

Supplementary Information for

Global systematic review with meta-analysis reveals yield advantage of legume-based rotations and its drivers

Jie Zhao¹, Ji Chen², Damien Beillouin³, Hans Lambers⁴, Yadong Yang¹, Pete Smith⁵,

Zhaohai Zeng^{1, *}, Jørgen E. Olesen², Huadong Zang^{1, *}

¹ *College of Agronomy and Biotechnology, China Agricultural University, Beijing, China*

² *Department of Agroecology, Aarhus University, Blichers Allé 20, 8830 Tjele, Denmark*

³ *CIRAD, UPR HORTSYS, Montpellier, France*

⁴ *School of Biological Sciences and Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Crawley (Perth), WA 6009, Australia*

⁵ *Institute of Biological and Environmental Sciences, University of Aberdeen, 23 St Machar Drive, AB24 3UU Aberdeen, UK*

*Corresponding author

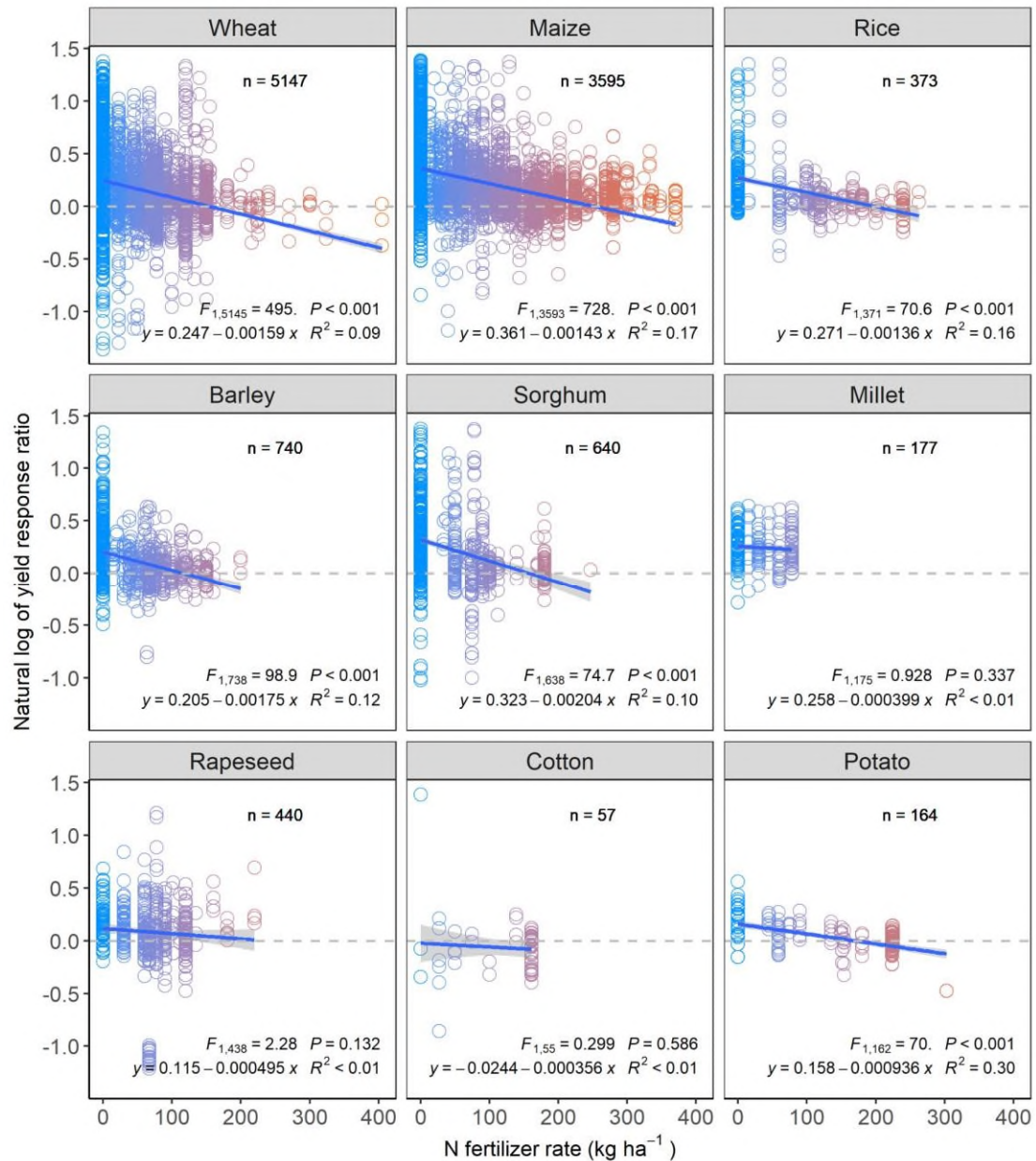
Zhaohai Zeng (zengzhaohai@cau.edu.cn)

Huadong Zang (zanghuadong@cau.edu.cn)

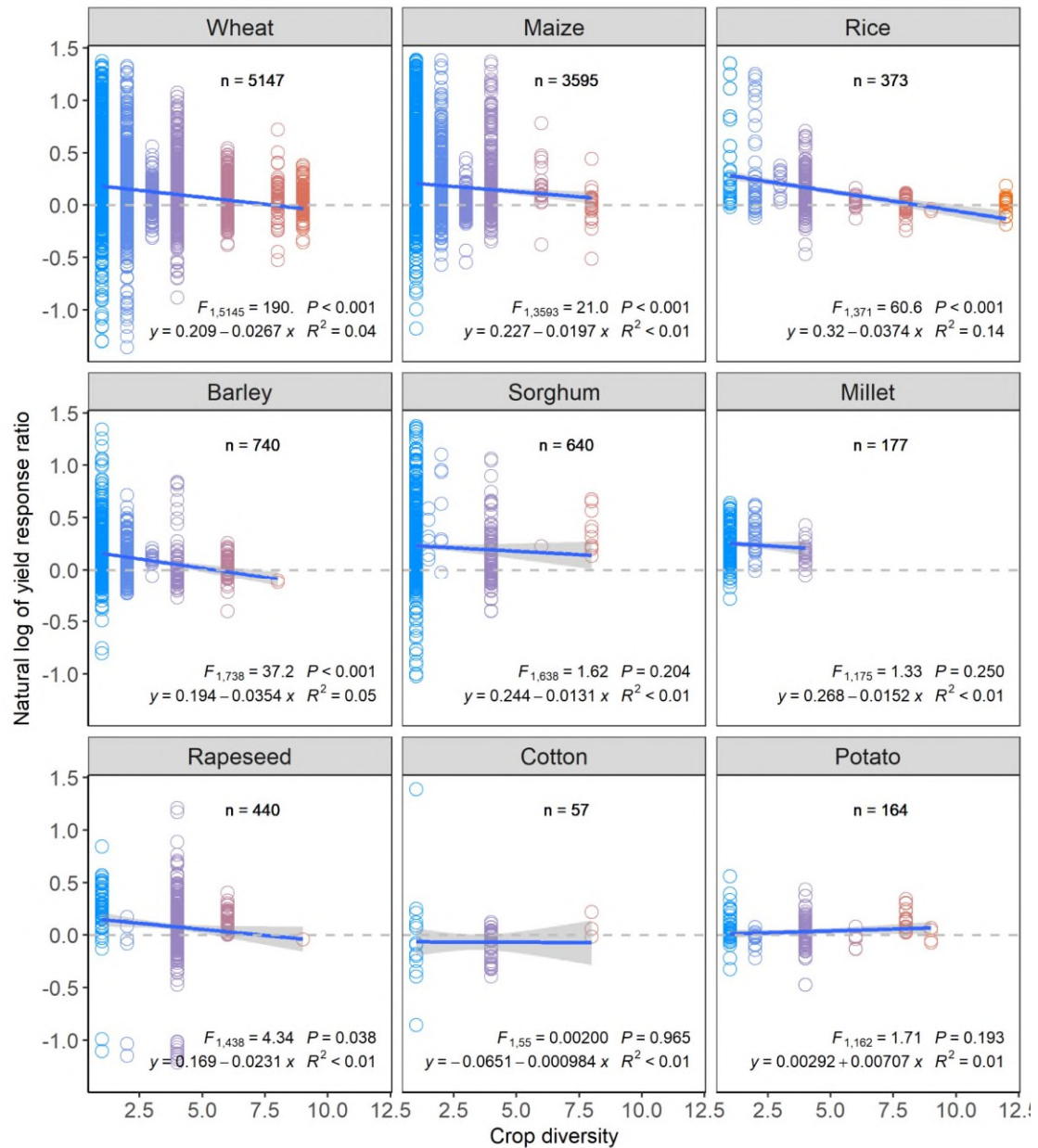
Supplementary Figures



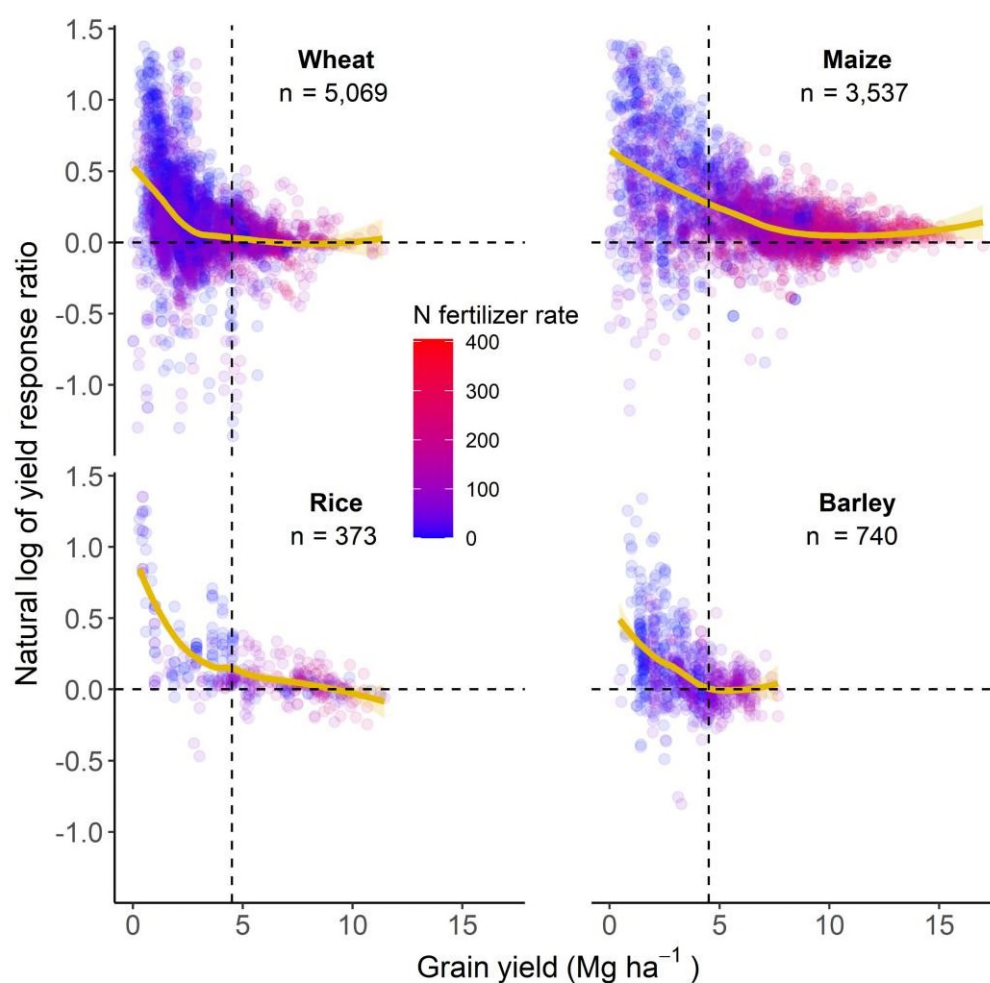
Supplementary Figure 1. Relative importance of 21 predictors determining the effect of legume pre-crops on main crop yield. The meta-forest models were fitted with different numbers of moderators by removing the variables containing missing values. **a**, 21 predictors, $n = 5676$ (208 studies). **b**, 20 predictors (no variable ‘main crop residue management’), $n = 6435$ (252 studies). **c**, 20 predictors (no variable ‘irrigation’), $n = 8256$ (297 studies). **d**, 19 predictors (no variable ‘main crop residue management’ and ‘irrigation’), $n = 9751$ (378 studies). The meta-forest analysis demonstrated that predictors ‘main crop residue management’ and ‘irrigation’ had a relatively small impact, whereas N fertilizer rate and crop diversity were always the most important predictors describing the response of main crop yield to legume-based crop rotation.



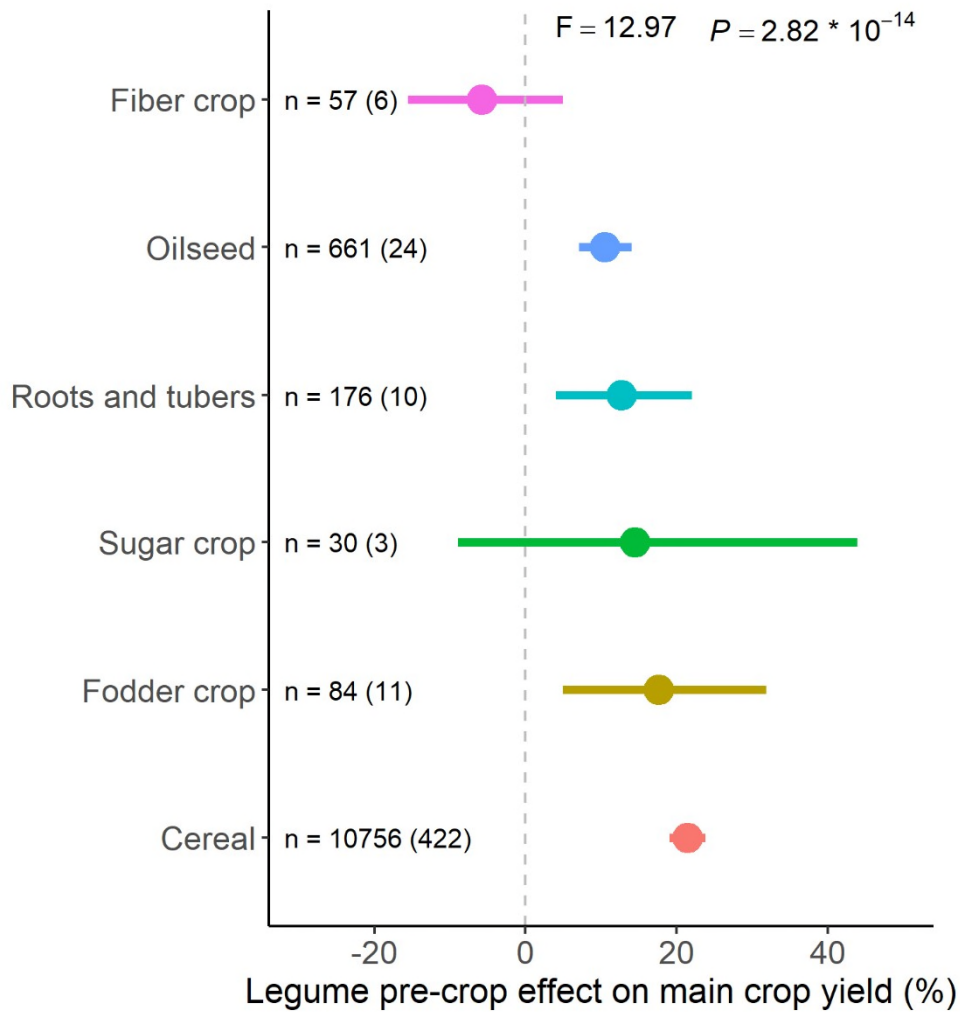
Supplementary Figure 2. Natural log of main crop yield ratios (main crop cultivated after legume pre-crops/main crop cultivated after non-legume pre-crops) as a function of the nitrogen (N) fertilizer rate (kg N ha^{-1}) applied to main crops. Linear relationships of N fertilizer rate and the natural log yield ratios of specific main crop species were fitted using a linear regression model. The blue curve in each panel indicates the average responses with their 95% confidence intervals indicated by shading.



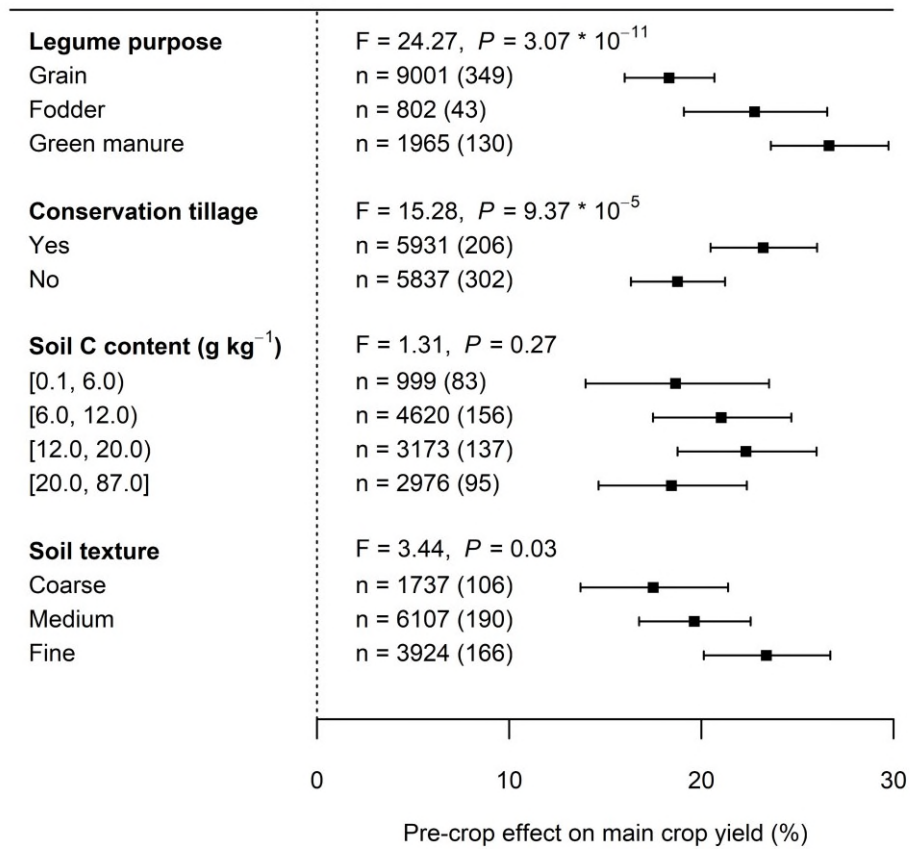
Supplementary Figure 3. Natural log of main crop yield ratios (main crop cultivated after legume pre-crops/main crop cultivated after non-legume pre-crops) as a function of the crop diversity (defined as number of crop species × number of crop functional groups × number of crop species per year) of main cropping systems. Linear relationships of crop diversity and the natural log yield ratios of specific main crop species were fitted using a linear regression model. The blue curve in each panel indicates the average responses with their 95% confidence intervals indicated by shading.



