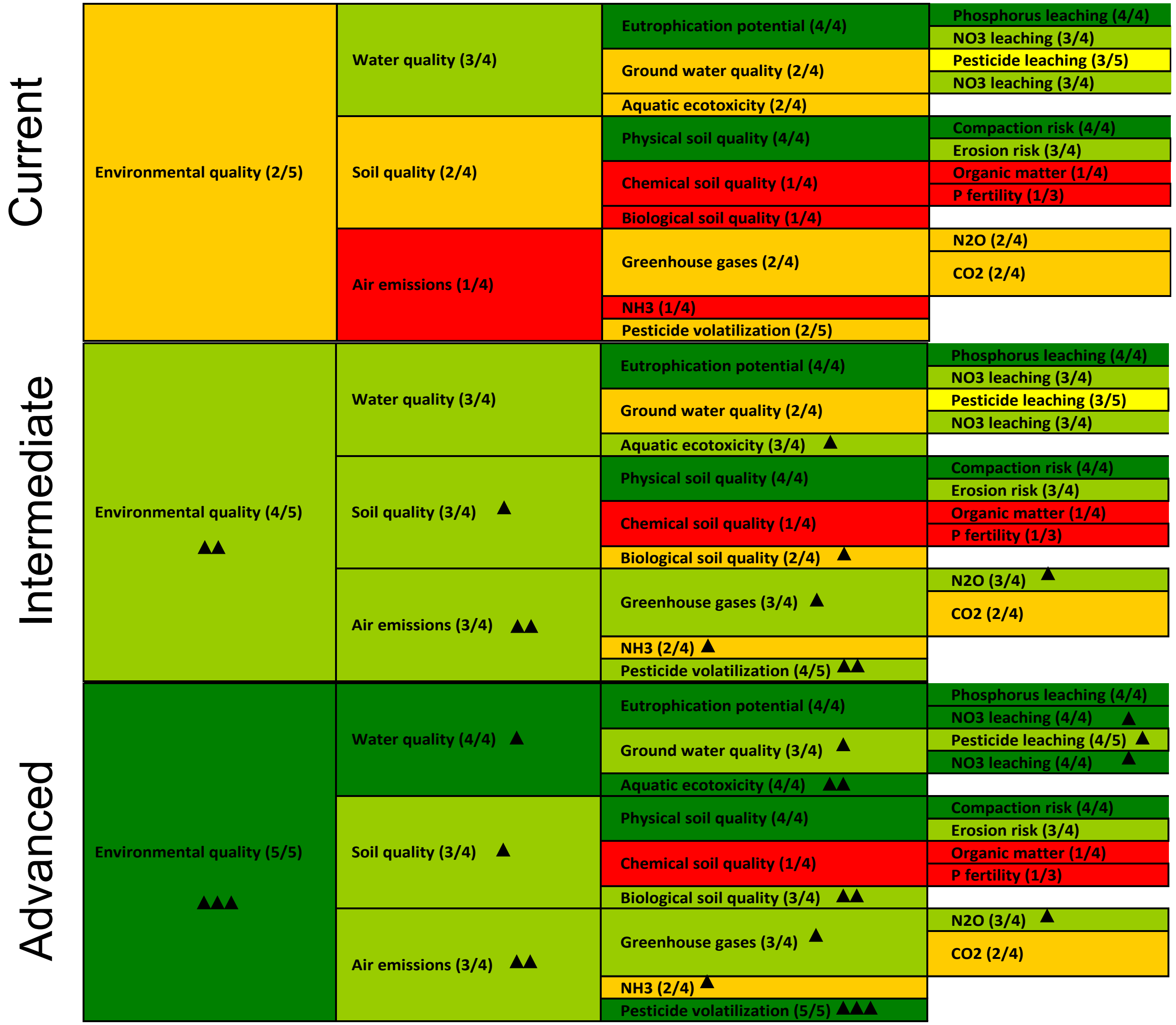
Research article

MASC, a qualitative multi-attribute decision model for ex ante assessment of the sustainability of cropping systems

