







Crop diversity for crop protection: getting the mix right

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Crop diversity is AMAZING

Increasing Cropping System Diversity Balances Productivity, Profitability and Environmental Health

Adam S. Davis[1]*, Jason D. Hill[2], Craig A. Chase[3], Ann M. Johanns[4], Matt Liebman[5]

Increasing crop rotational diversity can enhance cereal yields

Monique E. Smith[1], Giulia Vico[2], Alessio Costa[2], Timothy Bowles[3], Amélie C. M. Gaudin[4], Sara Hallin[5], Christine A. Watson[2,6], Remedios Alarcòn[7], Antonio Berti[8], Andrzej Blecharczyk[9], Francisco J. Calderon[10], Steve Culman[11], William Deen[12], Craig F. Drury[13], Axel Garcia y. Garcia[14], Andrés García-Díaz[15], Eva Hernández Plaza[16], Krzysztof Jonczyk[17], Ortrud Jäck[2], R. Michael Lehman[18], Francesco Montemurro[19], Francesco Morari[8], Andrea Onofri[20], Shannon L. Osborne[18], José Luis Tenorio Pasamón[21], Boël Sandström[22], Inés Santín-Montanyá[21], Zuzanna Sawinska[9], Marty R. Schmer[23], Jaroslaw Stalenga[17], Jeffrey Strock[24], Francesco Tei[20], Cairistiona F. E. Topp[25], Domenico Ventrella[19], Robin L. Walker[6] & Riccardo Bommarco[1]✉

National food production stabilized by crop diversity

Delphine Renard[1,2]* & David Tilman[1,3]

Crop Diversity: An Unexploited Treasure Trove for Food Security

Festo Massawe,[1,2,*] Sean Mayes,[1,2] and Acga Cheng[1]

Long-Term Evidence Shows that Crop-Rotation Diversification Increases Agricultural Resilience to Adverse Growing Conditions in North America

Timothy M. Bowles,[1,16,*] Maria Mooshammer,[1] Yvonne Socolar,[1] Francisco Calderón,[2] Michel A. Cavigelli,[3] Steve W. Culman,[4] William Deen,[5] Craig F. Drury,[6] Axel Garcia y Garcia,[7] Amélie C.M. Gaudin,[8] W. Scott Harkcom,[9] R. Michael Lehman,[10] Shannon L. Osborne,[10] G. Philip Robertson,[11] Jonathan Salerno,[12] Marty R. Schmer,[13] Jeffrey Strock,[14] and A. Stuart Grandy[15]

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]

Crop rotations sustain cereal yields under a changing climate

Lorenzo Marini[1], Audrey St-Martin[2], Giulia Vico[3], Guido Baldoni[4], Antonio Berti[1], Andrzej Blecharczyk[5], Irena Malecka-Jankowiak[5], Francesco Morari[1], Zuzanna Sawinska[5] and Riccardo Bommarco[2]

Positive outcomes between crop diversity and agricultural employment worldwide

Lucas A. Garibaldi*, Néstor Pérez-Méndez

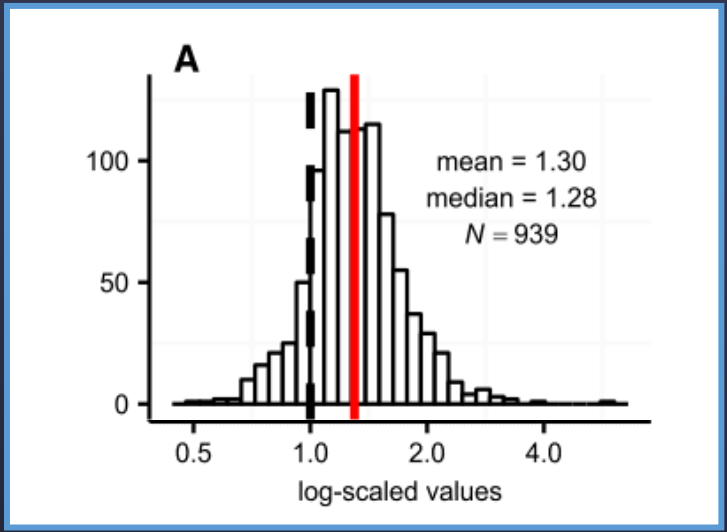
Farm performance and input self-sufficiency increases with functional crop diversity on Swedish farms

Pia Nilsson[b,*], Riccardo Bommarco[a], Helena Hansson[b], Brian Kuns[c], Henning Schaak[b]