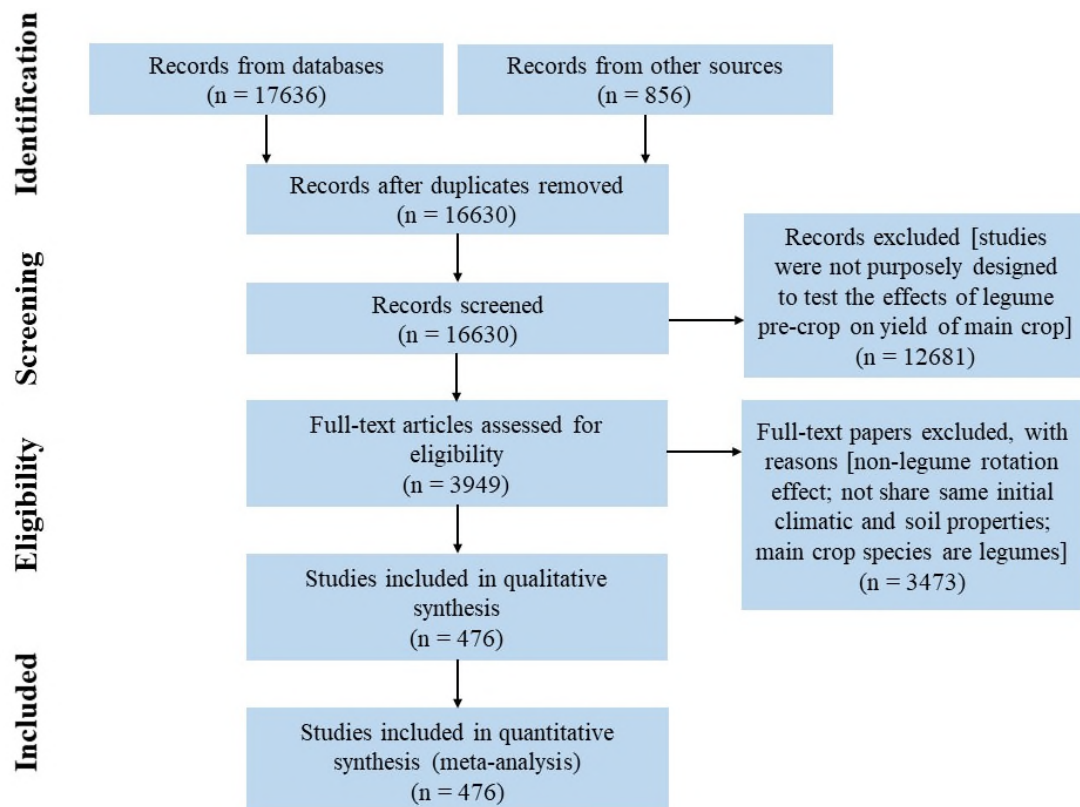
Supplementary Figure 4. The log yield response ratio (yield of crops following legumes vs. nonlegumes) decreased with increasing yield levels with a more pronounced pre-crop effect at low N fertilizer rate. The dashed horizontal and vertical lines were drawn at $\ln RR = 0$ and averaged grain yield of each crop, respectively. The solid lines and shading area represent the smoothed conditional average response and their 95% confidence intervals fitted by local weighted regression using “loess” function in R.



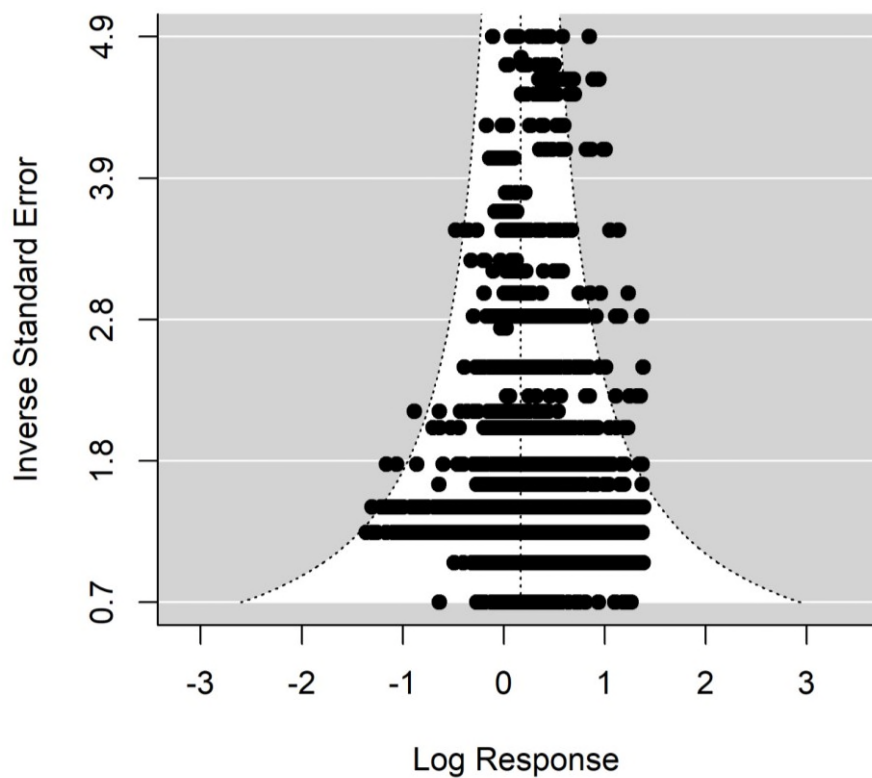
Supplementary Figure 5. Comparison of main crop yield in legume- versus non-legume-based cropping systems among functional groups of main crop species. Dots and horizontal bars represent overall effect sizes from a meta-analysis and 95% confidence intervals around the means. For each functional group, the number of observations is shown, with the number of studies in parentheses. Linear mixed-effect models used Satterthwaite approximation for degrees of freedom. *P* values, derived from the linear mixed model with the functional group as the fixed effect and study as the random effect, represent the significance of the difference in yield advantages among main crop types.



Supplementary Figure 6. Meta-analysis of legume pre-crop effects on main crop yield mediated by management and soil factors. For each sub-group, the number of observations is shown, with the number of studies in parentheses. Dots and horizontal bars represent overall effect sizes from a meta-analysis and 95% confidence intervals (CIs). Linear mixed-effect models used Satterthwaite approximation for degrees of freedom. Error bar does not overlap 0 means significant increase at $P < 0.05$. The mean effect sizes between groups were significantly different if their 95% CIs did not overlap with each other. Effect sizes were calculated and analyzed using log response-ratios, which were back-transformed and converted to percentage change.



Supplementary Figure 7. PRISMA diagram showing the process of locating publications included in the present meta-analysis.



Supplementary Figure 8. Funnel plots for log-response ratios of yield under legume- versus nonlegume-based cropping system.

Supplementary Table

Supplementary Table 1. Legume crop species, sample size, and their pre-crop effect on main crop yield, irrespective of main crop species

Common name	Scientific name	Number of data pairs	Number of studies	Effect on yield (%)	CI %
Soybean	<i>Glycine max</i>	3040	175	15.9	13.1 to 18.6
Pea	<i>Pisum sativum</i>	1866	69	21.4	18.1 to 24.6
Alfalfa	<i>Medicago sativa</i>	972	48	18.8	15.2 to 22.3
Faba bean	<i>Vicia faba</i>	936	31	21.5	17.6 to 25.4
Chickpea	<i>Cicer arietinum</i>	793	30	12.8	9.2 to 16.3
Clover	<i>Trifolium</i>	708	40	23.5	19.6 to 27.4
Lentil	<i>Lens culinaris</i>	671	29	15.4	11.8 to 19.0
Mixture	-	528	15	20.7	16.1 to 25.3
Vetch	<i>Vicia</i>	387	50	28.5	23.9 to 33.0
Lupine	<i>Lupinus</i>	381	22	29.3	24.2 to 34.4
Common bean	<i>Phaseolus vulgaris</i>	326	17	14.5	9.5 to 19.5
Cowpea	<i>Vigna unguiculata</i>	305	32	28.7	22.8 to 34.5
Mungbean	<i>Vigna radiata</i>	194	21	14.2	8.7 to 19.7
Peanut	<i>Arachis hypogaea</i>	132	21	19.2	12.0 to 26.3
Pigeon pea	<i>Cajanus cajan</i>	126	15	32.4	23.8 to 41.0
Lablab	<i>Lablab purpureus</i>	98	8	37.2	28.1 to 46.2
Sesbania	<i>Sesbania</i>	59	8	30.3	19.5 to 41.1
Black gram	<i>Vigna mungo</i>	37	6	16.0	3.7 to 28.3
Mucuna	<i>Mucuna</i>	37	7	58.6	43.1 to 74.1
Sunn hemp	<i>Crotalaria juncea</i>	37	5	25.7	12.6 to 38.8
Medic	-	31	6	19.0	11.3 to 26.7
Crotalaria	<i>Crotalaria</i>	24	4	60.4	33.6 to 87.1
Acacia angustissima	<i>Acaciella angustissima</i>	12	2	26.3	2.4 to 50.1
Desmanthus virgatus	<i>Desmanthus virgatus</i>	11	1	-2.3	-20.3 to 15.8
Misc. forage	-	10	1	67.7	20.0 to 115.3
Lima bean	<i>Phaseolus lunatus</i>	9	1	33.9	2.0 to 65.8
Jackbean	<i>Canavalia ensiformis</i>	7	1	68.1	23.6 to 112.6
Winged bean	<i>Psophocarpus tetragonolobus</i>	6	1	53.5	11.5 to 95.4
Cluster bean	<i>Cyamopsis tetragonoloba</i>	4	2	1.5	-18.5 to 21.5
Lathyrus	<i>Lathyrus</i>	4	2	30.2	11.4 to 49.0

Centrosema pascuorum	<i>Centrosema pascuorum</i>	3	1	56.7	-12.8 to 126.1
Chamaecrista rotundifolia	<i>Chamaecrista rotundifolia</i>	3	1	145.8	36.9 to 254.7
Stylosanthes	<i>Stylosanthes</i>	3	1	85.9	3.5 to 168.2

Supplementary Table 2. Main crop species, sample size, and their yield response to legume precrops, irrespective of legume crop species.

Common name	Scientific name	Number of data pairs	Number of studies	Effect on yield (%)	CI %
Wheat	<i>Triticum aestivum</i>	5147	137	14.6	11.4 to 17.7
Maize	<i>Zea mays</i>	3595	175	28.9	25.5 to 32.2
Barley	<i>Hordeum vulgare</i>	740	36	14.9	10.4 to 19.4
Sorghum	<i>Sorghum bicolor</i>	640	33	28.4	22.8 to 34.0
Rapeseed	<i>Brassica napus</i>	440	11	3.9	0.0 to 7.8
Rice	<i>Oryza sativa</i>	373	40	18.8	11.9 to 25.6
Millet	<i>Panicum miliaceum</i>	177	10	17.0	10.1 to 23.9
Potato	<i>Solanum tuberosum</i>	164	9	13.6	4.0 to 23.1
Sunflower	<i>Helianthus</i>	82	3	21.8	14.0 to 29.5
Cotton	<i>Gossypium</i>	57	6	-1.3	-12.0 to 9.5
Oat	<i>Avena sativa</i>	49	4	-0.2	-8.5 to 8.2
Buckwheat	<i>Fagopyrum esculentum</i>	42	1	5.4	-3.5 to 14.2
Safflower	<i>Carthamus tinctorius</i>	42	1	3.4	-5.6 to 12.4
Crambe	<i>Crambe</i>	41	1	-1.2	-9.9 to 7.6
Flax	<i>Linum usitatissimum</i>	41	1	1.9	-7.1 to 10.8
Triticale	<i>Triticosecale</i>	40	3	26.5	15.3 to 37.7
Sugarcane	<i>Saccharum</i>	26	3	8.9	-20.3 to 38.1
Rye	<i>Secale cereale</i>	20	5	26.5	9.2 to 43.8
Cuphea	<i>Cuphea</i>	12	1	18.9	2.5 to 35.2
Cassava	<i>Manihot esculenta</i>	9	1	-9.7	-44.8 to 25.4
Sudan grass	<i>Sorghum sudanense</i>	8	1	30.6	-17.4 to 78.5
Quinoa	<i>Chenopodium quinoa</i>	4	2	-7.5	-32.0 to 17.1
Sugar beet	<i>Beta vulgaris</i>	4	1	52.1	-7.6 to 111.8
Tobacco	<i>Nicotiana tabacum</i>	4	1	13.3	-35.3 to 61.8

Mustard	<i>Brassica juncea</i>	3	1	20.0	-6.2 to 46.1
Poa pratensis	<i>Poa pratensis</i>	3	1	21.2	-33.4 to 75.8
Sweet potato	<i>Ipomoea batatas</i>	3	1	4.5	-35.1 to 44.1
Teff	<i>Eragrostis tef</i>	2	1	16.4	-23.1 to 55.8

Supplementary Table 3. List of predictors used to examine the effect of legume-based rotations

Predictor	Class	Definition	Source
Latitude	Temperate	30°-66°	Reported in papers, Google map
	Subtropical	20°-30°	
	Tropical	0°-20°	
Altitude	-	Altitude of study site	Reported in papers
Mean annual temperature (MAT)	-	Long-term mean annual temperature	Reported in papers, WorldCli v 2.1
Mean annual precipitation (MAP)	-	Long-term mean annual precipitation	
Arid index	-	MAP divided by potential evapotranspiration	Reported in papers, WorldCli v 2.1
pH	-	Soil pH of top soil	Reported in papers, HWSD v 1.2
Soil organic carbon (SOC)	-	Soil organic carbon content in top soil (g kg ⁻¹)	Reported in papers, HWSD v 1.2
Total nitrogen (TN)	-	Soil total nitrogen concentration in topsoil (g kg ⁻¹)	Reported in papers, HWSD v 1.2
Soil texture	Coarse	Following USDA textural classification of soils	Reported in papers, HWSD v 1.2
	Medium		
	Fine		
Pre-crop species	-	Preceding legume crop species	Reported in papers
Pre-crop purpose	Seed	Preceding legume crop purpose	Reported in papers
	Green manure		
	Fodder		
Pre-crop residue management	Retain		Reported in papers
	Remove		
Main crop species	-	Subsequent main crop species	Reported in papers
Main crop type	Cereal Roots and tubers	Following FAO definitions	
	Oilseed		
	Sugar crop		
	Fiber crop		
	Fodder crop		

Main cropping system diversity	-	Crop diversity of the main cropping system calculated using equation (1)	
Nitrogen fertilization	-	Nitrogen fertilization rate on main crop (kg ha ⁻¹)	Reported in papers
Irrigation	Irrigated Rainfed	Irrigation or not for main crop	Reported in papers
Conservation tillage	Yes No	Conservation tillage or not for main crop	Reported in papers
Main crop residue management	Retain Remove	Subsequent main crop residue management	Reported in papers

WorldCli v 2.1: WorldClim version 2.1 climate data for 1970-2000 (<https://worldclim.org/data/worldclim21.html>);
HWSD v 1.2: Harmonized World Soil Database v 1.2 (<http://www.fao.org/soils-portal/data-hub/soil-maps-and-databases/harmonized-world-soil-database-v12/en/>)

Supplementary Table 4. Description of paired cropping sequences in the initial cropping system and after legume inclusion and the example for the calculation of crop diversity of the initial cropping system.

Initial cropping system (nonlegume)	After legume inclusion (legume-based)	Number of crop species	Number of crop functional groups	Number of crops per year	Crop diversity	References
wheat-wheat	pea-wheat	1	1	1	1	Bonciarelli et al., 2016
maize-wheat	pea-wheat	2	1	1	2	Bonciarelli et al., 2016
maize-maize/wheat	soybeanmaize/wheat	2	1	1.5	3	Gao et al., 2014
sunflower-wheat	pea-wheat	2	2	1	4	Bonciarelli et al., 2016
timothy-rye-wheatbarley	clover-rye-wheatbarley	4	1	1	4	Ingver et al., 2018
sunflower-maizewheat	soybean-maizewheat	3	2	1	6	Studdert & Echeverria, 2000
rapeseed-barleywheat	vetch-barleywheat	3	2	1	6	Álvaro-Fuentes et al., 2009
radish/wheat	clover/wheat	2	2	2	8	Cicek et al., 2014
oat-barleyrapeseed-wheat	pea-wheatrapeseed-wheat	4	2	1	8	Christen et al., 1992

potato -wheat/maize	peanut wheat/maize	3	2	1.5	9	Wang et al., 2020
buckwheat sunflower-wheat	chickpea sunflower-wheat	3	3	1	9	Tanaka et al., 2010
rapeseed /rice/rice	milkvetch /rice/rice	2	2	3	12	Qaswar et al., 2019
rapeseed -maizewheat-tobacco	soybean -maizewheat-tobacco	4	3	1	12	Butorac et al., 1999

‘-’, annual cropping; ‘/’, multiple cropping; paired initial cropping system (non-legume cropping system) and after legume inclusion (legume-based cropping system) in a cropping sequence are shown in boldface.

Supplementary Table 5. Performance of the metaforest models fitted with different numbers of moderators by removing the variables containing missing values.

Number of variables	Removed variable	Number of data pairs	Number of studies	RMSE	R_{oob}^2	R_{cv}^2
21	/	5,676	208	0.1957	0.5053	0.5051
20	main crop residue management	6,435	252	0.1941	0.4987	0.4932
20	Irrigation	8,256	297	0.2024	0.5046	0.4996
19	Main crop residue management, irrigation	9,751	378	0.2033	0.5135	0.4992
18	Main crop residue management, irrigation, and pre-crop residue management	11,768	462	0.2127	0.4615	0.4592

Root mean square error (RMSE) was used to select the optimal model using the smallest value; R_{oob}^2 , out of bag R^2 of the final model; R_{cv}^2 , cross-validated R^2 of the final model.