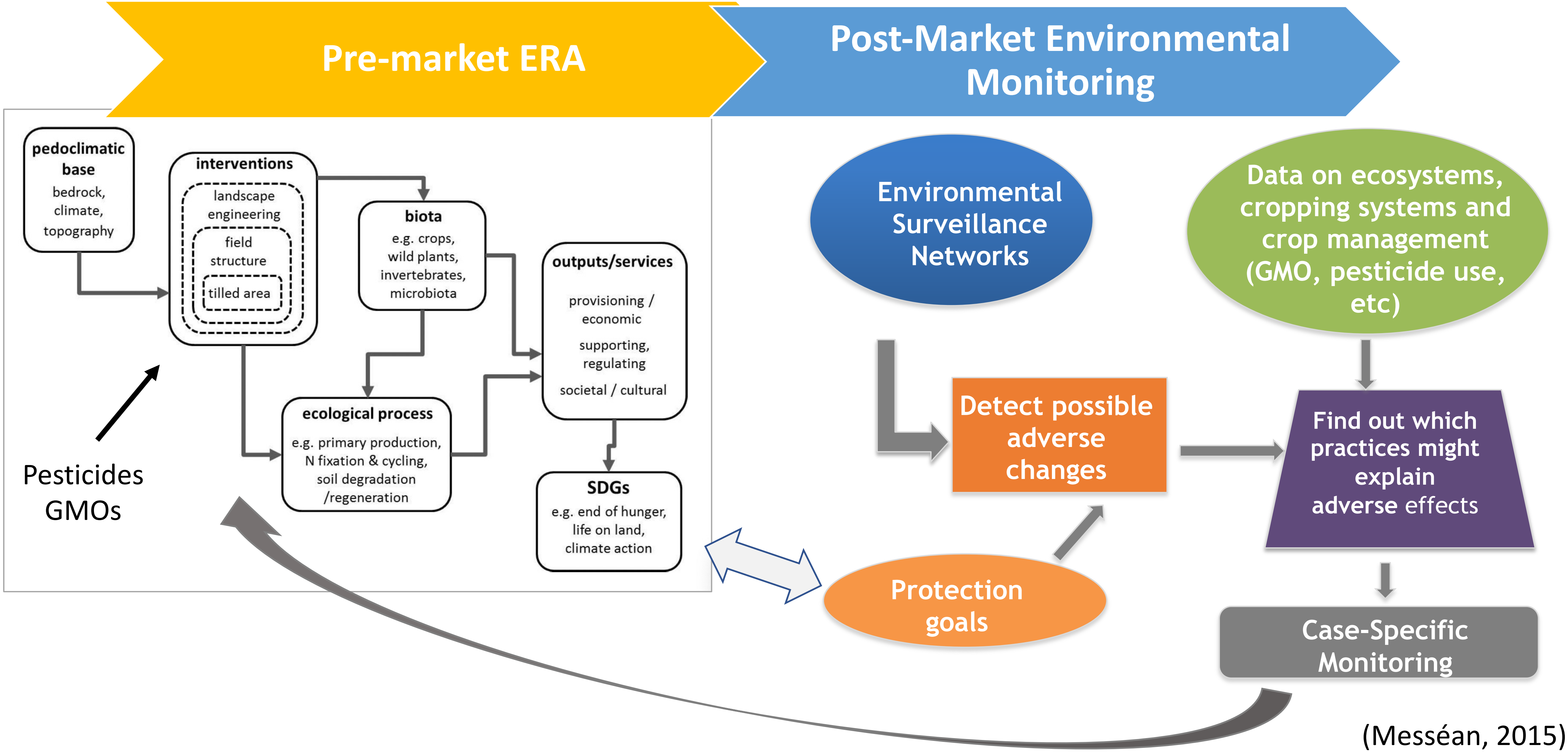
Walid SADOK[1], Frédérique ANGEVIN[2], Jacques-Eric BERGEZ[3], Christian BOCKSTALLER[4], Bruno COLOMB[3], Laurence GUICHARD[5], Raymond REAU[5], Antoine MESSÉAN[2], Thierry DORÉ[6*]

Such tools already used to assess innovations through participatory approaches

Outputs of MASC in a stepwise participatory design workshop



Towards a global and continuous environmental risk assessment



(Messéan, 2015)

Thank you for your attention