Perenniality and diversity drive output stability and resilience in a 26-year cropping systems experiment

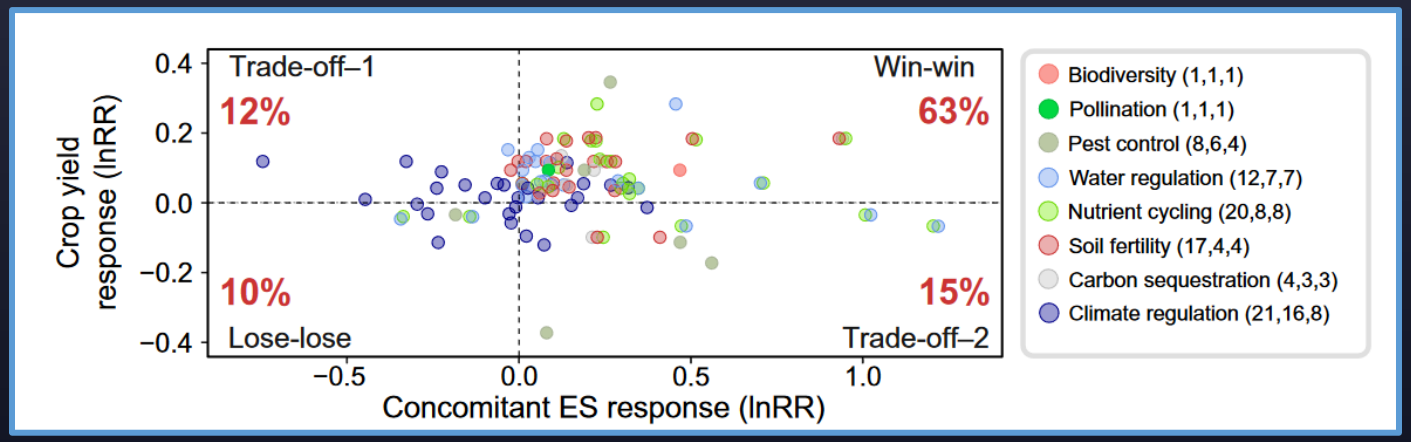
Gregg R. Sanford[a,*], Randall D. Jackson[a], Eric G. Booth[a,b], Janet L. Hedtcke[c], Valentin Picasso[a]

… or is it??



Meta-analyses show **20-30% higher** mean productivity in intercrops compared to monocrops, but the distribution of effect sizes across different studies ***ranges from around half to more than double …***

- Martin-Guay at al 2019, *Sci Tot Env* 615:767
- Yu et al 2016, *Agron J* 108(6):2269
- Yu et al 2016 *Field Crops Res* 198:269
- Daryanto et al 2020, *Agric Sys* 178:102761
- Li et al 2020, *Nat Plants* 6(6):653.



Most of the time diversification improves yields AND ecosystem services… ***but sometimes it decreases both – oops!***

- Tamburini et al 2020, *Sci Advances* 6(45)

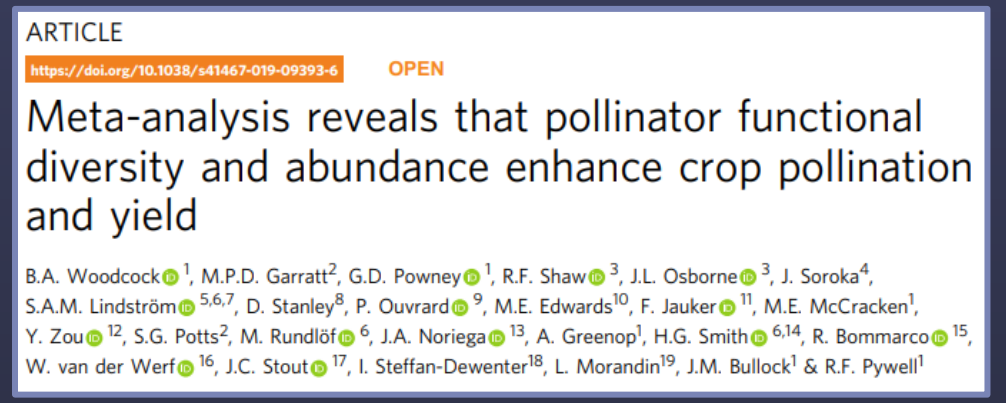
On average diversity is very beneficial …

… how do we make sure diversity is ***always*** beneficial?