Supplementary references

- 1 Alvaro-Fuentes, J., Lampurlanes, J. & Cantero-Martinez, C. Alternative crop rotations under Mediterranean no-tillage conditions: biomass, grain yield, and water-use efficiency. *Agron. J.* **101**, 1227-1233, doi:10.2134/agronj2009.0077 (2009).
- 2 Bonciarelli, U. *et al.* Long-term evaluation of productivity, stability and sustainability for cropping systems in Mediterranean rainfed conditions. *Eur. J. Agron.* **77**, 146-155, doi:10.1016/j.eja.2016.02.006 (2016).
- 3 Butorac, A. *et al.* Results of long-term experiments with growing flue-cured tobacco (*Nicotiana tabacum* L.) in monoculture and different types of crop rotations. *J. Agron. Crop Sci.* **183**, 271-285, doi:10.1046/j.1439-037x.1999.00349.x (1999).
- 4 Christen, O., Sieling, K. & Hanus, H. The effect of different preceding crops on the development, growth and yield of winter wheat. *Eur. J. Agron.* **1**, 21-28, doi:10.1016/s11610301(14)80058-0 (1992).
- 5 Cicek, H., Entz, M. H., Martens, J. R. T. & Bullock, P. R. Productivity and nitrogen benefits of late-season legume cover crops in organic wheat production. *Can. J. Plant Sci.* **94**, 771-783, doi:10.4141/cjps2013-130 (2014).
- 6 Gao, B. *et al.* Nitrous oxide and methane emissions from optimized and alternative cereal cropping systems on the North China Plain: A two-year field study. *Sci. Total Environ.* **472**, 112-124, doi:10.1016/j.scitotenv.2013.11.003 (2014).
- 7 Ingver, A. *et al.* Leguminous pre-crops improved quality of organic winter and spring cereals. *Biol. Agric. Hortic.* **35**, 46-60, doi:10.1080/01448765.2018.1509728 (2019).
- 8 Qaswar, M. *et al.* Long-term green manure rotations improve soil biochemical properties, yield sustainability and nutrient balances in acidic paddy soil under a rice-based cropping system. *Agronomy-Basel* **9**, doi:10.3390/agronomy9120780 (2019).
- 9 Studdert, G. A. & Echeverria, H. E. Crop rotations and nitrogen fertilization to manage soil organic carbon dynamics. *Soil Sci. Soc. Am. J.* **64**, 1496-1503, doi:10.2136/sssaj2000.6441496x (2000).
- 10 Tanaka, D. L., Liebig, M. A., Krupinsky, J. M. & Merrill, S. D. Crop sequence influences on sustainable spring wheat production in the northern Great Plains. *Sustainability* **2**, 3695-3709, doi:10.3390/su2123695 (2010).
- 11 Wang, L. *et al.* Effects of seven diversified crop rotations on selected soil health indicators and wheat productivity. *Agronomy-Basel* **10**, doi:10.3390/agronomy10020235 (2020).

Supplementary note: Publications used for the meta-analysis

- 1 Acharya, U., Chatterjee, A. & Daigh, A.L.M. Effect of subsurface drainage, crop rotation, and tillage on crop yield in Fargo clay soil. *J. Soil Water Conserv.* **74**, 456-465 (2019).
- 2 Adamou, A., Bationo, A., Tabo, R. & Koala, S. in *Advances in Integrated Soil Fertility Management in Sub-Saharan Africa: Challenges and Opportunities*. (ed A. Bationo, Waswa, B., Kihara, J., Kimetu, J.) 589-598 (Springer, 2007).
- 3 Adams, A. M. *et al.* Long-term effects of integrated soil fertility management practices on soil chemical properties in the Sahel. *Geoderma* **366**, doi:10.1016/j.geoderma.2020.114207 (2020).
- 4 Adeux, G., Giuliano, S., Cordeau, S., Savoie, J. & Alletto, L. Low-input maize-based cropping systems implementing IWM match conventional maize monoculture productivity and weed control. *Agriculture-Basel* **7**, 74 (2017).
- 5 Adiku, S.G.K., Jones, J.W., Kumaga, F.K. & Tonyigah, A. Effects of crop rotation and fallow residue management on maize growth, yield and soil carbon in a savannah-forest transition zone of Ghana. *J. Agric. Sci.* **147**, 313-322 (2009).
- 6 Adjei-Nsiah, S. et al. Farmers' agronomic and social evaluation of productivity, yield and N₂-fixation in different cowpea varieties and their subsequent residual N effects on a succeeding maize crop. *Nutr. Cycl. Agroecosystems* **80**, 199-209 (2008).
- 7 Adjei-Nsiah, S., Kuyper, T.W., Leeuwis, C., Abekoe, M.K. & Giller, K.E. Evaluating sustainable and profitable cropping sequences with cassava and four legume crops: Effects on soil fertility and maize yields in the forest/savannah transitional agro-ecological zone of Ghana. *Field. Crop. Res.* **103**, 87-97 (2007).
- 8 Agomoh, I.V., Drury, C.F., Phillips, L.A., Reynolds, W.D. & Yang, X. Increasing crop diversity in wheat rotations increases yields but decreases soil health. *Soil Sci. Soc. Am. J.* **84**, 170-181 (2020).
- 9 Agustin, E.O. et al. Role of indigo in improving the productivity of rainfed lowland rice-based cropping systems. *Exp. Agric.* **35**, 201-210 (1999).
- 10 Ahmad, T., Hafeez, F.Y., Mahmood, T. & Malik, K.A. Residual effect of nitrogen fixed by mungbean (*vigna radiata*) and blackgram (*Vigna Mungo*) on subsequent rice and wheat crops. *Aust. J. Exp. Agric.* **41**, 245-248 (2001).
- 11 Ai, C. et al. Distinct responses of soil bacterial and fungal communities to changes in fertilization regime and crop rotation. *Geoderma* **319**, 156-166 (2018).
- 12 Aiken, R.M., O'Brien, D.M., Olson, B.L. & Murray, L. Replacing fallow with continuous cropping reduces crop water productivity of semiarid wheat. *Agron. J.* **105**, 199-207 (2013). Akande, M.O., Makinde, E.A. & Adetunji, M.T. Response of maize and cowpea grown
- 13 sequentially to application of phosphate rock in the humid tropics. *Commun. Soil Sci. Plant Anal.* **42**, 1027-1037 (2011).
- 14 Álvaro-Fuentes, J., Lampurlanés, J. & Cantero-Martínez, C. Alternative crop rotations under Mediterranean no-tillage conditions: Biomass, grain yield, and water-use efficiency. *Agron. J.* **101**, 1227-1233 (2009).
- 15 Anders, M. M. *et al.* The effect of rotation, tillage, fertility, and variety on rice grain yield and nutrient uptake. AAES Research Series **529**, 250-258 (2004).
- 16 Andrade, J.F., Poggio, S.L., Ermácora, M. & Satorre, E.H. Land use intensification in the rolling pampa, Argentina: Diversifying crop sequences to increase yields and resource use.

- Eur. J. Agron.* **82**, 1-10 (2017).
- Anyanzwa, H. et al. Effects of conservation tillage, crop residue and cropping systems on changes in soil organic matter and maize–legume production: A case study in Teso District.
- Nutr. Cycl. Agroecosystems* **88**, 39-47 (2010).
- Ardjasa, W.S.R.A., Ando, H. & Kimura, M. Yield and soil erosion among cassava-based cropping patterns in South Sumatra. *Soil Sci. Plant Nutr.* **47**, 101-112 (2001).
- Arihara, J.H.N.A. & Karasawa, T. Effect of previous crops on arbuscular mycorrhizal formation and growth of succeeding maize. *Soil Sci. Plant Nutr.* **46**, 43-51 (2000).
- Armstrong, R.D. et al. Effects of long-term rotation and tillage practice on grain yield and protein of wheat and soil fertility on a Vertosol in a medium-rainfall temperate environment.
- Crop Past. Sci.* **70**, 1 (2019).
- Armstrong, R.D. et al. Legume and opportunity cropping systems in Central Queensland. 2. Effect of legumes on following crops. *Aust. J. Agric. Resour. Econ.* **50**, 925-936 (1999).
- Army, T. J. & Hide, J. C. Effects of green manure crops on dryland wheat production in the Great Plains Area of Montana. *Agron. J.* **51**, 196–198 (1959).
- Ashworth, A.J., Allen, F.L., Saxton, A.M. & Tyler, D.D. Long-term corn yield impacted by cropping rotations and bio-covers under no-tillage. *Agron. J.* **108**, 1495-1502 (2016).
- Ashworth, A.J., Owens, P.R. & Allen, F.L. Long-term cropping systems management influences soil strength and nutrient cycling. *Geoderma* **361**, 114062 (2020).
- Austenson, H.M., Wenhardt, A. & White, W.J. Effect of summer fallowing and rotation on yield of wheat, barley and flax. *Can. J. Plant Sci.* **50**, 659-666 (1970).
- Azevedo, D.M.P.D., Landivar, J., Vieira, R.M. & Moseley, D. The effect of cover crop and crop rotation on soil water storage and on sorghum yield. *Pesqui Agropecu Bras* **34**, 391-398 (1999).
- Badaruddin, M. & Meyer, D. W. Green-manure legume effects on soil nitrogen, grain yield, and nitrogen nutrition of wheat. *Crop Sci.* **30**, 819-825 (1990).
- Badaruddin, M. & Meyer, D.W. Forage legume effects on soil nitrogen and grain yield, and nitrogen nutrition of wheat. *Agron. J.* **81**, 419-424 (1989).
- Badaruddin, M. & Meyer, D.W. Grain legume effects on soil nitrogen, grain yield, and nitrogen nutrition of wheat. *Crop Sci.* **34**, 1304-1309 (1994).
- Bado, V., Bationo, A., Lompo, F., Cescas, M. & Sedogo, M. in *Advances in Integrated Soil Fertility Management in sub-Saharan Africa: Challenges and Opportunities*. (ed A. Bationo, Waswa, B., Kihara, J., Kimetu, J.) 171-177 (Springer, 2007).
- Bagayoko, M., Mason, S.C. & Sabata, R.J. Effects of previous cropping systems on soil nitrogen and grain sorghum yield. *Agron. J.* **84**, 862-868 (1992).
- Bakhshandeh, S., Corneo, P.E., Mariotte, P., Kertesz, M.A. & Dijkstra, F.A. Effect of crop rotation on mycorrhizal colonization and wheat yield under different fertilizer treatments.
- Agric. Ecosyst. Environ.* **247**, 130-136 (2017).
- Bakht, J., Shafi, M., Jan, M.T. & Shah, Z. Influence of crop residue management, cropping system and N fertilizer on soil N and C dynamics and sustainable wheat (*Triticum Aestivum* L.) production. *Soil Tillage Res.* **104**, 233-240 (2009).
- Baldock, J.O., Higgs, R.L., Paulson, W.H., Jackobs, J.A. & Shrader, W.D. Legume and

- 34 mineral N effects on crop yields in several crop sequences in the upper
Mississippi Valley.
Agron. J. **73**, 885-890 (1981).
- Balkcom, K. S. & Reeves, D. W. Sunn-hemp utilized as a legume cover crop for corn
35 production. *Agron. J.* **97**, 26–31 (2005).
- Ballesta, A. & Lloveras, J.I.D.R. Nitrogen replacement value of alfalfa to corn and wheat
36 under irrigated Mediterranean conditions. *Span J. Agric. Res.* **8**, 159-169 (2010).
- Bavougian, C.M., Sarno, E., Knezevic, S. & Shapiro, C.A. Cover crop species and termination
37 method effects on organic maize and soybean. *Biol. Agric. Hortic* **35**, 1-20 (2019).
- Beckie, H. J. & Brandt, S. A. Nitrogen contribution of field pea in annual cropping systems. 1.
38 Nitrogen residual effect. *Can. J. Plant Sci.* **77**, 311–322 (1997).
- Bell, L.W., Lawrence, J., Johnson, B. & Peoples, M.B. New ley legumes increase nitrogen 39
fixation and availability and grain crop yields in subtropical cropping systems. *Crop Past. Sci.*
68, 11 (2017).
- Bergerou, J.A., Gentry, L.E., David, M.B. & Below, F.E. Role of N₂ fixation in the soybean
40 N credit in maize production. *Plant Soil* **262**, 383-394 (2004).
- Biederbeck, V. O., Bouman, O. T., Campbell, C. A., Bailey, L. D. & Winkleman, G. E.
41 Nitrogen benefits from four green-manure legumes in dryland cropping systems. *Can. J. Plant
Sci.* **76**, 307–315 (1996).
- Bitew, Y., Alemayehu, G., Adeg, E. & Assefa, A. Impact of precursor crop and nitrogen
42 fertilizer on the productivity of finger millet based cropping system and soil fertility in Lake
Tana basin of Ethiopia. *J. Plant Nutr.* **43**, 1824-1839 (2020).
- Blevins, R. L., Herbek, J. H. & Frye, W. W. Legume cover crops as a nitrogen source for no-
43 till corn and grain sorghum. *Agron. J.* **82**, 769–772 (1990).
- Bolton, E.F., Dirks, V.A. & Aylesworth, J.W. Some effects of alfalfa, fertilizer and lime on 44
corn yield in rotations on clay soil during a range of seasonal moisture conditions. *Can. J.
Plant Sci.* **56**, 21-25 (1976).
- Bolton, E.F., Dirks, V.A. & McDonnell, M.M. The effect of drainage, rotation and fertilizer
45 on corn yield, plant height, leaf nutrient composition and physical properties of Brookston
clay soil in Southwestern Ontario. *Can. J. Plant Sci.* **62**, 297-309 (1982).
- Bonciarelli, U. et al. Long-term evaluation of productivity, stability and sustainability for
46 cropping systems in Mediterranean rainfed conditions. *Eur. J. Agron.* **77**, 146-155 (2016).
- Boomsma, C.R. et al. Maize grain yield responses to plant height variability resulting from
47 crop rotation and tillage system in a long-term experiment. *Soil Tillage Res.* **106**, 227-240
(2011).
- Borase, D. N. et al. Long-term impact of grain legumes and nutrient management practices on
48 soil microbial activity and biochemical properties. *Arch. Agron. Soil Sci.* **67**,
2015-2032, doi:10.1080/03650340.2020.1819532 (2021).
- Borrell, A.N. et al. Fungal diversity associated with pulses and its influence on the subsequent
49 wheat crop in the Canadian prairies. *Plant Soil* **414**, 13-31 (2017).
- Borrelli, K. et al. Transition cropping system impacts on organic wheat yield and quality.
50 *Renew. Agr. Food Syst.* **30**, 461-472 (2015).
- Boyer, C.N., Roberts, R.K., Larson, J.A., McClure, M.A. & Tyler, D.D. Risk effects on
51 optimal nitrogen rates for corn rotations in Tennessee. *Agron. J.* **107**, 896-902 (2015).
- Bremer, E., Janzen, H.H., Ellert, B.H. & McKenzie, R.H. Soil organic carbon after twelve

52 years of various crop rotations in an Aridic Boroll. *Soil Sci. Soc. Am. J.* **72**, 970-974 (2008).

Brye, K.R. et al. Methane emissions as affected by crop rotation and rice cultivar in the Lower
53 Mississippi River Valley, USA. *Geoderma Reg.* **11**, 8-17 (2017).

Bullied, W.J., Entz, M.H., Smith, J.S. & Bamford, K.C. Grain yield and N benefits to
54 sequential wheat and barley crops from single-year alfalfa, berseem and red clover, chickling
vetch and lentil. *Can. J. Plant Sci.* **82**, 53-65 (2002).

Bundy, L.G., Andraski, T.W. & Wolkowski, R.P. Nitrogen credits in soybean-corn crop
55 sequences on three soils. *Agron. J* **85**, 1061-1067 (1993).

Bunemann, E. K., Smithson, P. C., Jama, B., Frossard, E. & Oberson, A. Maize productivity
56 and nutrient dynamics in maize-fallow rotations in western Kenya. *Plant Soil* **264**, 195-208,
doi:10.1023/B:PLSO.0000047749.43017.f0 (2004).

Bünemann, E.K., Heenan, D.P., Marschner, P. & McNeill, A.M. Long-term effects of crop 57
rotation, stubble management and tillage on soil phosphorus dynamics. *Soil Res.* **44**, 611 (2006).

Buraczynska, D., Ceglarek, F., Gąsiorowska, B., Zaniewicz-Bajkowska, A. & Płaza, A.
58 Cultivation of wheat following pea and triticale/pea mixtures increases yields and nitrogen
content. *Acta Agric. Scand B Soil Plant Sci.* **61**, 622-632 (2011).

Buxton, D.R. et al. Performance of sweet and forage sorghum grown continuously, double-
59 cropped with winter rye, or in rotation with soybean and maize. *Agron. J.* **91**, 93-101 (1999).

Cai, S. et al. Rice rotation system affects the spatial dynamics of the diazotrophic community
60 in paddy soil of the Yangtze delta, China. *Eurasian Soil Sci+* **52**, 696-706 (2019).

Cai, S., Pittelkow, C.M., Zhao, X. & Wang, S. Winter legume-rice rotations can reduce
61 nitrogen pollution and carbon footprint while maintaining net ecosystem economic benefits. *J.*
Clean. Prod. **195**, 289-300 (2018).

Calzarano, F. et al. Durum wheat quality, yield and sanitary status under conservation
62 agriculture. *Agriculture* **8**, 140 (2018).

Campbell, C.A., Selles, F., Lafond, G.P., Biederbeck, V.O. & Zentner, R.P. Tillage-fertilizer
63 changes: Effect on some soil quality attributes under long-term crop rotations in a thin Black
Chernozem. *Can. J. Plant Sci.* **81**, 157-165 (2001).

Campbell, C.A., Zentner, R.P., Bowren, K.E., Townley-Smith, L. & Schnitzer, M. Effect of
64 crop rotations and fertilization on soil organic matter and some biochemical properties of a
Thick Black Chernozem. *Can. J. Plant Sci.* **71**, 377-387 (1991).

Campbell, C.A., Zentner, R.P., Selles, F., Biederbeck, V.O. & Leyshon, A.J. Comparative
65 effects of grain lentil–wheat and monoculture wheat on crop production, N economy and N
fertility in a Brown Chernozem. *Can. J. Plant Sci.* **72**, 1091-1107 (1992).

Campiglia, E., Paolini, R., Colla, G. & Mancinelli, R. The effects of cover cropping on yield
66 and weed control of potato in a transitional system. *Field. Crop. Res.* **112**, 16-23 (2009).

Cates, A.M. & Ruark, M.D. Soil aggregate and particulate C and N under corn rotations:
67 Responses to management and correlations with yield. *Plant Soil* **415**, 521-533 (2017).

