

# A systematic synthesis of agricultural management impacts on crop yield, soil quality, and environment

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*Knowledge transfer to society: soil education and evidence  
in agro-environmental sciences*

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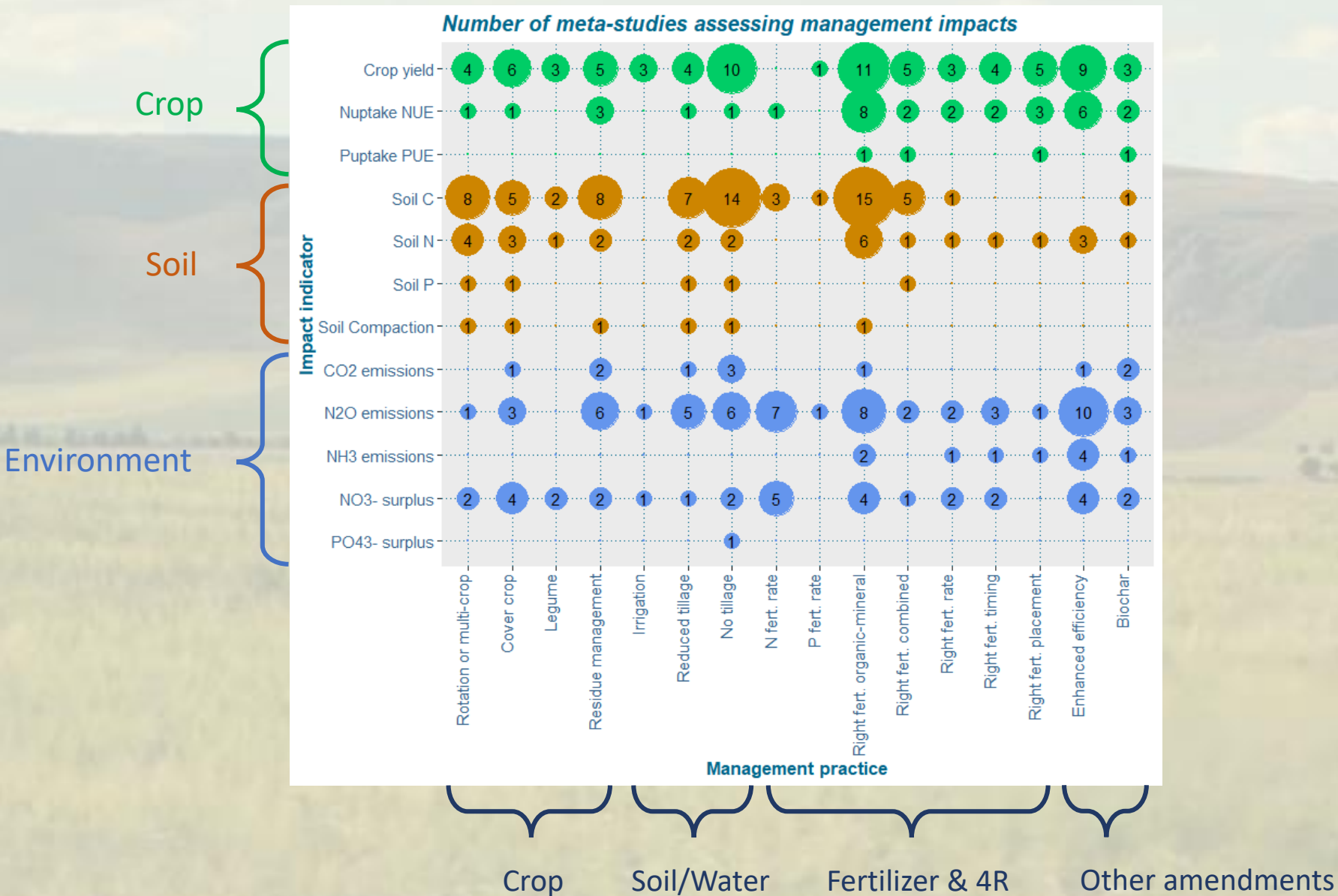


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# Introduction

- Many meta-analysis studies have been done in agriculture, especially in the last decade (*Krupnik et al. 2019*).
- Our aim was to develop a decision support system and integrate simple algorithms on the effects of recommended agronomic management practices on agricultural sustainability indicators.
  - **Crop:** crop yield, N and P use efficiency (NUE and PUE)
  - **Soil:** C, N and P contents and soil compaction
  - **Environment:** N and P surplus, N ( $\text{NH}_3$  and  $\text{N}_2\text{O}$ ) losses to air
- This resulted in a review of 113 meta-studies to:
  - Identify gaps where more studies are needed
  - Synthesize mean effects of management while accounting for site properties

# Overview of selected studies



# Methods of selected studies

- Weighting

- 58% – weighted meta-analysis
- 40% – inverse-variance weighting
- 23% – inverse-variance weighting and removal of studies with missing variance