Functional diversity is a good start

- Mix different types of crops together (plant families, seasonality, growth forms, lifespans)

- Maximise functional complementarity
- Maximise multi-functionality

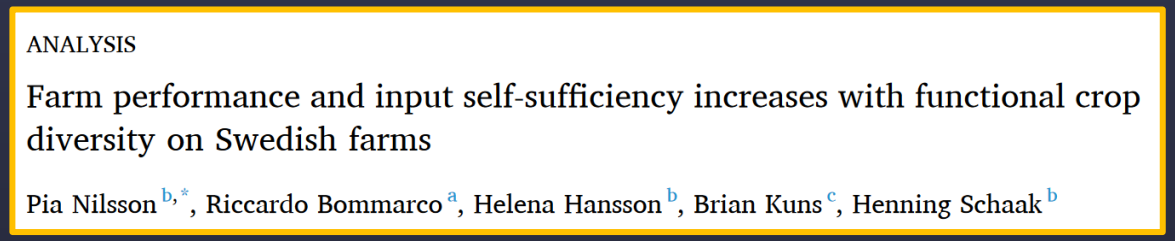


ARTICLE

https://doi.org/10.1038/s41467-019-09393-6 OPEN

Meta-analysis reveals that pollinator functional diversity and abundance enhance crop pollination and yield

B.A. Woodcock[1], M.P.D. Garratt[2], G.D. Powney[1], R.F. Shaw[3], J.L. Osborne[3], J. Soroka[4], S.A.M. Lindström[5,6,7], D. Stanley[8], P. Ouvrard[9], M.E. Edwards[10], F. Jauker[11], M.E. McCracken[1], Y. Zou[12], S.G. Potts[2], M. Rundlöf[6], J.A. Noriega[13], A. Greenop[1], H.G. Smith[6,14], R. Bommarco[15], W. van der Werf[16], J.C. Stout[17], I. Steffan-Dewenter[18], L. Morandin[19], J.M. Bullock[1] & R.F. Pywell[1]



ANALYSIS

Farm performance and input self-sufficiency increases with functional crop diversity on Swedish farms

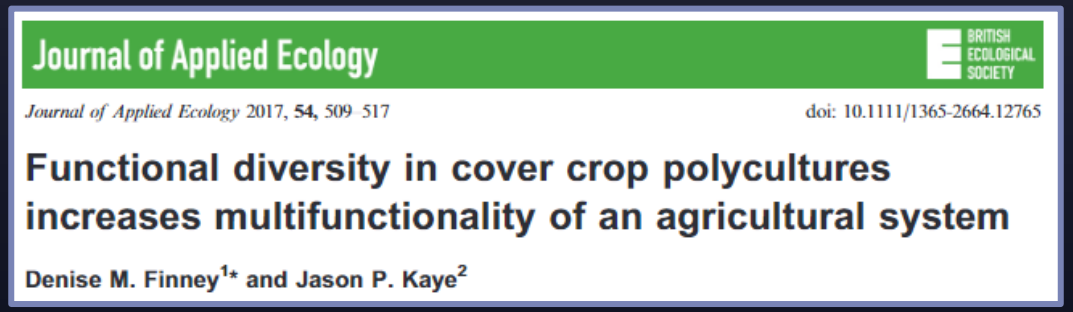
Pia Nilsson[b,*], Riccardo Bommarco[a], Helena Hansson[b], Brian Kuns[c], Henning Schaak[b]

RESEARCH ARTICLE

Journal of Applied Ecology BRITISH ECOLOGICAL SOCIETY

Crop functional diversity drives multiple ecosystem functions during early agroforestry succession

Diego dos Santos[1,2] | Fernando Joner[1] | Bill Shipley[3] | Marinice Teleginski[1] | Renata Rodrigues Lucas[1] | Ilyas Siddique[1]



Journal of Applied Ecology BRITISH ECOLOGICAL SOCIETY

Journal of Applied Ecology 2017, **54**, 509–517 doi: 10.1111/1365-2664.12765

Functional diversity in cover crop polycultures increases multifunctionality of an agricultural system