Chapman, A.L. & Myers, R. Nitrogen contributed by grain legumes to rice grown in rotation
68 on the Cununurra soils of the Ord Irrigation Area, Western Australia. *Aust. J. Exp. Agric.*
27, 155-163 (1987).

Chen, S. et al. Effect of various crop rotations on rice yield and nitrogen use efficiency in
69 paddy–upland systems in southeastern China. *Crop J.* **6**, 576–588 (2018).

- Chen, S. *et al.* The influence of the type of crop residue on soil organic carbon fractions: An
 70 11-year field study of rice-based cropping systems in southeast China. *Agric. Ecosyst. Environ.* **223**, 261–269 (2016).
- Cheruiyot, E. K., Mumera, L. M., Nakhone, L. N. & Mwonga, S. M. Effect of
 legumemanaged fallow on weeds and soil nitrogen in following maize (*Zea mays* L.) and
 wheat
 71 (*Triticum aestivum* L.) crops in the Rift Valley highlands of Kenya. *Aust. J. Exp. Agric.* **43**,
 597–604 (2003).
- Cheruiyot, E. K., Mumera, L. M., Nakhone, L. N. & Mwonga, S. M. Rotational effects of
 72 grain legumes on maize performance in the Rift Valley Highlands of Kenya. *Afr. crop
 sci. j.*
 (Online) **9**, 667–676 (2001).
- Chikowo, R., Mapfumo, P., Leffelaar, P.A. & Giller, K.E. Integrating legumes to improve N
 73 cycling on smallholder farms in sub-humid Zimbabwe: Resource quality, biophysical and
 environmental limitations. *Nutr. Cycl. Agroecosystems* **76**, 219-231 (2007).
- Chikowo, R., Mapfumo, P., Nyamugafata, P. & Giller, K.E. Maize productivity and mineral N
 74 dynamics following different soil fertility management practices on a depleted sandy soil in
 Zimbabwe. *Agric. Ecosyst. Environ.* **102**, 119-131 (2004).
- Chikowo, R., Mapfumo, P., Nyamugafata, P. & Giller, K.E. Woody legume fallow
 75 productivity, biological N-2-fixation and residual benefits to two successive maize crops in
 Zimbabwe. *Plant Soil* **262**, 303-315 (2004).
- Cicek, H., Entz, M.H., Martens, J.R.T. & Bullock, P.R. Productivity and nitrogen benefits of
 76 late-season legume cover crops in organic wheat production. *Can. J. Plant Sci.* **94**, 771-
 783 (2014).
- Clay, S.A., Clay, S.A., Aguilar, I. & Aguilar, I. Weed seedbanks and corn growth following
 77 continuous corn or alfalfa. *Agron. J.* **90**, 813-818 (1998).
- Clegg, M.D. Effect of soybean on yield and nitrogen response of subsequent sorghum crops in
 78 Eastern Nebraska. *Field. Crop. Res.* **5**, 233-239 (1982).
- Congreves, K.A., Hooker, D.C., Hayes, A., Verhallen, E.A. & Van Eerd, L.L. Interaction of
 79 long-term nitrogen fertilizer application, crop rotation, and tillage system on soil carbon and
 nitrogen dynamics. *Plant Soil* **410**, 113-127 (2017).
- Cox, H.W., Kelly, R.M. & Strong, W.M. Pulse crops in rotation with cereals can be a 80
 profitable alternative to nitrogen fertiliser in Central Queensland. *Crop Past. Sci.* **61**, 752
 (2010).
- Crookston, K. R., Kurle, J. E. & Lueschen, E. Relative ability of soybean, fallow, and 81
 triacontanol to alleviate yield reductions associated with growing corn continuously. *Crop Sci.*
28, 145–147 (1988).
- Crookston, R. K. & Kurle, J. E. Corn residue effect on the yield of corn and soybean grown in
 82 rotation. *Agron. J.* **81**, 229–232 (1989).
- Cutforth, H.W., Jefferson, P.G., Campbell, C.A. & Ljunggren, R.H. Yield, water use, and
 83 protein content of spring wheat grown after six years of alfalfa, crested wheatgrass,
 or spring wheat in semiarid Southwestern Saskatchewan. *Can. J. Plant Sci.* **90**, 489-
 497 (2010).

84 Daigh, A.L.M. et al. Subsurface drainage nitrate and total reactive phosphorus losses in
bioenergy-based prairies and corn systems. *J. Environ. Qual.* **44**, 1638-1646 (2015).

85 Daigh, A.L.M. et al. Yields and yield stability of no-till and chisel-plow fields in the
Midwestern us corn belt. *Field. Crop. Res.* **218**, 243-253 (2018).

86 Dalal, R.C. et al. Sustaining productivity of a Vertisol at Warra, Queensland, with fertilisers,
no-tillage, or legumes. 5. Wheat yields, nitrogen benefits and water-use efficiency of
chickpea-wheat rotation. *Aust. J. Exp. Agric.* **38**, 489-501 (1998).

87 Dalal, R.C. et al. Sustaining productivity of a Vertisol at Warra, Queensland, with fertilisers,
no-tillage or legumes. 8. Effect of duration of lucerne ley on soil nitrogen and water, wheat
yield and protein. *Aust. J. Exp. Agric.* **44**, 1013-1024 (2004).

88 Dapaah, H.K.C.R. & Vyn, T.J. Nitrogen fertilization and cover crop effects on soil structural
stability and corn performance. *Commun. Soil Sci. Plant Anal.* **29**, 2557-2569 (1998).

89 Das, A. et al. Tillage and cropping sequence effect on physico-chemical and biological
properties of soil in Eastern Himalayas, India. *Soil Tillage Res.* **180**, 182-193 (2018).

90 Davis, J.R. et al. Ecological relationships of verticillium wilt suppression of potato by green
manures. *Am. J. Potato Res.* **87**, 315-326 (2010).

91 Davis, R.A., Huggins, D.R., Cook, J.R. & Paulitz, T.C. Nitrogen and crop rotation effects on
fusarium crown rot in no-till spring wheat. *Can. J. Plant Pathol.* **31**, 456-467 (2009).

92 De, R., Yogeswara Rao, Y. & Ali, W. Grain and fodder legumes as preceding crops affecting
the yield and N economy of rice. *J. Agric. Sci.* **101**, 463-466 (1983).

93 Debaeke, P. & Hilaire, A. Production of rainfed and irrigated crops under different crop
rotations and input levels in Southwestern France. *Can. J. Plant Sci.* **77**, 539-548 (1997).

94 Delroy, N.D. & Bowden, J.W. Effect of deep ripping, the previous crop, and applied nitrogen
on the growth and yield of a wheat crop. *Aust. J. Exp. Agric.* **26**, 469-479 (1986). DeMaria,
I.C., Nnabude, P.C. & de Castro, O.M. Long-term tillage and crop rotation effects
95 on soil chemical properties of a Rhodic Ferralsol in Southern brazil. *Soil Tillage Res.* **51**,
7179 (1999).

96 Díaz-Ambrona, C.H. & Mínguez, M.I. Cereal-legume rotations in a Mediterranean
environment: Biomass and yield production. *Field. Crop. Res.* **70**, 139-151 (2001). Dick,
W. A., Van Doren, D. M., Triplett, G. B. & Henry, J. E. Influence of long-term tillage
97 and rotation combinations on crop yields and selected soil parameters. I. Results obtained
for a Mollic Ochraqualf soil. 30 (1986).

98 Dick, W. A., Van Doren, D. M., Triplett, G. B. & Henry, J. E. Influence of long-term tillage
and rotation combinations on crop yields and selected soil parameters. II. Results obtained
for a Typic Fragiudalf soil. 30 (1986).

99 Ding, W., Hume, D.J., Vyn, T.J. & Beauchamp, E.G. N credit of soybean to a following corn
crop in Central Ontario. *Can. J. Plant Sci.* **78**, 29-33 (1998).

100 Doolette, A. et al. Phosphorus uptake benefit for wheat following legume break crops in semi-
arid Australian farming systems. *Nutr. Cycl. Agroecosystems* **113**, 247-266 (2019).

101 Doughton, J.A. & Mackenzie, J. Comparative effects of black and green gram (mung
beans)
and grain sorghum on soil mineral nitrogen and subsequent grain sorghum yields on the
Eastern Darling Downs. *Aust. J. Exp. Agric.* **24**, 244-249 (1984).

102 Dowler, C. C., Hauser, E. W. & Johnson, A. W. Crop-herbicide sequences on a southeastern
Coastal Plain soil. *Weed Sci.* **22**, 500-505 (1974).

Drury, C.F. & Tan, C.S. Long-term (35 years) effects of fertilization, rotation and weather on
103 corn yields. *Can. J. Plant Sci.* **75**, 355-362 (1995).

Drury, C.F. et al. Impacts of 49-51 years of fertilization and crop rotation on growing season
104 nitrous oxide emissions, nitrogen uptake and corn yields. *Can. J. Plant Sci.* **94**, 421-433
(2014).

Dyke G. V. & Slope, D. B. Effects of previous legume and oat crops on grain yield and take-
105 all in spring barley. *J. Agric. Sci.* **91**, 443-451
(1978).

Ebelhar, S. A., Frye, W. W. & Blevins, R. L. Nitrogen from legume cover crops for no-tillage
106 corn. *Agron. J.* **76**, 51-55 (1984).

Eckert, D.J. Ridge planting for row crops on a poorly drained soil. 1. Rotation and drainage
107 effects. *Soil Tillage Res.* **18**, 181-188 (1990).

Edwards, J.H., Thurlow, D.L. & Eason, J.T. Influence of tillage and crop rotation on yields of
108 corn, soybean, and wheat. *Agron. J.* **80**, 76-80
(1988).

Eghball, B. & Varvel, G.E. Fractal analysis of temporal yield variability of crop sequences:
109 implications for site-specific management.
Agron. J. **89**, 851-855 (1997).

Ellis, J.R., Mason, S.C. & Roder, W. Grain sorghum-soybean rotation and fertilization
110 influence on vesicular-arbuscular mycorrhizal
fungi. *Soil Sci. Soc. Am. J.* **56**, 789-794 (1992). Engström,
L. & Lindén, B. Importance of soil mineral N in early spring
and subsequent net N 111 mineralisation for winter wheat
following winter oilseed rape and peas in a milder climate.
Acta. Agric. Scand B Soil Plant Sci. **59**, 402-413 (2009).

Entz, M.H., Bullied, W.J., Forster, D.A., Gulden, R. & Vessey, J.K. Extraction of subsoil
112 nitrogen by alfalfa, alfalfa-wheat, and perennial grass systems. *Agron. J.* **93**, 495-503 (2001).

Espinoza, S. et al. Contribution of legumes to wheat productivity in Mediterranean
113 environments of Central Chile. *Field. Crop. Res.* **133**, 150-159 (2012).

Espinoza, S., Ovalle, C. & Del Pozo, A. The contribution of nitrogen fixed by annual legume
114 pastures to the productivity of wheat in two contrasting Mediterranean environments in
Central Chile. *Field. Crop. Res.* **249**, 107709 (2020).

Evans, D.R., Williams, T.A. & Mason, S.A. Residual N effect of grazed white clover
115 (*trifolium repens*)/ryegrass (*Lolium perenne*) swards on subsequent yields of spring barley. *J.*
Agric. Sci. **118**, 175-178 (1992).

Evans, J. et al. Towards a more productive and sustainable cropping system in the democratic
116 people's republic of Korea. I. Rice production. *J. Sustain. Agric.* **33**, 528-551 (2009).

Fan, R. et al. Tillage and rotation effects on crop yield and profitability on a black soil in
117 Northeast China. *Can. J. Plant Sci* **92**, 463-470 (2012).

Faris, M.A., Smith, D.L. & Coulman, B.E. Plow down effects of different forage legume
118 species, cultivars, cutting strategies and seeding rates on the yields of subsequent crops. *Plant*
Soil **95**, 419-430 (1986).

Fischler, M. & Wortmann, C. S. Green manures for maize-bean systems in eastern Uganda:
119 Agronomic performance and farmers' perceptions. *Agrofor. Syst.* **47**, 123-138,
doi:10.1023/a:1006234523163 (1999).

Flower, K.C., Ward, P.R., Cordingley, N., Micin, S.F. & Craig, N. Rainfall, rotations and
120 residue level affect no-tillage wheat yield and gross margin in a Mediterranean-type
environment. *Field. Crop. Res.* **208**, 1-10 (2017).

121 Fordoński, G., Pszczółkowska, A., Krzebietke, S., Olszewski, J. & Okorski, A. Yield and
mineral composition of seeds of leguminous plants and grain of spring wheat as well as their
residual effect on the yield and chemical composition of winter oilseed rape seeds. *J. Elem.*
20, 827–838 (2015).

122 Fouli, Y. et al. Double cropping effects on forage yield and the field water balance. *Agric.*
Water Manag. **115**, 104–117 (2012).

123 Fox, R. H. & Piekielek, W. P. Fertilizer N equivalence of alfalfa, birdsfoot trefoil, and red
clover for succeeding corn crops. *J. Prod. Agric.* **317**, 313–317 (1988).

124 Franco, J.G. et al. Spring wheat yields following perennial forages in a semiarid no-till
cropping system. *Agron. J.* **110**, 2408–2416 (2018).

125 Franzluebbers, A.J., Hons, F.M. & Saladino, V.A. Sorghum, wheat and soybean production as
affected by long-term tillage, crop sequence and N fertilization. *Plant Soil* **173**,
55–65 (1995). Friberg, H., Persson, P., Jensen, D.F. & Bergkvist, G. Preceding
crop and tillage system affect
126 winter survival of wheat and the fungal communities on young wheat roots and in
soil. *FEMS Microbiol. Lett.* **366**, fnz189 (2019).

127 Gakale, L.P. & Clegg, M.D. Nitrogen from soybean for dryland sorghum. *Agron. J.* **79**, 1057–
1061 (1987).

128 Gan, Y.T. et al. Diversifying crop rotations with pulses enhances system productivity. *Sci.*
Rep. **5**, 14625 (2015).

129 Gan, Y.T. et al. Influence of diverse cropping sequences on durum wheat yield and protein in
the semiarid Northern Great Plains. *Agron. J.* **95**, 245–252 (2003).

130 Gan, Y.T., Hamel, C., Kutcher, H.R. & Poppy, L. Lentil enhances agroecosystem productivity
with increased residual soil water and nitrogen. *Renew. Agr. Food Syst.*
32, 319–330 (2017). Gao, Y., et al. Interactive effects of tillage practices and cropping
systems on the interannual 131 variation of soil carbon, nitrogen content and corn
yield in Mollisol. *Soil and Crops* **9**, 323334 (2020).

132 Gaudin, A.C.M. et al. Increasing crop diversity mitigates weather variations and improves
yield stability. *PLoS One* **10**, e0113261 (2015).

Gaudin, A.C.M., Janovicek, K., Deen, B. & Hooker, D.C. Wheat improves nitrogen use 133
efficiency of maize and soybean-based cropping systems. *Agric. Ecosyst. Environ.* **210**, 1–10
(2015).

134 Gentry, L.F., Ruffo, M.L. & Below, F.E. Identifying factors controlling the continuous corn
yield penalty. *Agron. J.* **105**, 295–303
(2013).

135 Gesch, R.W., Archer, D.W. & Forcella, F. Rotational effects of cuphea on corn, spring wheat,
and soybean. *Agron. J.* **102**, 145–153 (2010).

136 Ghosh, B.N., Khola, O.P.S., Bhattacharyya, R., Dadhwal, K.S. & Mishra, P.K. Effect of
potassium on soil conservation and
productivity of maize/cowpea based crop
rotations in the North-west Indian
Himalayas. *J. Mt. Sci.* **13**, 754–762 (2016).

Ghosh, P. K. et al. Grain legume inclusion in cereal-cereal rotation increased base crop 137
productivity in the long run. *Exp. Agric.* **56**, 142–158, doi:10.1017/s0014479719000243
(2020).

- Giambalvo *et al.* Nitrogen efficiency component analysis in wheat under rainfed
138 Mediterranean conditions: effects of crop rotation and nitrogen fertilization.
Options Mediterraneennes. Serie A, Seminaires Mediterraneens **60**, 169–173
(2004).
- Gill, K.S. Crop rotations compared with continuous canola and wheat for crop production and
139 fertilizer use over 6 yr. *Can. J. Plant Sci.* **98**, 1139-1149 (2018).
- Giri, G. & De, R. Effect of preceding grain legumes on dryland pearl millet in NW India. *Exp.*
140 *Agric.* **15**, 169-172 (1979).
- Gong, M.Q. *et al.* Effects of nitrogen reduction on rice yield and soil nutrients under different
141 rotation systems. *J. Anhui Agric. Sci.* **48**,152-156 (2020).
- Goplen, J.J. *et al.* Economic performance of crop rotations in the presence of herbicide-
142 resistant giant ragweed. *Agron. J.* **110**, 260-268 (2018).
- Götze, P., Rücknagel, J., Wensch-Dorendorf, M., Märlander, B. & Christen, O. Crop rotation
143 effects on yield, technological quality and yield stability of sugar beet after 45
trial years. *Eur. J. Agron.* **82**, 50-59 (2017).
- Grace, P.R., Oades, J.M., Keith, H.A. & Hancock, T.W. Trends in wheat yields and soil
144 organic carbon in the permanent rotation trial at the Waite Agricultural
Research Institute, South Australia. *Aust. J. Exp. Agric.* **35**, 857-864 (1995).
- Grageda-Cabrera, O.A. *et al.* Fertilizer dynamics in different tillage and crop rotation systems
145 in a Vertisol in Central Mexico. *Nutr. Cycl. Agroecosystems* **89**, 125-134
(2011).
- Griffin, T.S., Larkin, R.P. & Honeycutt, C.W. Delayed tillage and cover crop effects in potato
146 systems. *Am. J. Potato Res.* **86**, 79-87 (2009).
- Griffith, D.R., Kladvko, E.J., Mannering, J.V., West, T.D. & Parsons, S.D. Long-term tillage
147 and rotation effects on corn growth and yield on high and low organic matter,
poorly drained soils. *Agron. J.* **80**, 599-605 (1988).
- Grover, K. K., Karsten, H. D. & Roth, G. W. Corn grain yields and yield stability in four long-
148 term cropping systems. *Agron. J.* **101**, 940–946 (2009).
- Guertal, E.A., Bauske, E.M. & Edwards, J.H. Crop rotation effects on sweet potato yield and
149 quality. *J. Prod. Agric* **10**, 70-73 (1997).
- Gul, I., Akinci, C., Doran, I., Kilic, H. & Baytekin, H. Effects of different previous crops and
150 nitrogen rates on double cropping maize (*Zea mays* L.). *Asian J. Chem.* **20**, 2947
(2008).
- Halvorson, A.D. & Reule, C.A. Irrigated corn and soybean response to nitrogen under no-till
151 in Northern Colorado. *Agron. J* **98**, 1367-1374 (2006).
- Hamblin, J., Delane, R., Bishop, A. & Adam, G. The yield of wheat following lupins: Effects
152 of different lupin genotypes and management. *Aust. J. Agric. Res.* **44**, 645–649
(1993).
- Haque, I. & Lupwayi, N.Z. Nitrogen fixation by annual forage legumes and its contribution to
153 succeeding wheat in the Ethiopian Highlands. *J. Plant Nutr.* **23**, 963-977 (2000).
- Hargrove, W.L. Winter legumes as a nitrogen source for no-till grain sorghum. *Agron. J.* **78**,
154 70-74 (1986).
- Hargrove, W.L., Touchton, J.T. & Johnson, J.W. Previous crop influence on fertilizer nitrogen
155 requirements for double-cropped wheat. *Agron. J.* **75**, 855-859 (1983).
- Heenan, D.P. Effects of broad-leaf crops and their sowing time on subsequent wheat
156 production. *Field. Crop. Res.* **43**, 19-29 (1995).
- Heenan, D.P., Taylor, A.C., Cullis, B.R. & Lill, W.J. Long term effects of rotation, tillage and

157 stubble management on wheat production in Southern NSW. *Aust. J. Agric. Resour. Econ.* **45**, 93-117 (1994).