→ Indicates guidelines needed for weighting and study variance

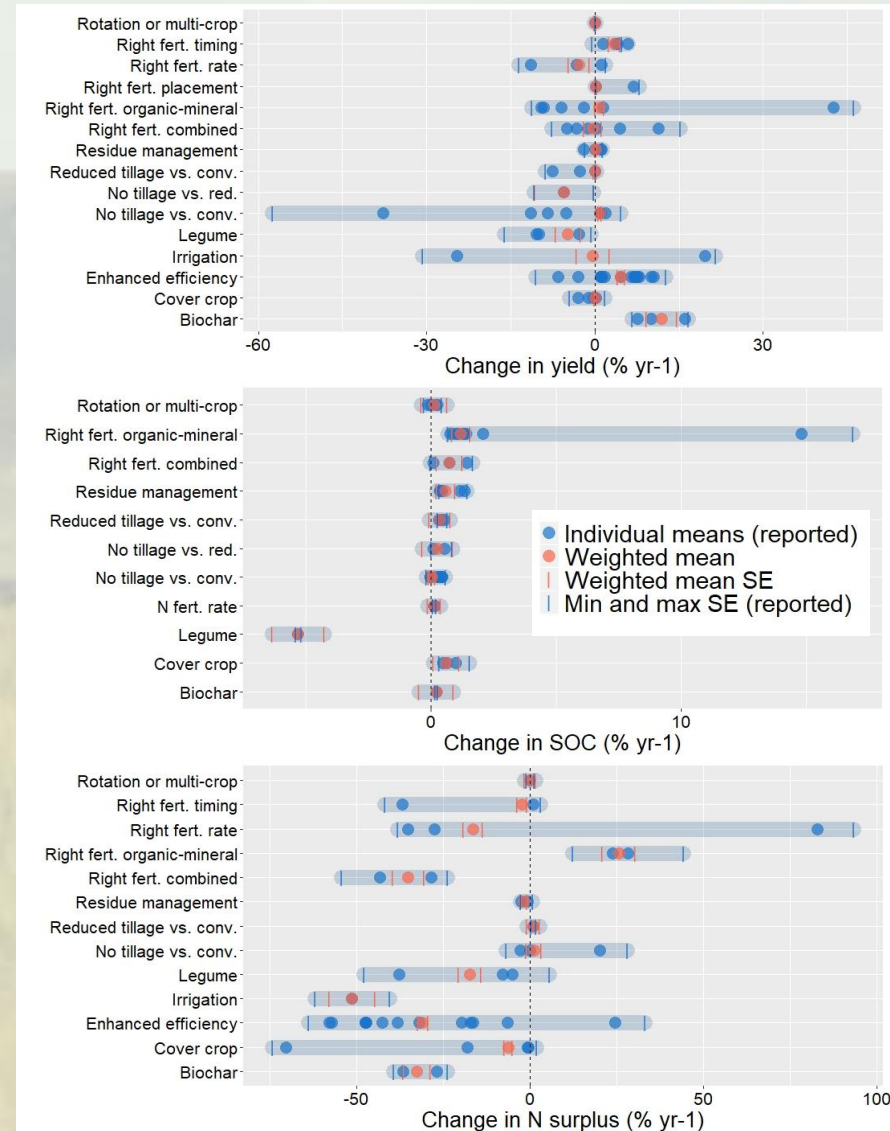
- Assessment of covariate effects (site properties)

- 58% – division of total observations into subgroups
- 23% – single factor multiple regression (one covariate)
- 7% – multiple factor multiple regression (several covariates)

→ Indicates data needed from field studies on site properties to allow for integrated analysis of local effects

# Synthesis of meta-analysis effect sizes

- Effects are quantified for all mentioned indicators
  - (Here key examples presented for crop yield, soil carbon, N surplus)
- More than 10 types of measures are evaluated
- Each individual mean is an effect size reported by one meta-study
  - All effects transformed to annual percentage change
- The weighted mean is the inverse-variance weighted mean of multiple individual means





# Effect of measures are site-specific!

Overall effect, synthesized by  
major types of management



Average deviation of covariate  
groups compared to overall effect



Indicator	Management measure	Overall impact (% yr-1)	n overall effect sizes	Average effects of covariates on impact of measure (+/-)															n covariate effect sizes
				Soil texture			Soil pH			Crop type			Climate			N fertilizer level			
				Coarse	Medium	Soil	Low	Medium	High	Maize	Grains	Root crops	Temperate	Subtropical	Tropical	Low	Medium	High	
yield	Diverse rotation	-0.04	8							+	-	+							4
	Organic-inorganic	1	12	-	+	-	+	+	+	-	+	-	+	-	+	-	-	-	16
	Reduced Tillage	-2	11	-	-	-	-	-	-	-	-	-	-	-	-				13
SOC	Diverse rotation	0.2	15	+	+	+				-	-		-	-					8
	Organic-inorganic	1	20	-	-	-	-	-	-	+	-		-	-	-	-	-	-	14
	Reduced Tillage	0.2	13	+	-	+				+	+		-	-	-	+		+	11
N2O emissions	Diverse rotation	-4	7	+	+	+	+	+	+		+			+	-	+	+	+	12
	Organic-inorganic	-5	4	+	-	-	-	+	+		+		-	-	+				10
	Reduced Tillage	4	4	+	+	-	-	+	+	-	-		+	-	-				11
N surplus	Diverse rotation	13	10	-	-	-													3
	Organic-inorganic	10	8								-								1
	Reduced Tillage	8	10																0

+ Positive/increase  
 - Negative/decrease  
 No data

→ This table illustrates that the overall effect of a measure depends on site properties