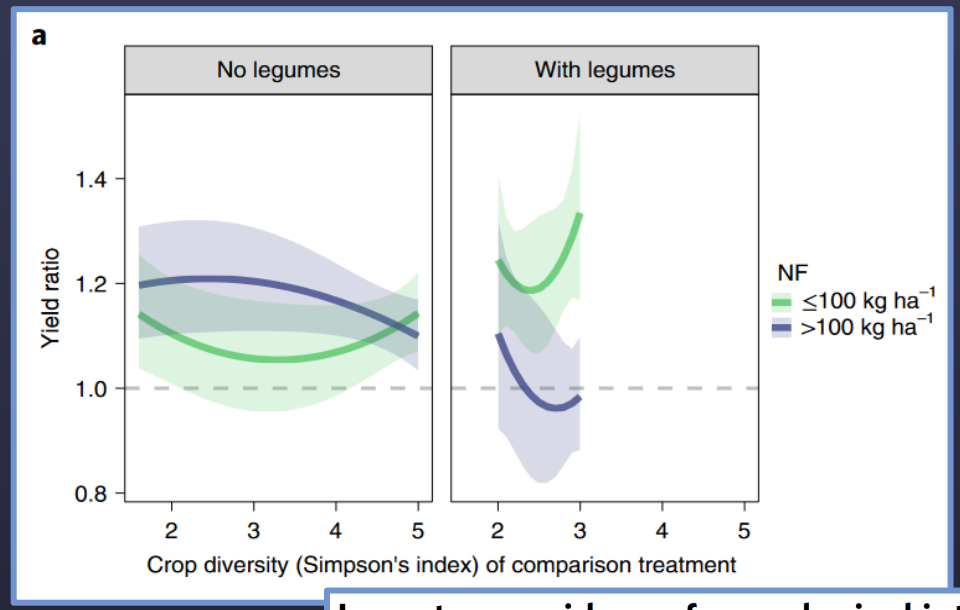
Denise M. Finney[1]* and Jason P. Kaye[2]

The right functions for the right context – even better

Cover Crop Biomass Production Is More Important than Diversity for Weed Suppression

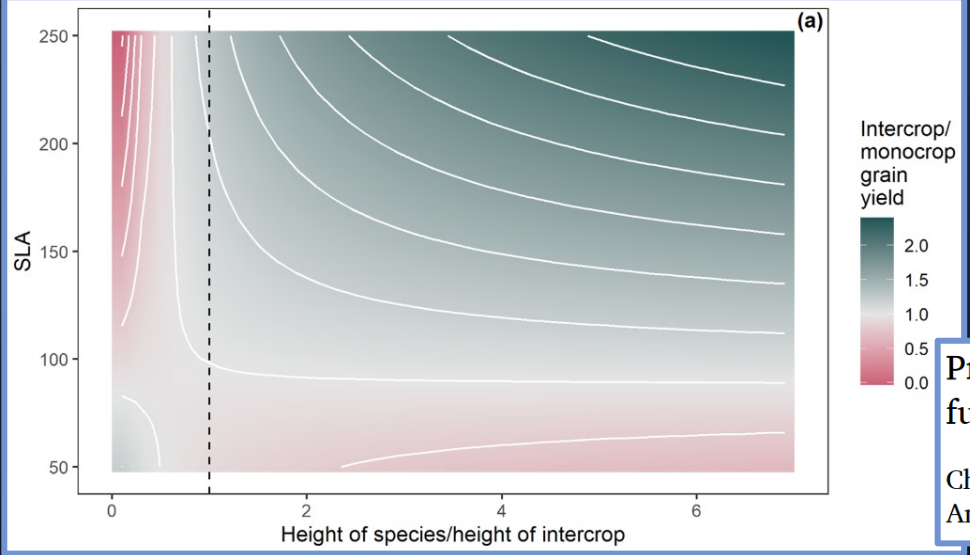
Chloe MacLaren,* Pieter Swanepoel, James Bennett, Julia Wright, and Katharina Dehnen-Schmutz

results indicate that it is important to consider the competitiveness of individual species when designing cover crop mixes. Diverse mixes remain valuable to perform multiple functions but may contribute to weed problems if composed of poorly competitive species.