Helmets, M.J., Zhou, X., Baker, J.L., Melvin, S.W. & Lemke, D.W. Nitrogen loss on tile-
158 drained Mollisols as affected by nitrogen application rate under continuous corn and cornsoybean rotation systems. *Can. J. Plant Sci* **92**, 493-499 (2012).

Hergert, G.W. et al. Cropping systems for stretching limited irrigation supplies. *J. Prod. Agric*
159 **6**, 520-529 (1993).

Hesterman, O.B., Sheaffer, C.C., Barnes, D.K., Lueschen, W.E. & Ford, J.H. Alfalfa dry
160 matter and nitrogen production, and fertilizer nitrogen response in legume-corn rotations. *Agron. J.* **78**, 19-23 (1986).

Hirzel, J. et al. Different residues affect wheat nutritional composition. *J. Soil Sci. Plant Nutr.*
161 **20**, 75-82 (2020).

Holderbaum, J.F., Decker, A.M., Messinger, J.J., Mulford, F.R. & Vough, L.R. Fall-seeded
162 legume cover crops for no-tillage corn in the humid East. *Agron. J.* **82**, 117-124 (1990).

Holford, I. Effects of duration of grazed lucerne on long-term yields and nitrogen uptake of
163 subsequent wheat. *Aust. J. Agric. Resour. Econ.* **31**, 239-250 (1980).

Holland, J.F. & Herridge, D.F. Production of summer crops in Northern New South Wales. II.
164 Effects of tillage and crop rotation on yields of sorghum. *Aust. J. Agric. Resour. Econ.* **43**, 123-134 (1992).

Honeycutt, C.W., Clapham, W.M. & Leach, S.S. Crop rotation and N fertilization effects on
165 growth, yield, and disease incidence in potato. *Am. J. Potato Res.* **73**, 45-61 (1996).

Hou, X.K., Zhai, R.C., Zhu, G.H. & Bei, L.X. Effects of crop rotation, continuous cropping
166 and different cultivation methods on fertilizer utilization ratio of nitrogen and phosphorus. *J. Heilongjiang Aug. First Land Reclam Univ.*, 44-52 (1995).

Howard, D.D.W.T., Chambers, A.Y. & Lessman, G.M. Rotation and fertilization effects on
167 corn and soybean yields and soybean cyst nematode populations in a no-tillage system. *Agron. J.* **90**, 518-522 (1998).

Hoyt, P.B. Residual effects of alfalfa and brome grass cropping on yields of wheat grown for
168 15 subsequent years. *Can. J. Plant Sci* **70**, 109-113 (1990).

Huggins, D. R., Allmaras, R. R., Clapp, C. E., Lamb, J. A. & Randall, G. W. Corn-soybean
169 sequence and tillage effects on soil carbon dynamics and storage. *Soil Sci. Soc. Am. J.* **71**, 145-154 (2007).

Ingver, A. et al. Leguminous pre-crops improved quality of organic winter and spring cereals.
170 *Biol. Agric. Horti* **35**, 46-60 (2019).

Iragavarapu, T.K.U.O., Randall, G.W. & Russelle, M.P. Yield and nitrogen uptake of rotated
171 corn in a ridge tillage system. *Agron. J.* **89**, 397-403 (1997).

Izaurrealde, R.C., Juma, N.G., McGill, W.B., Haderlein, L. & Choudhary, M. Crop and
172 nitrogen yield in legume-based rotations practiced with zero tillage and low-input methods. *Agron. J.* **87**, 958-964 (1995).

- Jain, N.K., Besarwal, H.S. & Dashora, L.N. Production potential, profitability, sustainability and energetics of different wheat (*Triticum aestivum*)-based cropping systems. *Arch. Agron. Soil Sci.* **57**, 477-487 (2011).
- Janovicek, K.J.U.O., Vyn, T.J. & Voroney, R.P. No-till corn response to crop rotation and in-row residue placement. *Agron. J.* **89**, 588-596 (1997).
- Jat, R.A., Dungrani, R.A., Arvadia, M.K. & Sahrawat, K.L. Diversification of rice (*Oryza Sativa* L.)-Based cropping systems for higher productivity, resource-use efficiency and economic returns in South Gujarat, India. *Arch. Agron. Soil Sci.* **58**, 561-572 (2012).
- Jensen, C.R. et al. The effect of lupins as compared with peas and oats on the yield of the subsequent winter barley crop. *Eur. J. Agron.* **20**, 405-418 (2004).
- Jeske, E.S., Tian, H., Hanford, K., Walters, D.T. & Drijber, R.A. Long-term nitrogen fertilization reduces extraradical biomass of arbuscular mycorrhizae in a maize (*zea mays* L.) cropping system. *Agric. Ecosyst. Environ.* **255**, 111-118 (2018).
- Johnson, A.W., Dowler, C.C., Baker, S.H. & Handoo, Z.A. Crop yields and nematode population densities in triticale-cotton and triticale-soybean rotations. *J. Nematol.* **30**, 353 (1998).
- Johnson, N. C., Copeland, P. J., Crookston, R. K. & Pfleger, F. L. Mycorrhizae: Possible explanation for yield decline with continuous corn and soybean. *Agron. J.* **84**, 387-390 (1992).
- Jones, M. J. Effects of previous crop on yield and nitrogen response of maize at samaru, nigeria. *Exp. Agric.* **10**, 273-279 (1974).
- Jones, M.J. & Singh, M. Time trends in crop yields in long-term trials. *Exp. Agric.* **36**, 165-179 (2000).
- Karlen, D.L., Kovar, J.L., Cambardella, C.A. & Colvin, T.S. Thirty-year tillage effects on crop yield and soil fertility indicators. *Soil Tillage Res.* **130**, 24-41 (2013).
- Katsvairo, T.W. & Cox, W.J. Tillage× rotation× management interactions in corn. *Agron. J.* **92**, 493-500 (2000).
- Kaye, N.M., Mason, S.C., Galusha, T.D. & Mamo, M. Nodulating and non-nodulating soybean rotation influence on soil nitrate-nitrogen and water, and sorghum yield. *Agron. J.* **99**, 599-606 (2007).
- Keisling, T. C., Scott, H.D., Waddle, B.A., Williams, W. & Frans, R.E. Winter cover crops influence on cotton yield and selected soil properties¹. *Commun. Soil Sci. Plant Anal.* **25**, 3087-3100 (1994).
- Kelley, K.W. & Sweeney, D.W. Placement of preplant liquid nitrogen and phosphorus fertilizer and nitrogen rate affects no-till wheat following different summer crops. *Agron. J.* **99**, 1009-1017 (2007).
- Kermah, M. et al. Legume–maize rotation or relay? Options for ecological intensification of smallholder farms in the Guinea savanna of Northern Ghana. *Exp. Agric.* **55**, 673-691 (2019).
- Kermah, M. et al. Legume–maize rotation or relay? Options for ecological intensification of smallholder farms in the Guinea savanna of Northern Ghana. *Exp. Agric.* **55**, 673-691 (2020).
- Khakbazan, M., Gan, Y.T., Bandara, M. & Huang, J. Economics of pulse crop frequency and sequence in a wheat-based rotation. *Agron. J.* **112**, 2058-2080 (2020).

- Kimaro, A.A., Timmer, V.R., Chamshama, S.A.O., Ngaga, Y.N. & Kimaro, D.A. Competition
190 between maize and pigeonpea in semi-arid Tanzania: Effect on yields and nutrition of
crops.
Agric. Ecosyst. Environ. **134**, 115-125 (2009).
- Kirkegaard, J.A. et al. Effect of previous crops on crown rot and yield of durum and bread
191 wheat in Northern NSW. *Aust. J. Agric. Resour. Econ.* **55**, 321-334 (2004).
- Kouyaté, Z., Franzluebbers, K., Juo, A.S.R. & Hossner, L.R. Tillage, crop residue, legume
192 rotation, and green manure effects on sorghum and millet yields in the semiarid
tropics of Mali. *Plant Soil* **225**, 141-151 (2000).
- Kramberger, B., Gselman, A., Janzekovic, M., Kaligalic, M. & Bracko, B. Effects of cover
193 crops on soil mineral nitrogen and on the yield and nitrogen content of maize. *Eur. J.*
Agron. **31**, 103-109 (2009).
- Krupinsky, J. M., Tanaka, D. L., Lares, M. T. & Merrill, S. D. Leaf spot diseases of barley
194 and spring wheat as influenced by preceding crops. *Agron. J.* **96**, 259-266
(2004).
- Krupinsky, J.M., Tanaka, D.L., Merrill, S.D., Liebig, M.A. & Hanson, J.D. Crop sequence
195 effects of 10 crops in the Northern Great Plains. *Agr. Syst.* **88**, 227-254
(2006).
- Kumar Rao, J. V. D. K., Dart, P. J. & Sastry, P. V. S. S. Residual effect of pigeonpea
196 (*Cajanus cajan*) on yield and nitrogen response of maize. *Exp. Agric.* **19**, 131-141 (1983).
- Kumar, K., Goh, K.M., Scott, W.R. & Frampton, C.M. Effects of N-15-labelled crop residues
197 and management practices on subsequent winter wheat yields, nitrogen benefits and
recovery under field conditions. *J. Agric. Sci.* **136**, 35-53 (2001).
- Kuo, S. & Jellum, E. J. Influence of winter cover crop and residue management on soil
198 nitrogen availability and corn. *Agron. J.* **94**, 501-508 (2002).
- Kuo, S. & Jellum, E. J. Long-term winter cover cropping effects on corn (*Zea mays* L.)
199 production and soil nitrogen availability. *Biol. Fertil. Soils* **31**, 470-477 (2000).
- Kureh, I., Kamara, A.Y. & Tarfa, B.D. Influence of cereal-legume rotation on striga control
200 and maize grain yield in farmers' fields in the Northern Guinea savanna of Nigeria. *J.*
Agri. Rural Develop. in the Tropics and Subtropics (JARTS) **107**, 41-54 (2006).
- Kutcher, H. R., Johnston, A. M., Bailey, K. L. & Malhi, S. S. Managing crop losses from
201 plant diseases with foliar fungicides, rotation and tillage on a Black Chernozem in
Saskatchewan, Canada. *Field. Crop. Res.* **124**, 205-212 (2011).
- Lamb, J.A., Dowdy, R.H., Anderson, J.L. & Allmaras, R.R. Water quality in an irrigated
202 sandy soil: Ridge tillage in rotated corn and soybean compared with full-width tillage
in continuous corn. *Soil Tillage Res.* **48**, 167-177 (1998).
- LaMondia, J.A. & Halbrendt, J.M. Rotation and green manure crops for management of lesion
203 and dagger nematodes. *J. Nematol.* **42**, 251-251 (2010).
- Langdale, G. W., Wilson, R. L. & Bruce, R. R. Cropping frequencies to sustain long-term
204 conservation tillage systems. *Soil Sci. Soc. Am. J.* **54**, 193-198 (1990).
- Lenssen, A.W., Johnson, G.D. & Carlson, G.R. Cropping sequence and tillage system 205
influences annual crop production and water use in semiarid Montana, USA. *Field. Crop. Res.*
100, 32-43 (2007).
- Li, Z.P., Wang, J., Shang, Y.Q. & Zhang, S.H. Decomposition of cover crop residues in soils
206 and its effects on winter wheat yield. *Agri. Res. Arid Areas* **37**, 75-82+90 (2019).
- Liang, A. Lodging in corn varies with tillage and crop rotation: A case study after typhoon

207 bolaven pummeling over the black soil Zeon in Northeast China. *Pakistan Journal of*
Agricultural Sciences **54**, 539-545 (2017).

208 Liben, F.M. et al. Conservation agriculture effects on crop productivity and soil properties in
 Ethiopia. *Agron. J.* **110**, 758-767 (2018).

209 Liben, F.M. et al. Conservation agriculture for maize and bean production in the Central Rift
 Valley of Ethiopia. *Agron. J.* **109**, 2988-2997 (2017).

210 Liebman, M., Drummond, F. A., Corson, S. & Zhang, J. Tillage and rotation crop effects on
 weed dynamics in potato production systems. *Agron. J.* **88**, 18–26 (1996).

211 Limon-Ortega, A., Govaerts, B. & Sayre, K.D. Straw management, crop rotation, and nitrogen
 source effect on wheat grain yield and nitrogen use efficiency. *Eur. J. Agron.* **29**, 21-28
 (2008).

212 Lin, R. & Chen, C. Tillage, crop rotation, and nitrogen management strategies for wheat in
 Central Montana. *Agron. J.* **106**, 475-485 (2014).

213 Linh, T. B. *et al.* Inclusion of upland crops in rice-based rotations affects chemical properties
 of clay soil (vol 31, pg 313, 2015). *Soil Use Manag.* **31**, 544-544,
 doi:10.1111/sum.12218 (2015).

214 Linh, T.B., Sleutel, S., Vo Thi, G., Le Van, K. & Cornelis, W.M. Deeper tillage and root
 growth in annual rice-upland cropping systems result in improved rice yield and
 economic profit relative to rice monoculture. *Soil Tillage Res.* **154**, 44-52
 (2015).

215 Liu, K., Bandara, M., Hamel, C., Knight, J.D. & Gan, Y.T. Intensifying crop rotations with
 pulse crops enhances system productivity and soil organic carbon in semi-arid
 environments.
Field Crop. Res. **248**, 107657 (2020).

216 Lombin, L.G. Continuous cultivation and soil productivity in the semi-arid savannah: The
 influence of crop rotation. *Agron. J.* **73**, 357-363 (1981).

217 López-Fando, C. & Almendros, G. Interactive effects of tillage and crop rotations on yield and
 chemical properties of soils in semi-arid central Spain. *Soil Tillage Res.* **36**, 45–
 57 (1995).

218 Lund, M.G., Carter, P.R. & Oplinger, E.S. Tillage and crop rotation affect corn, soybean, and
 winter wheat yields. *J. Prod. Agric* **6**, 207-213 (1993).

219 Lupwayi, N.Z. & Soon, Y.K. Nitrogen-related rotational effects of legume crops on three
 consecutive subsequent crops. *Soil Sci. Soc. Am. J.* **80**, 306-316 (2016).

220 M. E. Probert, P. S. Carberry, R. L. McCown, & J. E. T. Nitrogen benefits of lupins, field pea,
 and chickpea to wheat production in south-eastern Australia. *Aust. J. Agric. Res.* **49**, 317–327
 (1998).

221 Ma, B.L., Ying, J., Dwyer, L.M., Gregorich, E.G. & Morrison, M.J. Crop rotation and soil N
 amendment effects on maize production in Eastern Canada. *Can. J. Plant Sci.* **83**, 483-
 495 (2003).

222 Ma, B.L., Zheng, Z.M., Morrison, M.J. & Gregorich, E.G. Nitrogen and phosphorus nutrition
 and stoichiometry in the response of maize to various N rates under different
 rotation systems.
Nutr. Cycl. Agroecosystems **104**, 93-105 (2016).

Maaz, T. & Pan, W. Residual fertilizer, crop sequence, and water availability impact rotational

223 nitrogen balances. *Agron. J.* **109**, 2839-2862 (2017).

Macholdt, J., Styczen, M.E., Macdonald, A., Piepho, H. & Honermeier, B. Long-term analysis
 224 from a cropping system perspective: Yield stability, environmental adaptability,
 and production risk of winter barley. *Eur. J. Agron.* **117**, 126056 (2020).

Mady Kaye, N., Mason, S.C., Jackson, D.S. & Galusha, T.D. Crop rotation and soil
 225 amendment alters sorghum grain quality. *Crop Sci.* **47**, 722-727 (2007).

Mahama, G.Y., Prasad, P.V.V., Roozeboom, K.L., Nippert, J.B. & Rice, C.W. Cover crops,
 226 fertilizer nitrogen rates, and economic return of grain sorghum. *Agron. J.* **108**, 1-
 16 (2016).

Mahler, R. L. & Auld, D. L. Evaluation of the green manure potential of Austrian winter peas
 227 in northern Idaho. *Agron. J.* **81**, 258–264 (1989).

Malik, R. S. *et al.* Dynamic crop sequencing in Western Australian cropping systems. *Crop*
 228 *Past. Sci.* **66**, 594–609 (2015).

Maloney, T.S., Silveira, K.G. & Oplinger, E.S. Rotational vs. Nitrogen-fixing influence of
 229 soybean on corn grain and silage yield and nitrogen use. *J. Prod. Agric.* **12**, 175-187 (1999).

Maltas, A., Corbeels, M., Scopel, E., Wery, J. & Macena da Silva, F. A. Cover crop and
 230 nitrogen effects on maize productivity in no-tillage systems of the Brazilian cerrados. *Agron.*
J. **101**, 1036–1046 (2009).

Mannan, M. A. Organic matter, nitrogen, and carbon: Nitrogen ratio of soils as affected by
 231 crops and cropping systems. *Soil Sci.* **93**, 83–86 (1961).

Marcelo, A.V., Corá, J.E., Fernandes, C., Martins, M.D.R. & Jorge, R.F. Crop sequences in
 232 no-tillage system: Effects on soil fertility and soybean, maize and rice yield. *Rev. Bras.*
Cienc. Solo **33**, 417-428 (2009).

Martinrueda, I. *et al.* Tillage and crop rotation effects on barley yield and soil nutrients on a
 233 Calciortidic Haploxeralf. *Soil Tillage Res.* **92**, 1-9 (2007).

Mashingaidze, N., Twomlow, S., Madakadze, I.C., Mupangwa, W. & Mavunganidze, Z.
 234 Weed growth and crop yield responses to tillage and mulching under different
 crop rotation sequences in semi-arid conditions. *Soil Use Manage.* **33**, 311-327
 (2017).

Masri, Z. & Ryan, J. Soil organic matter and related physical properties in a Mediterranean
 235 wheat-based rotation trial. *Soil Tillage Res.* **87**, 146–154 (2006).

Mazzoncini, M., Bàrberi, P., Cerrai, D., Rinaudo, V. & Belloni, P. Effects of green manure on
 236 soil nitrogen availability and crop productivity in a Mediterranean organic farming
 system. 1– 9 (2004).

Mbewe, D.N.M., Chishala, B.H., Chirwa, T.S. & Mafongoya, P.L. Changes in soil properties
 237 and their effects on maize productivity following *Sesbania Sesban* and *Cajanus Cajan*
 improved fallow systems in Eastern Zambia. *Biol. Fertil. Soils* **40**, 20-27 (2004).

McEwen, J., Darby, R.J., Hewitt, M.V. & Yeoman, D.P. Effects of field beans, fallow, lupins,
 238 oats, oilseed rape, peas, ryegrass, sunflowers and wheat on nitrogen residues in the soil and on
 the growth of a subsequent wheat crop. *J. Agric. Sci.* **115**, 209-219 (1990).

Meyer-Aurich, A., Janovicek, K., Deen, W. & Weersink, A. Impact of tillage and rotation on
 239 yield and economic performance in corn-based cropping systems. *Agron. J.* **98**, 1204–
 1212 (2006).

Milev, G., Tonev, T.K. & Kiryakova, V. Influence of some agronomy factors on spike

- 240 components after rare incidence of fusarium head blight epiphytity of winter
wheat. II. Effect of post-harvest residue incorporation. *Bulg. J. Agric. Sci* **14**, 41
(2008).
- Mohammed, M.S. & Clegg, M.D. Pearl millet-soybean rotation and nitrogen fertilizer effects
241 on millet productivity. *Agron. J* **85**, 1009-1013 (1993).
- Montemurro, F. & Maiorana, M. Agronomic practices at low environmental impact for durum
242 wheat in Mediterranean conditions. *J. Plant Nutr.* **38**, 624-638 (2015).
- Montemurro, F. & Maiorana, M. Cropping systems, tillage and fertilization strategies for
243 durum wheat performance and soil properties. *Int. J. Plant Prod.* **8**, 51-75 (2014).
- Moyer, J.R., Blackshaw, R.E., Doram, R.C., Huang, H.C. & Entz, T. Effect of previous crop
244 and herbicides on weed growth and wheat yield. *Can. J. Plant Sci.* **85**, 735-746
(2005).
- Munyinda, K., O'Halloran, I.P. & Karamanos, R.E. Yields of wheat in rotation with maize and
245 soybeans in Zambia. *Can. J. Plant Sci.* **68**, 747-753 (1988).
- Muoni, T., Mhlanga, B., Forkman, J., Sitali, M. & Thierfelder, C. Tillage and crop rotations
246 enhance populations of earthworms, termites, dung beetles and centipedes:
Evidence from a long-term trial in Zambia. *J. Agric. Sci.* **157**, 504-514 (2019).
- Mupangwa, W., Thierfelder, C. & Ngwira, A. Fertilization strategies in conservation 247
agriculture systems with maize–legume cover crop rotations in Southern Africa. *Exp. Agric.*
53, 288-307 (2017).
- Mussnug, F., Becker, M., Son, T.T., Buresh, R.J. & Vlek, P.L.G. Yield gaps and nutrient
248 balances in intensive, rice-based cropping systems on degraded soils in the Red River Delta of
Vietnam. *Field. Crop. Res.* **98**, 127-140 (2006).
- Naab, J.B., Mahama, G.Y., Yahaya, I. & Prasad, P.V.V. Conservation agriculture improves
249 soil quality, crop yield, and incomes of smallholder farmers in North Western Ghana. *Front.*
Plant Sci. **8**, 996 (2017).
- Nafziger, E.D. & Dunker, R.E. Soil organic carbon trends over 100 years in the Morrow Plots.
250 *Agron. J* **103**, 261-267 (2011).
- Ncube, B., Dimes, J.P., van Wijk, M.T., Twomlow, S.J. & Giller, K.E. Productivity and
residual benefits of grain legumes to sorghum under semi-arid conditions in South-western
251 Zimbabwe: Unravelling the effects of water and nitrogen using a simulation model. *Field.*
Crop. Res. **110**, 173-184 (2009).
- Ngwira, A.R., Kabambe, V., Simwaka, P., Makoko, K. & Kamoyo, K. Productivity and
252 profitability of maize-legume cropping systems under
conservation agriculture among smallholder farmers in
Malawi. *Acta Agric. Scand B Soil Plant Sci.* **70**, 241-
251 (2020).
- Nielsen, D. C. & Vigil, M. F. Legume green fallow effect on soil water content at wheat
253 planting and wheat yield. *Agron. J.* **97**, 684–689 (2005).
- Niu, Y., Bainard, L., Bandara, M.S., Hamel, C. & Gan, Y. Soil residual water and nutrients
254 explain about 30% of the rotational effect in 4-year
pulse-intensified rotation systems. *Can. J.*
Plant Sci. **97**, 852-864 (2017).
- Norwood, C.A. Dryland winter wheat as affected by previous crops. *Agron. J* **92**, 121-127
255 (2000).

- Nouri, A. et al. Crop species in no-tillage summer crop rotations affect soil quality and yield in an Alfisol. *Geoderma* **345**, 51-62 (2019).
- Nyagumbo, I. et al. Maize yield effects of conservation agriculture based maize–legume cropping systems in contrasting agro-ecologies of Malawi and Mozambique. *Nutr. Cycl. Agroecosystems* **105**, 275-290 (2016).
- Nykänen, A., Granstedt, A. & Jauhiainen, L. Residual effect of clover-rich leys on soil nitrogen and successive grain crops. *AFSci* **17**, 73-87 (2008).
- O'Donovan, J. T. et al. Effect of preceding crop and nitrogen application on malting barley quality. *Can. J. Plant Sci.* **97**, 1014–1023 (2017).
- O'donovan, J. T. et al. Rotational effects of legumes and non-legumes on hybrid canola and malting barley. *Agron. J.* **106**, 1921–1932 (2014).
- Obour, A.K., Stahlman, P.W. & Holman, J.D. Soil chemical properties as influenced by long-term glyphosate-resistant corn and soybean production in the central Great Plains, USA. *Geoderma* **277**, 1-9 (2016).
- Oikeh, S.O. et al. Integrated soil fertility management involving promiscuous dual-purpose soybean and upland NERICA enhanced rice productivity in the savannas. *Nutr. Cycl. Agroecosystems* **88**, 29-38 (2010).
- Oikeh, S.O. et al. Integrated soil fertility management involving promiscuous dual-purpose soybean and upland nERICA enhanced rice productivity in the savannas. *Nutr. Cycl. Agroecosystems* **88**, 29-38 (2011).
- Ojiem, J.O., Franke, A.C., Vanlauwe, B., de Ridder, N. & Giller, K.E. Benefits of legume–maize rotations: Assessing the impact of diversity on the productivity of smallholders in Western Kenya. *Field. Crop. Res.* **168**, 75-85 (2014).
- Oliveira, M., Castro, C., Coutinho, J. & Trindade, H. N supply and pre-cropping benefits to triticale from three legumes in rainfed and irrigated Mediterranean crop rotations. *Field. Crop. Res.* **237**, 32-42 (2019).
- Oswald, A. & Ransom, J.K. Striga control and improved farm productivity using crop rotation. *Crop Prot.* **20**, 113-120 (2001).
- Owen, K.J., Clewett, T.G., Bell, K.L. & Thompson, J.P. Wheat biomass and yield increased when populations of the root-lesion nematode (*Pratylenchus thornei*) were reduced through sequential rotation of partially resistant winter and summer crops. *Crop Past. Sci.* **65**, 227 (2014).
- Oyer, L.J. & Touchton, J.T. Utilizing legume cropping systems to reduce nitrogen fertilizer requirements for conservation-tilled corn. *Agron. J.* **82**, 1123-1127 (1990).
- Pal, M.S. Alternative crop production strategies for rice-wheat cropping systems in the Indo-Gangetic Plains of India. *Aust. J. Exp. Agric.* **43**, 605 (2003).
- Papastylianou, I. Effect of preceding legume or cereal on barley grain and nitrogen yield. *J. Agric. Sci.* **108**, 623–626 (1987).
- Papastylianou, I. Productivity and nitrogen fertilizer requirements of barley in rotation systems in rainfed Mediterranean conditions. *Eur. J. Agron.* **2**, 119–129 (1993).
- Paré, T., Chalifour, F.P., Bourassa, J. & Antoun, H. Forage-corn production and N fertilizer replacement values following 1 or 2 years of legumes. *Can. J. Plant Sci.* **73**, 477-493 (1993).
- Parsons, K.J., Zheljazkov, V.D., MacLeod, J. & Caldwell, C.D. Soil and tissue phosphorus,

273 potassium, calcium, and sulfur as affected by dairy manure application in a no-till corn,
wheat, and soybean rotation. *Agron. J.* **99**, 1306-1316 (2007).

274 Partey, S.T., Saito, K., Preziosi, R.F. & Robson, G.D. Biochar use in a legume-rice rotation
system: Effects on soil fertility and crop performance. *Arch. Agron. Soil Sci.* **62**, 199-215
(2016).

Perez-Brandan, C. *et al.* The effect of crop sequences on soil microbial, chemical and physical
275 indicators and its relationship with soybean sudden death syndrome (complex of *Fusarium*
species). *Span J. Agric. Res.* **12**, 252–264 (2014).

Peterson, T. A. & Varvel, G. E. Crop yield as affected by rotation and nitrogen rate. III. Corn.
276 *Agron. J.* **81**, 735–738 (1989).

Peterson, T.A. & Varvel, G.E. Crop yield as affected by rotation and nitrogen rate. II. Grain
277 sorghum. *Agron. J.* **81**, 731-734 (1989).

Pikul Jr, J.L., Osborne, S.L. & Riedell, W.E. Corn yield and nitrogen-and water-use under no-
278 tillage rotations. *Commun. Soil Sci. Plant Anal.* **43**, 2722-2734
(2012).

Pikul, J. L., Aase, J. K. & Cochran, V. L. Lentil green manure as fallow replacement in the
279 semiarid northern Great Plains. *Agron. J.* **89**, 867–874 (1997).

Pikul, J. L., Hammack, L. & Riedell, W. E. Corn yield, nitrogen use, and corn rootworm
280 infestation of rotations in the northern corn belt. *Agron. J.* **97**, 854–
863 (2005).

Porter, P. M., Crookston, R. K., Ford, J. H., Huggins, D. R. & Lueschen, W. E. Interrupting
281 yield depression in monoculture corn: Comparative effectiveness
of grasses and dicots. *Agron. J.* **89**, 247–250 (1997).

Potratz, D.J. *et al.* Strip-till, other management strategies, and their interactive effects on corn
282 grain and soybean seed yield. *Agron. J.* **112**, 72-80 (2020).

Prew, R. D. & Dyke, G. V. Experiments comparing ‘break crops’ as a preparation for winter
283 wheat followed by spring barley. *J. Agric. Sci.* **92**, 189–201 (1979).

Propheter, J.L. & Staggenborg, S. Performance of annual and perennial biofuel crops:
284 Nutrient removal during the first two years. *Agron. J.* **102**, 798-805 (2010).

Propheter, J.L. & Staggenborg, S. Performance of annual and perennial biofuel crops:
285 Nutrient removal during the first two years. *Agron. J.* **102**, 798-805 (2011).

Przednowek, D., Entz, M.H., Irvine, B., Flaten, D.N. & Thiessen Martens, J.R. Rotational 286
yield and apparent N benefits of grain legumes in Southern Manitoba. *Can. J. Plant Sci.* **84**, 1093-
1096 (2004).

Qin, W., Zhang, X., Chen, S., Sun, H. & Shao, L. Crop rotation and N application rate 287
affecting the performance of winter wheat under deficit irrigation. *Agric. Water Manag.* **210**,
330-339 (2018).

Raimbault, B.A. & Vyn, T.J. Crop rotation and tillage effects on corn growth and soil
288 structural stability. *Agron. J.* **83**, 979-985 (1991).

Rao, M.R. & Mathuva, M.N. Legumes for improving maize yields and income in semi-arid
289 Kenya. *Agric. Ecosyst. Environ.* **78**, 123-137 (2000).

Rasiah, V. Temporal dynamics of soil nitrate-n after termination of forage phases in corn-
290 forage rotation. *Biol. Fertil. Soils* **29**, 201-206 (1999).

- Reddy, K. N., Zablotowicz, R. M. & Krutz, L. J. Corn and soybean rotation under reduced
291 tillage management: Impacts on soil properties, yield, and net return. *Am. J. Plant Sci.*
04, 10–17 (2013).
- Rego, T. J. & Nageswara Rao, V. Long-term effects of grain legumes on rainy-season
292 sorghum productivity in a semi-arid tropical Vertisol. *Exp. Agric.* **36**, 205–221
(2000).
- Rembon, F.S. & MacKenzie, A.F. Soybean nitrogen contribution to corn and residual nitrate
293 under conventional tillage and no-till. *Can. J. Plant Sci.* **77**, 543–551 (1997).
- Rice, W. A., Olsen, P. E., Bailey, L. D., Biederbeck, V. O. & Slinkard, A. E. The use of
294 annual legume green-manure crops as a substitute for summerfallow in the Peace
River region. *Can. J. Soil Sci.* **73**, 243–252 (1993).
- Riedell, W.E. et al. Corn and soil fertility responses to crop rotation with low, medium, or
295 high inputs. *Crop Sci.* **38**, 427–433 (1998).
- Rochester, I.J., Peoples, M.B., Hulgalle, N.R., Gault, R.R. & Constable, G.A. Using legumes
296 to enhance nitrogen fertility and improve soil condition in cotton cropping systems.
Field.
Crop. Res. **70**, 27–41 (2001).
- Roder, W., Mason, S. C., Clegg, M. D. & Kniep, K. R. Crop root distribution as influenced
297 by grain sorghum–soybean rotation and fertilization. *Soil Sci. Soc. Am. J.* **53**, 1464–1470
(1989).
- Roder, W., Mason, S.C., Clegg, M.D. & Kniep, K.R. Yield-soil water relationships in
298 sorghum-soybean cropping systems with different fertilizer regimes. *Agron. J.* **81**, 470–475
(1989).
- Rogers, C. W., Smartt, A. D., Brye, K. R. & Norman, R. J. Nitrogen source effects on
299 methane emissions from drill-seeded, delayed-flood rice production. *Soil Sci.* **182**, 9–17
(2017).
- Ross, S.M. et al. The effects of three pulse crops on a second subsequent crop. *Can. J. Plant*
300 *Sci.* **95**, 779–786 (2015).
- Rubin, J.C., Struffert, A.M., Fernández, F.G. & Lamb, J.A. Maize yield and nitrogen use
301 efficiency in upper Midwest irrigated sandy soils. *Agron. J.* **108**, 1681–1691 (2016).
- Ryan, J. et al. Crop sequences, nitrogen fertilizer and grazing intensity in relation to wheat
302 yields in rainfed systems. *J. Agric. Sci.* **148**, 205–216 (2010).
- Sadras, V.O., Baldock, J.A., Cox, J.W. & Bellotti, W.D. Crop rotation effect on wheat grain
303 yield as mediated by changes in the degree of water and nitrogen co-limitation.
Aust J Agric Resour Econ **55**, 599–607 (2004).
- Sainju, U. M., Lenssen, A. W., Caesar-TonThat, T. & Evans, R. G. Dryland crop yields and
304 soil organic matter as influenced by long-term tillage and cropping sequence. *Agron. J.*
101, 243–251 (2009).
- Sainju, U. M., Singh, B. P., Whitehead, W. F. & Wang, S. Carbon supply and storage in tilled
305 and nontilled soils as influenced by cover crops and nitrogen fertilization. *J. Environ.*
Qual.
35, 1507–1517 (2006).
- Sainju, U. M., Whitehead, W. F. & Singh, B. P. Biculture legume-cereal cover crops for
306 enhanced biomass yield and carbon and nitrogen. *Agron. J.* **97**, 1403–1412 (2005).
- Sainju, U.M. Cropping sequence and nitrogen fertilization impact on surface residue, soil

307 carbon sequestration, and crop yields. *Agron. J.* **106**, 1231-1242 (2015).

Sainju, U.M., Lenssen, A.W. & Barsotti, J.L. Dryland malt barley yield and quality affected
308 by tillage, cropping sequence, and nitrogen fertilization. *Agron. J.* **105**, 329-340
(2013). Sainju, U.M., Stevens, W.B., Caesar-TonThat, T. & Liebig, M.A. Soil
greenhouse gas
309 emissions affected by irrigation, tillage, crop rotation, and nitrogen fertilization. *J.*
Environ. Qual. **41**, 1774-1786 (2012).

Salim Khan, M. A., Katti, M. S. & Raja, V. Fodder legumes affecting sequential crop
310 production and fertilizer N use efficiency. *J. Agric. Sci.* **105**, 1–7 (1985).

Salmerón, M., Caverro, J., Quílez, D. & Isla, R. Winter cover crops affect monoculture maize
311 yield and nitrogen leaching under irrigated Mediterranean conditions. *Agron. J.* **102**,
1700– 1709 (2010).

Salmerón, M., Isla, R. & Caverro, J. Effect of winter cover crop species and planting methods
312 on maize yield and N availability under irrigated Mediterranean conditions. *Field. Crop.*
Res. **123**, 89-99 (2011).

Sanford, J.O. & Hairston, J.E. Effects of N fertilization on yield, growth, and extraction of
313 water by wheat following soybeans and grain sorghum. *Agron. J.* **76**, 623-627 (1984).

Schahbazian, N. & Gretzmacher, R. Improving the productivity of winter wheat in Iran 314
through rotation of wheat, fallow, soybean and alfalfa and manuring. *Bodenkultur* **49**, 151-157
(1998).