Long-term evidence for ecological intensification as a pathway to sustainable agriculture

Chloe MacLaren[1,2✉], Andrew Mead[3], Derk van Balen[4], Lieven Claessens[4,5], Ararso Etana[6], Janjo de Haan[4], Wiepie Haagsma[4], Ortrud Jäck[7], Thomas Keller[6,8], Johan Labuschagne[9], Åsa Myrbeck[6,10], Magdalena Necpalova[11,12], Generose Nziguheba[13], Johan Six[12], Johann Strauss[2,9], Pieter Andreas Swanepoel[2], Christian Thierfelder[14], Cairistiona Topp[15], Flackson Tshuma[2], Harry Verstegen[4], Robin Walker[16], Christine Watson[7,16], Marie Wesselink[4] and Jonathan Storkey[1]



Predicting intercrop competition, facilitation, and productivity from simple functional traits

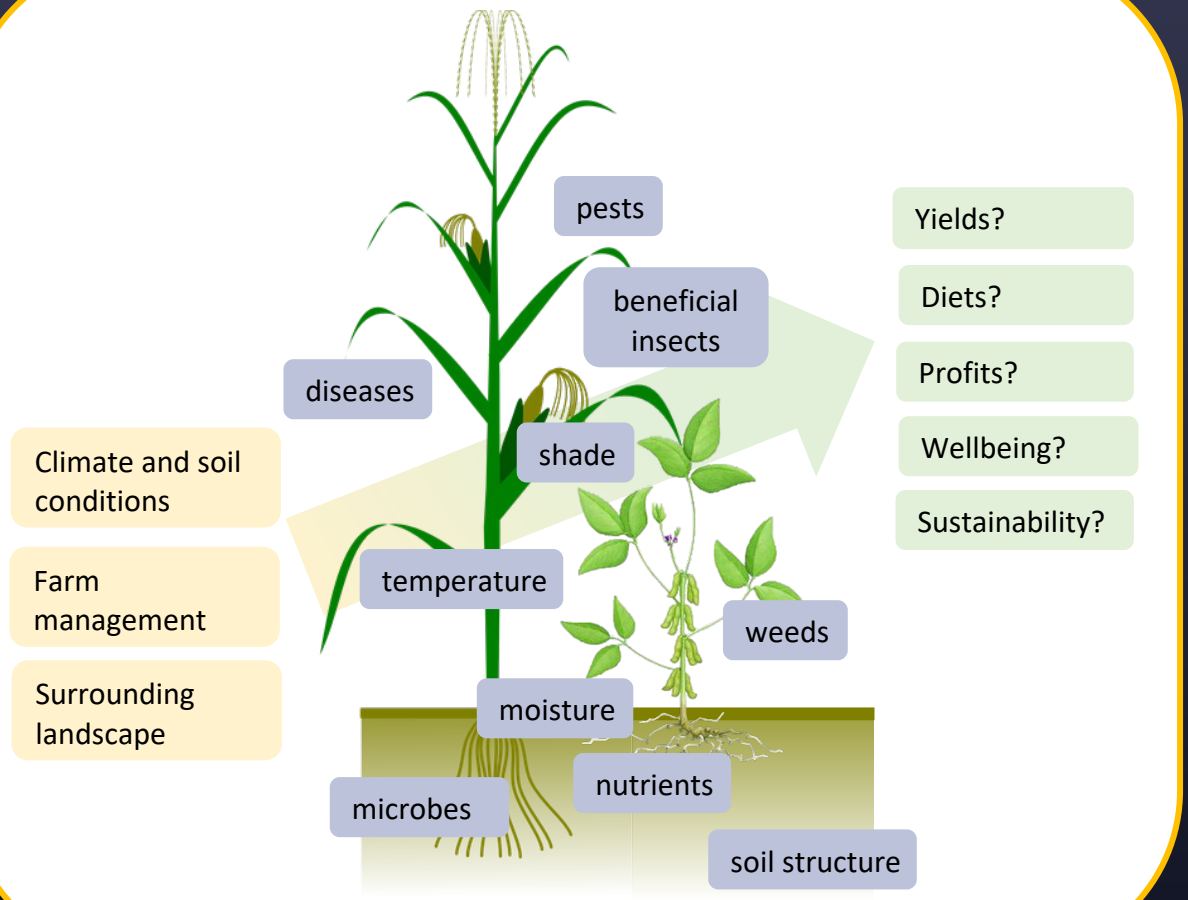
Chloe MacLaren[a,b,*], Wycliffe Waswa[c], Kamaluddin Tijjani Aliyu[d], Lieven Claessens[e], Andrew Mead[f], Christian Schöb[g], Bernard Vanlauwe[c], Jonathan Storkey[a]

How to combine the right functions?

Explore **interactions**:

- between crops
- other organisms
- farm management practices
- the biophysical environment
- the socioeconomic context

Enable the design and implementation of **reliable and effective** diversification strategies



My next steps?

Which diversification strategies for maize farming in southern Africa best maximise benefits and minimise costs?

CIMMYT
International Maize and Wheat Improvement Center









Thank you!

Questions?

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