Schlegel, A.J. et al. Limited irrigation of corn-based no-till crop rotations in West Central
315 Great Plains. *Agron. J.* **108**, 1132-1141 (2016).

Schlegel, A.J., Assefa, Y., Haag, L.A., Thompson, C.R. & Stone, L.R. Soil water and water
316 use in long-term dryland crop rotations. *Agron. J.* **111**, 2590-2599 (2019).

Schlegel, A.J., Assefa, Y., Haag, L.A., Thompson, C.R. & Stone, L.R. Yield and overall 317
productivity under long-term wheat-based crop rotations: 2000 through 2016. *Agron. J.* **111**,
264-274 (2019).

Schulz, S., Keatinge, J. & Wells, G.J. Productivity and residual effects of legumes in rice-
318 based cropping systems in a warm-temperate environment: I. Legume biomass production and
N fixation. *Field. Crop. Res.* **61**, 23-35 (1999).

Schulz, S., Keatinge, J.D.H., J. Wells, G. & Shrestha, R. Effect of legume management on 319
forage production and residual effects on upland rice. *J. Agron. Crop Sci.* **184**, 173-180 (2000).

Schwenke, G. D., Brock, P. M., Haigh, B. M. & Herridge, D. F. Greenhouse gas emission
320 reductions in subtropical cereal-based cropping sequences using legumes, DMPP-coated urea
and split timings of urea application. *Soil Res.* **56**, 724-736, doi:10.1071/sr18108 (2018).

Shafi, M., Bakht, J., & Khan, M.A. Effect of crop sequence and crop residues on soil C, soil N
321 and yield of maize. *Pakistan Journal of Botany* **42**, 1651-1664 (2010).

Shafi, M., Bakht, J., Jan, M. & Shah, Z. Soil C and N dynamics and maize (*Zea mays* L.) Yield
322 as affected by cropping systems and residue management in North-western Pakistan. *Soil*
Tillage Res. **94**, 520-529 (2007).

Shah, Z., Shah, S.H., Peoples, M.B., Schwenke, G.D. & Herridge, D.F. Crop residue and
323 fertiliser N effects on nitrogen fixation and yields of legume–cereal rotations and soil organic
fertility. *Field. Crop. Res.* **83**, 1-11 (2003).

- Shahzad, M., Farooq, M., Jabran, K. & Hussain, M. Impact of different crop rotations and 324 tillage systems on weed infestation and productivity of bread wheat. *Crop Prot.* **89**, 161-169 (2016).
- Sharma, A. R. & Behera, U. K. Nitrogen contribution through Sesbania green manure and 325 dual-purpose legumes in maize-wheat cropping system: Agronomic and economic considerations. *Plant Soil* **325**, 289–304 (2009).
- Sharma, A.R. & Behera, U.K. Recycling of legume residues for nitrogen economy and higher 326 productivity in maize (*zea mays*)–wheat (*Triticum Aestivum*) cropping system. *Nutr. Cycl. Agroecosystems* **83**, 197-210 (2009).
- Sharma, S. N. & Prasad, R. Effects of Sesbania green manuring and mungbean residue 327 incorporation of productivity and nitrogen uptake of a rice-wheat cropping system. *Bioresour. Technol.* **67**, 171–175 (1999).
- Sharma, S.N.I.A., Prasad, R. & Singh, S. Residual effects of growing mungbean and uridbean 328 on the yield and nitrogen uptake of a succeeding wheat crop. *Fertil. Res.* **44**, 163-168 (1996).
- Sheaffer, C.C., Simmons, S.R. & Schmitt, M.A. Annual medic and berseem clover dry matter 329 and nitrogen production in rotation with corn. *Agron. J.* **93**, 1080-1086 (2001).
- Siadat, S. A. *et al.* Rapeseed (*Brassica napus* L. var. oleifera) response to nitrogen fertilizer 330 following different previous crops. *Ital. J. Agron.* **6**, 199–203 (2011).
- Sieling, K. & Christen, O. Crop rotation effects on yield of oilseed rape, wheat and barley and 331 residual effects on the subsequent wheat. *Arch. Agron. Soil Sci.* **61**, 1531-1549 (2015).
- Sieling, K., Christen, O., Nemati, B. & Hanus, H. Effects of previous cropping on seed yield 332 and yield components of oil-seed rape (*Brassica napus* L.). *Eur. J. Agron.* **6**, 215–223 (1997). Sileshi, G. & Mafongoya, P.L. Effect of rotational fallows on abundance of soil insects and 333 weeds in maize crops in Eastern Zambia. *Appl. Soil Ecol.* **23**, 211-222 (2003).
- Sincik, M., Turan, Z. M. & Göksoy, A. T. Responses of potato (*Solanum tuberosum* L.) to 334 green manure cover crops and nitrogen fertilization rates. *Am. J. Potato Res.* **85**, 150–158 (2008).
- Sindelar, A.J., Schmer, M.R., Jin, V.L., Wienhold, B.J. & Varvel, G.E. Crop rotation affects 335 corn, grain sorghum, and soybean yields and nitrogen recovery. *Agron. J.* **108**, 1592-1602 (2016).
- Sindelar, A.J., Schmer, M.R., Jin, V.L., Wienhold, B.J. & Varvel, G.E. Long-term corn and 336 soybean response to crop rotation and tillage. *Agron. J.* **107**, 2241-2252 (2015).
- Singer, J. W. & Cox, W. J. Corn growth and yield under different crop rotation, tillage, and 337 management systems. *Crop Sci.* **38**, 996–1003 (1998).
- Singer, J.W. & Cox, W.J. Agronomics of corn production under different crop rotations in 338 New York. *J. Prod. Agric* **11**, 462-468 (1998).
- Singh, R.K., Bohra, J.S., Nath, T., Singh, Y. & Singh, K. Integrated assessment of 339 diversification of rice-wheat cropping system in Indo-Gangetic plain. *Arch. Agron. Soil Sci.* **57**, 489-506 (2011).
- Singh, S., Prasad, R., Singh, B. V., Goyal, S. K. & Sharma, S. N. Effect of green manuring, 340 blue-green algae and neem-cake-coated urea on wetland rice (*Oryza sativa* L.). *Biol. Fertil. Soils* **9**, 235–238 (1990).

- Singh, V.K., Sharma, B.B. & Dwivedi, B.S. The impact of diversification of a rice–wheat
341 cropping system on crop productivity and soil fertility. *J. Agric. Sci.* **139**, 405–412
(2002).
- Slope, D. B. & Etheridge, J. Effects of previous cropping and N fertilizer on grain yield and
342 take-all in spring barley. *J. Agric. Sci.* **89**, 459–465 (1977).
- Smiley, R. W., Ingham, R. E., Uddin, W. & Cook, G. H. Crop sequences for managing cereal
343 cyst nematode and fungal pathogens of winter wheat. *Plant Dis.* **78**, 1142–1149
(1994).
- Smith, B.J., Kirkegaard, J.A. & Howe, G.N. Impacts of brassica break-crops on soil biology
344 and yield of following wheat crops. *Aust. J. Agric. Resour. Econ.* **55**, 1–11 (2004).
- Smith, R.G. & Gross, K.L. Weed community and corn yield variability in diverse
345 management systems. *Weed Sci.* **54**, 106–113 (2006).
- Soon, Y.K. & Arshad, M.A. Contribution of di-nitrogen fixation by pea to the productivity
346 and N budget of a wheat-based cropping system. *J. Agric. Sci.* **142**, 629–637 (2004).
- Soon, Y.K. & Darwent, A.L. Effect of integrated management of couch grass (*Elytrigia*
347 *repens*) on soil quality and crop nutrition. *J. Agric. Sci.* **130**, 323–328 (1998).
- Sparrow, S.D., Cochran, V.L. & Sparrow, E.B. Residual effects of harvested and
green-
348 manured legumes on a subsequent barley crop in a subarctic environment. *Can. J.*
Plant Sci. **75**, 453–456 (1995).
- St. Luce, M. et al. Legumes can reduce economic optimum nitrogen rates and increase yields
349 in a wheat–canola cropping sequence in Western Canada. *Field. Crop. Res.* **179**, 12–25
(2015).
- Stanger, T.F. & Lauer, J.G. Corn grain yield response to crop rotation and nitrogen over 35
350 years. *Agron. J.* **100**, 643–650 (2008).
- Starovoytov, A., Gallagher, R. S., Jacobsen, K. L., Kaye, J. P. & Bradley, B. Management of
351 small grain residues to retain legume-derived nitrogen in corn cropping systems. *Agron.*
J. **102**, 895–903 (2010).
- Stecker, J.A., Buchholz, D.D., Hanson, R.G., Wollenhaupt, N.C. & McVay, K.A. Tillage and
352 rotation effects on corn yield response to fertilizer nitrogen on Aqualf soils. *Agron. J.* **87**,
409–415 (1995).
- Stempkowski, L. A. et al. Management of wheat stripe mosaic virus by crop rotation. *Eur. J.*
353 *Plant Pathol.* **158**, 349–361, doi:10.1007/s10658-020-02077-8 (2020).
- Stevens, W.B., Sainju, U.M., Caesar-TonThat, T. & Iversen, W.M. Malt barley yield and
354 quality affected by irrigation, tillage, crop rotation, and nitrogen fertilization. *Agron. J.*
107, 2107–2119 (2015).
- Strom, N., Hu, W., Haarith, D., Chen, S. & Bushley, K. Interactions between soil properties,
355 fungal communities, the soybean cyst nematode, and crop yield under continuous corn and
soybean monoculture. *Appl. Soil Ecol.* **147**, 103388 (2020).
- Strong, W. M., Harbison, J., Nielsen, R. G. H., Hall, B. D. & Best, E. K. Nitrogen availability
356 in a darling downs soil following cereal, oilseed and grain legume crops. 1. Soil nitrogen
accumulation. *Aust. J. Exp. Agric.* **26**, 347–351 (1986).
- Stute, J.K. & Posner, J.L. Legume cover crops as a nitrogen source for corn in an oat-corn
357 rotation. *J. Prod. Agric.* **8**, 385–390 (1995).
- Sun, T. & Li, Z. Alfalfa-corn rotation and row placement affects yield, water use, and
358 economic returns in Northeast China. *Field. Crop. Res.* **241**, 107558 (2019).
- Swanepoel, C.M. et al. The benefits of conservation agriculture on soil organic carbon and

359 yield in Southern Africa are site-specific. *Soil Tillage Res.* **183**, 72-82 (2018).

Swanton, C.J., Chandler, K. & Janovicek, K.J. Integration of cover crops into no-till and
 360 ridge-till wheat (*triticum aestivum* L.)–corn (*Zea mays* L.) cropping sequence. *Can. J. Plant
 Sci.* **76**, 85-91 (1996).

Sweeney, D. W. & Moyer, J. L. Legume green manures and conservation tillage for grain
 361 sorghum production on prairie soil. *Soil Sci. Soc. Am. J.* **58**, 1518–1524 (1994).

Szymanska, G. et al. The long-term effect of legumes as forecrops on the productivity of
 362 rotation winter triticale-winter rape with nitrogen fertilisation. *Acta Agric. Scand B Soil Plant
 Sci.* **70**, 128-134 (2020).

Tan, C.S., Drury, C.F., Reynolds, W.D., Groenevelt, P.H. & Dadfar, H. Water and nitrate loss
 363 through tiles under a clay loam soil in Ontario after 42 years of consistent fertilization and
 crop rotation. *Agric. Ecosyst. Environ.* **93**, 121-130 (2002).

Tanaka, D. L., Krupinsky, J. M., Merrill, S. D., Liebigh, M. A. & Hanson, J. D. Dynamic
 364 cropping systems for sustainable crop production in the northern Great Plains. *Agron.
 J.* **99**, 904–911 (2007).

Tanaka, D. L., Liebigh, M. A., Krupinsky, J. M. & Merrill, S. D. Crop sequence influences on
 365 sustainable spring wheat production in the northern Great Plains. *Sustainability* **2**, 3695–3709
 (2010).

Taner, A., Kaya, Y., Aisoy, R.Z., Gültekin, O. & Partigöç, F. Effect of tillage systems on
 366 energy use efficiency in wheat based cropping sequence. *Int. J. Agric. Biol.* **18**, 353-
 361 (2016).

Tang, W.G. et al. Impacts of winter planting patterns on soil heavy metal content and grain
 367 quality in late rice in double cropping rice area. *Acta Agron. Sin.* **37**, 1457-1464 (2011).

Tedla, A., Mamo, T., Klaij, M.C. & Diedhiou, M.L. Effects of cropping system, seed bed
 368 management and fertility interactions on biomass of crops grown on a Vertisol in the
 central highlands of Ethiopia. *J. Agron. Crop. Sci.* **183**, 205-211 (1999).

Tekin, S. et al. Comparison of wheat-based rotation systems and monocropping systems under
 369 dryland Mediterranean conditions. *Int J Agr Biol Eng* **10**, 203-213 (2017).

Thierfelder, C. & Wall, P.C. Rotation in conservation agriculture systems of Zambia: Effects
 370 on soil quality and water relations. *Exp. Agric.* **46**, 309-325 (2010).

Thomas, G.A. et al. Crop rotations for sustainable grain production on a Vertisol in the semi-
 371 arid subtropics. *J. Sustain. Agric.* **35**, 2-26 (2010).

Thomas, G.A. et al. Pasture - crop rotations for sustainable production in a wheat and sheep-
 372 based farming system on a Vertisol in South-west Queensland, Australia. *Anim. Prod.
 Sci.* **49**, 682 (2009).

Tian, G., Kolawole, G. O., Kang, B. T. & Kirchhof, G. Nitrogen fertilizer replacement indexes
 373 of legume cover crops in the derived savanna of West Africa. *Plant Soil* **224**, 287–296
 (2000).

Toomsan, B. et al. Biological N-2 fixation and residual N benefit of pre-rice leguminous crops
 374 and green manures. *NJAS-WAGEN J LIFE SC* **48**, 19-29 (2000).

Toomsan, B., McDonagh, J. F., Limpinuntana, V. & Giller, K. E. Nitrogen fixation by
 375 groundnut and soyabean and residual nitrogen benefits to rice in farmers' fields in
 Northeast Thailand. *Plant Soil* **175**, 45–56 (1995).

Torbert, H.A., Reeves, D.W. & Mulvaney, R.L. Winter legume cover crop benefits to corn:
 376 Rotation vs. Fixed-nitrogen effects. *Agron. J.* **88**, 527-535 (1996).

Torstensson, G. Nitrogen delivery and utilization by subsequent crops after incorporation of
 377 leys with different plant composition. *Biol. Agric. Horticult* **16**, 129-143 (1998).

Tounkara, A. et al. Inorganic fertilizer use efficiency of millet crop increased with organic
 378 fertilizer application in rainfed agriculture on smallholdings in Central Senegal. *Agric.
 Ecosyst. Environ.* **294**, 106878 (2020).

Traore, H., Barro, A., Yonli, D., Stewart, Z. & Prasad, V. Water conservation methods and
 379 cropping systems for increased productivity and economic resilience in Burkina Faso.
Water **12**, 976 (2020).

Turco, R.F., Bischoff, M., Breakwell, D.P. & Griffith, D.R. Contribution of soil-borne
 380 bacteria to the rotation effect in corn. *Plant Soil* **122**, 115-120 (1990).

Van Duijnen, R., Roy, J., Härdtle, W. & Temperton, V.M. Precrop functional group identity
 381 affects yield of winter barley but less so high carbon amendments in a mesocosm experiment.
Front. Plant Sci. **9**, 912 (2018).

Vanlauwe, B. et al. Utilization of rock phosphate by crops on a representative toposequence in
 382 the Northern Guinea savanna zone of Nigeria: Response by maize to previous herbaceous
 legume cropping and rock phosphate treatments. *Soil Biol. Biochem.* **32**, 2079-2090 (2000).

Vanotti, M. B. & Bundy, L. G. Soybean effects on soil nitrogen availability in crop rotations.
 383 *Agron. J.* **87**, 676–680 (1995).

Varvel, G.E. & Peterson, T.A. Nitrogen fertilizer recovery by corn in monoculture and
 384 rotation systems. *Agron. J.* **82**, 935-938
 (1990).

Varvel, G.E. & Peterson, T.A. Nitrogen fertilizer recovery by grain sorghum in monoculture
 385 and rotation systems. *Agron. J.* **83**, 617-622
 (1991).

Varvel, G.E. & Wilhelm, W.W. Soybean nitrogen contribution to corn and sorghum in
 386 Western corn belt rotations. *Agron. J.* **95**, 1220-1225 (2003).

Varvel, G.E. Monoculture and rotation system effects on precipitation use efficiency of corn.
 387 *Agron. J.* **86**, 204-208 (1994).

Varvel, G.E. Precipitation use efficiency of soybean and grain sorghum in monoculture and
 388 rotation. *Soil Sci. Soc. Am. J.* **59**, 527-531
 (1995).

Varvel, G.E., Klocke, N.L. & Wilhelm, W. Corn-soybean rotation effects on soil and plant N
 389 indices. *Amer. Soc. Agri. Eng.* **95**, 235-238
 (1995).

Veloso, M. G., Cecagno, D. & Bayer, C. Legume cover crops under no-tillage favor
 390 organomineral association in microaggregates and soil C accumulation. *Soil Tillage Res.* **190**,
 139–146 (2019).

Videnovic, Z. et al. Effect of long term crop rotation and fertiliser application on maize
 391 productivity. *Turk. J. Field Crops* **18**, 233-237
 (2013).

Vogel, A. & Below, F. Hybrid selection and agronomic management to lessen the continuous
 392 corn yield penalty. *Agronomy* **8**, 228 (2018).

Vogel, A.M. & Below, F.E. Residue and agronomic management to reduce the continuous
 393 corn yield penalty. *Agronomy (Basel)* **9**, 567
 (2019).

- Vrtílek, P., Smutný, V., Dryšlová, T., Neudert, L. & Křen, J. The effect of agronomic
394 measures on grain yield of winter wheat in drier conditions. *Plant Soil Environ.* **65**,
63-70 (2019).
- Wagger, M. G. Cover Cover crops management and nitrogen rate in relation to growth and
395 yield of no-till corn. *Agron. J.* **81**, 533–538
(1989).
- Wagger, M.G. & Denton, H.P. Crop and tillage rotations: grain yield, residue cover, and soil
396 water. *Soil Sci. Soc. Am. J.* **56**, 1233-1237
(1992).
- Wang, L. et al. Effects of seven diversified crop rotations on selected soil health indicators
397 and wheat productivity. *Agronomy* **10**, 235
(2020).
- Wang, S.B. et al. Effects of multiple winter cropping on soil organic carbon and double-
398 cropping rice yield in the south of China. *Acta*
Ecol. Sin. **38**, 6603-6610 (2018).
- Wang, Y.M., Lei, Y.F., Wei, Z.W. & Han, Z.S. Effects of different rotation modes on yield,
399 quality of silage corn, and soil fertility. *Acta*
Agric. Nucl. Sin. **31**, 1803-1810 (2017).
- Warman, P. R. Effect of incorporated green manure crops on subsequent oat production in an
400 acid, infertile silt loam. *Plant Soil* **134**, 115–
119 (1991).
- Watkins, K.B., Anders, M.M. & Windham, T.E. An economic comparison of alternative rice
401 production systems in Arkansas. *J. Sustain.*
Agric. **24**, 57-78 (2004).
- Watson, E. R. The influence of subterranean clover pastures on soil fertility i. Short-term
402 effects. *Aust. J. Agric. Res.* **14**, 796–807 (1963).
- Watson, E. R., Lapins, P. & Barron, R. J. W. Effects of initial clover seeding rate and length
403 of ley on pasture production, soil nitrogen and crop yields in a ley farming system. *Aust.*
J. Exp. Agric. **16**, 484–490 (1976).
- Wei, X., Hao, M., Shao, M. & Gale, W. J. Changes in soil properties and the availability of
404 soil micronutrients after 18 years of cropping and fertilization. *Soil Till. Res.* **91**, 120–130
(2006).
- Weil, R.R. & Samaranayake, A. Effects of winged bean on a following maize crop. *Exp.*
405 *Agric.* **27**, 329-338 (1991).
- Wesley, R.A., Elmore, C.D. & Spurlock, S.R. Deep tillage and crop rotation effects on cotton,
406 soybean, and grain sorghum on clayey soils. *Agron. J.* **93**, 170-178 (2001).
- West, T.D., Griffith, D.R., Steinhardt, G.C., Kladvík, E.J. & Parsons, S.D. Effect of tillage
407 and rotation on agronomic performance of corn and soybean: twenty-year study on
dark silty clay loam soil. *J. Prod. Agric* **9**, 241-248 (1996).
- Westphal, A. & Scott, A.W. Implementation of soybean in cotton cropping sequences for
408 management of reniform nematode in South Texas. *Crop Sci.* **45**, 233-239 (2005).
- Whalen, J.K., Hu, Q. & Liu, A. Compost applications increase water-stable aggregates in
409 conventional and no-tillage systems. *Soil Sci. Soc. Am. J.* **67**, 1842-1847 (2003).
- Widdowson, F. V., Penny, A., Gutteridge, R. J., Darby, R. J. & Hewitt, M. V. Tests
of amounts and times of application of nitrogen and of sequential sprays of aphicide
and

- 410 fungicides on winter wheat, following either beans or wheat, and the effects of take-
all (*Gaeumannomyces graminis* var. *tritici*), on two varieties at Saxmundham, Suffolk
1980–3. *J. Agric. Sci.* **105**, 97–122 (1985).
- Wiedenfeld, R.P. Previous-crop effects on sugarcane responses to nitrogen fertilization.
411 *Agron. J.* **90**, 161–165 (1998).
- Wieme, R.A., Carpenter-Boggs, L.A., Crowder, D.W., Murphy, K.M. & Reganold, J.P.
412 Agronomic and economic performance of organic forage, quinoa, and grain crop rotations
in the Palouse region of the Pacific Northwest, USA. *Agr. Syst.* **177**, 102709 (2020).
- Wilhelm, W.W. & Wortmann, C.S. Tillage and rotation interactions for corn and soybean
413 grain yield as affected by precipitation and air temperature. *Agron. J.* **96**, 425–432 (2004).
- Wolfe, A.M., Eckert, D.J. & Eckert, D.J. Crop sequence and surface residue effects on the
414 performance of no-till corn grown on a poorly drained soil. *Agron. J.* **91**, 363–367 (1999).
- Wolfe, A.M., Eckert, D.J. & Eckert, D.J. Crop sequence and surface residue effects on the
415 performance of no-till corn grown on a poorly drained soil. *Agron. J.* **91**, 363–367 (2000).
- Woźniak, A. & Soroka, M. Effect of crop rotation and tillage system on the weed
infestation
416 and yield of spring wheat and on soil properties. *Appl. Ecol. Environ. Res.* **16**, 3087–3096
(2018).
- Woźniak, A. Effect of cereal monoculture and tillage systems on grain yield and weed
417 infestation of winter durum wheat. *Int. J. Plant Prod.* **14**, 1–8 (2020).
- Woźniak, A. Effect of crop rotation and cereal monoculture on the yield and quality of winter
418 wheat grain and on crop infestation with weeds and soil properties. *Int. J. Plant. Prod.* **13**,
177–182 (2019).
- Woźniak, A. Effect of various systems of tillage on winter barley yield, weed infestation and
419 soil properties. *Appl. Ecol. Environ. Res.* **18**, 3483–3496 (2020).
- Woźniak, A., Nowak, A., Haliniarz, M. & Gawęda, D. Yield and economic results of spring
420 barley grown in crop rotation and in monoculture. *Pol. J. Environ. Stud.* **28**, 2441–2448
(2019).
- Woźniak, A., Wesołowski, M. & Soroka, M. Effect of long-term reduced tillage on grain
421 yield, grain quality and weed infestation of spring wheat. *J. Agric. Sci. Technol.* **17**,
899–908 (2015).
- Wright, A.T. Yield effect of pulses on subsequent cereal crops in the Northern prairies. *Can.*
422 *J. Plant Sci.* **70**, 1023–1032 (1990).
- Yadav, R.L., Singh, V.K., Dwivedi, B.S. & Shukla, A.K. Wheat productivity and N use-
423 efficiency as influenced by inclusion of cowpea as a grain legume in a rice–wheat system. *J.*
Agric. Sci. **141**, 213–220 (2003).
- Yau, S. K., Bounejmate, M., Ryan, J. & Nassar, A. Sustainable barley-legume rotations for
424 semi-arid areas of Lebanon. *Challenges Strateg. Dryl. Agric.* **32**, 219–227 (2004).
- Yusuf, A.A., Abaidoo, R.C., Iwuafor, E.N.O., Olufajo, O.O. & Sanginga, N. Rotation effects
425 of grain legumes and fallow on maize yield, microbial biomass and chemical properties of an
Alfisol in the Nigerian savanna. *Agric. Ecosyst. Environ.* **129**, 325–331 (2009).
- Yusuf, A.A., Iwuafor, E.N.O., Abaidoo, R.C., Olufajo, O.O. & Sanginga, N. Grain legume
426 rotation benefits to maize in the Northern Guinea savanna of Nigeria: Fixed-nitrogen versus
other rotation effects. *Nutr. Cycl. Agroecosystems* **84**, 129–139 (2009).

427 Zebarth, B.J. & Sheard, R.W. Yield and protein response of hard red winter wheat to rate of
nitrogen fertilization and previous legume crop. *Can. J. Plant Sci.* **72**, 21-25 (1992).

428 Zentner, R.P. et al. Long-term assessment of management of an annual legume green manure
crop for fallow replacement in the brown soil zone. *Can. J. Plant Sci.* **84**, 11-22 (2004).

429 Zentner, R.P., Campbell, C.A., Bowren, K.E. & Edwards, W. Effects of crop rotations and
fertilization on yields and quality of spring wheat grown on a Black Chernozem in
Northcentral Saskatchewan. *Can. J. Plant Sci.* **70**, 383-397 (1990).

430 Zentner, R.P., Campbell, C.A., Selles, F., Jefferson, P.G. & Lemke, R. Effect of fallow
frequency, flexible rotations, legume green manure, and wheat class on the economics of
wheat production in the Brown soil zone. *Can. J. Plant Sci.* **86**, 413-423 (2006).

431 Zhang, B., Drury, C. F., Yang, X., Reynolds, D. & Zhang, X. Crop rotation, red clover and
cropping history influences microbial amino sugars of a clay loam soil. *Soil Sci. Soc.
Am. J.* **78**, 818-824 (2014).

432 Zhang, X., Bi, J., Sun, H., Zhang, J. & Zhou, S. Greenhouse gas mitigation potential under
different rice-crop rotation systems: From site experiment to model evaluation. *Clean
Technol. Environ. Policy* **21**, 1587-1601 (2019).

433 Zhao, X., Wang, S. & Xing, G. Maintaining rice yield and reducing N pollution by
substituting winter legume for wheat in a heavily-fertilized rice-based cropping system of
Southeast China. *Agric. Ecosyst. Environ.* **202**, 79-89 (2015).

434 Zhong, C., Yang, B.J., Zhang, P., Li, P. & Huang, G.Q. Effect of paddy-upland rotation with
different winter crops on rice yield and CH₄ and N₂O emissions in paddy fields. *Acta
Agric. Nucl. Sin.* **33**, 379-388 (2019).

435 Zhou, G.Y. et al. No-tillage effects on corn and soybean yield and profitability: based on a
long-term field trial of black soil in northeast China. *J. Jilin Agri. Univ.* **37**, 260-267 (2015).

436 Zhou, T. et al. Effects of alfalfa and kentucky bluegrass rotations on agronomic characters and
nutritional quality. *Acta Agrestia Sin.* **28**, 720-726 (2020).

437 Zielke, R. C. & Christenson, D. R. Organic carbon and nitrogen changes in soil under selected
cropping systems. *Soil Sci. Soc. Am. J.* **50**, 363-367 (1986).

438 Zingore, S., Murwira, H.K., Delve, R.J. & Giller, K.E. Variable grain legume yields,
responses to phosphorus and rotational effects on maize across soil fertility gradients on
African smallholder farms. *Nutr. Cycl. Agroecosystems* **80**, 1-18 (2008).

439 Adhikary, S., Bagchi, D. K., Ghosal, P., Banerjee, R. N. & Chatterjee, B. N. Studies on
maize - legume intercropping and their residual effects on soil fertility status and succeeding
crop in upland situation. *Journal of Agronomy and Crop Science-Zeitschrift Fur Acker Und
Pflanzenbau* **167**, 289-293, doi:10.1111/j.1439-037X.1991.tb00959.x (1991).

440 Bado, B. V., Bationo, A. & Cescas, M. P. Assessment of cowpea and groundnut contributions
to soil fertility and succeeding sorghum yields in the Guinean savannah zone of Burkina Faso
(West Africa). *Biology and Fertility of Soils* **43**, 171-176, doi:10.1007/s00374-006-0076-7
(2006).

Bationo, A. & Ntare, B. R. Rotation and nitrogen fertilizer effects on pearl millet, cowpea and
groundnut yield and soil chemical properties in a sandy soil in the semi-arid tropics, West

441 Africa. *Journal of Agricultural Science* **134**, 277-284, doi:10.1017/s0021859699007650
(2000).
Do Thi, X. *et al.* Different crop rotation systems as drivers of change in soil bacterial
community
442 structure and yield of rice, *Oryza sativa*. *Biology and Fertility of Soils* **48**, 217-225,
doi:10.1007/s00374-011-0618-5 (2012).
Feng, B. *et al.* Effects of crop rotation systems on microbial structure under low N application
443 in rice field. *Journal of Plant Nutrition* **43**, 500-511, doi:10.1080/01904167.2019.1685104
(2020).
Grabau, Z. J. & Chen, S. Determining the role of plant-parasitic nematodes in the corn-
soybean
444 crop rotation yield effect using nematicide application: I. Corn. *Agronomy Journal* **108**,
782793, doi:10.2134/agronj2015.0431 (2016).
Izaurrealde, R. C., Choudhary, M., Juma, N. G., McGill, W. B. & Haderlein, L. Crop and
445 nitrogen yield in legume-based rotations practiced with zero tillage and low-input methods.
Agronomy Journal **87**, 958-964, doi:10.2134/agronj1995.00021962008700050031x (1995).
Stecker, J. A., Buchholz, D. D., Hanson, R. G., Wollenhaupt, N. C. & McVay, K. A. Tillage
446 and rotation effects on corn yield response to fertilizer nitrogen on Aqualf soils. *Agronomy
Journal* **87**, 409-415, doi:10.2134/agronj1995.00021962008700030004x (1995).
Ryan, J., Singh, M. & Christiansen, S. Assessment of long-term barley-legume rotations in a
447 typical Mediterranean agro-ecosystem: grain and straw yields. *Archives of Agronomy and Soil
Science* **58**, 233-246, doi:10.1080/03650340.2010.514267 (2012).
Liu, D. L., Chan, K. Y. & Conyers, M. K. Simulation of soil organic carbon under different
448 tillage and stubble management practices using the Rothamsted carbon model. *Soil & Tillage
Research* **104**, 65-73, doi:10.1016/j.still.2008.12.011 (2009).
Badaruddin, M. & Meyer, D. W. Forage legume effects on soil nitrogen and grain yield, and
449 nitrogen nutrition of wheat. *Agronomy Journal* **81**, 419-424,
doi:10.2134/agronj1989.00021962008100030004x (1989).
Kermah, M. *et al.* Legume-maize rotation or relay? Options for ecological intensification of
450 smallholder farms in the Guinea savanna of northern Ghana. *Experimental Agriculture* **55**,
673-691, doi:10.1017/s0014479718000273 (2019).
Kazula, M. J., Lauer, J. G. & Arriaga, F. J. Crop rotation effect on selected physical and
451 chemical properties of Wisconsin soils. *Journal of Soil and Water Conservation* **72**, 553-563,
doi:10.2489/jswc.72.6.553 (2017).
Mason, M. G. & Rowland, I. C. Nitrogen fertiliser response of wheat in lupin-wheat,
452 subterranean clover-wheat and continuous wheat rotations. *Australian Journal of
Experimental Agriculture* **30**, 231-236, doi:10.1071/ea9900231 (1990).
Muchane, M. N. *et al.* Influence of improved fallow systems and phosphorus application on
453 arbuscular mycorrhizal fungi symbiosis in maize grown in western Kenya. *Agroforestry
Systems* **78**, 139-150, doi:10.1007/s10457-009-9249-3 (2010).
Muleba, N. Effects of cowpea, crotalaria and sorghum crops and phosphorus fertilizers on
maize
454 productivity in semi-arid West Africa. *Journal of Agricultural Science* **132**, 61-70,
doi:10.1017/s0021859698006182 (1999).

Samake, O., Stomph, T. J., Kropff, M. J. & Smaling, E. M. A. Integrated pearl millet management in the sahel: Effects of legume rotation and fallow management on productivity and *Striga hermonthica* infestation. *Plant and Soil* **286**, 245-257, doi:10.1007/s11104-0069041-3 (2006).

Yadav, R. L. & Verma, R. P. Crop residue management to conserve soil organic matter content in sugarcane-based crop rotations. *Bioresource Technology* **51**, 241-245, doi:10.1016/09608524(94)00135-n (1995).

Rao, A. V., Tarafdar, J. C., Sharma, S. K., Praveenkumar & Aggarwal, R. K. Influence of cropping systems on soil biochemical properties in an arid rain-fed environment. *Journal of Arid Environments* **31**, 237-244, doi:10.1006/jare.1995.0063 (1995).

Tarawali, S. A. & Peters, M. The potential contribution of selected forage legume pastures to cereal production in crop-livestock farming systems. *Journal of Agricultural Science* **127**, 175182, doi:10.1017/s0021859600077959 (1996).

Jagadamma, S., Lal, R., Hoef, R. G., Naffiger, E. D. & Ade, E. A. Nitrogen fertilization and cropping system impacts on soil properties and their relationship to crop yield in the central Corn Belt, USA. *Soil & Tillage Research* **98**, 120-129, doi:10.1016/j.still.2007.10.008 (2008).

Stevenson, F. C. & vanKessel, C. The nitrogen and non-nitrogen rotation benefits of pea to succeeding crops. *Canadian Journal of Plant Science* **76**, 735-745, doi:10.4141/cjps96-126 (1996).

Sun, B. *et al.* No tillage combined with crop rotation improves soil microbial community composition and metabolic activity. *Environmental Science and Pollution Research* **23**, 64726482, doi:10.1007/s11356-015-5812-9 (2016).

Riedell, W. E., Pikul, J. L., Jr., Jaradat, A. A. & Schumacher, T. E. Crop rotation and nitrogen input effects on soil fertility, maize mineral nutrition, yield, and seed composition. *Agronomy Journal* **101**, 870-879, doi:10.2134/agronj2008.0186x (2009).

Yadav, R. L. & Prasad, S. R. Maximizing sugarcane yield by increasing plant population density, minimizing NO₃-N leaching and improving soil organic matter in different crop rotations. *Journal of Agronomy and Crop Science-Zeitschrift Fur Acker Und Pflanzenbau* **178**, 117-123, doi:10.1111/j.1439-037X.1997.tb00359.x (1997).

Cui, H. *et al.* Effect of crop rotation and irrigation on wheat yield and water-use efficiency. *Chinese Journal of Eco-Agriculture* **17**, 479-483, doi:10.3724/sp.j.1011.2009.00479 (2009).

Fang, Y., Wang, F., Li, Q., Lin, C. & He, C. Effect of continuous paddy-upland crop rotation on bacterial community structure in cold waterlogged paddy soil. *Acta Pedologica Sinica* **55**, 515-525 (2018).

Li, Q. *et al.* Effects of paddy-upland rotation on the nutrient activation of soil carbon, nitrogen and phosphorus in cold waterlogged paddy field. *Journal of Soil and Water Conservation* **29**, 113-117 (2015).

Xu, W. *et al.* Effects of crop stubbles on cotton yield and soil environment in continuously cropped cotton field. *Transactions of the Chinese Society of Agricultural Engineering* **27**, 271275 (2011).

Zhang, X. *et al.* Yield and profitability of corn and soybean under different tillage in the black

468 soils of Northeast China. *Chinese Journal of*
Eco-Agriculture **16**, 858-864,
doi:10.3724/sp.j.1011.2008.00858 (2008).

Xu, H. Test on the cultivation model of broad bean and highland barley reduce fertilizer and
469 increasing efficiency. *Sci. Tech. Qinghai Agric. For.*, 79-81 (2018).

Dong, C.H. Studies on reddish paddy field microbial properties of long-term fertilization and
470 crop rotation system[D]. Hunan Agricultural University, 2014.

Gu, J.L. Effects of different planting modes on soil characters and maize growth and
471 development and yield[D]. Northeast Agricultural University,
2019.

Guo, J.R. Impacts of long-term different fertilizer cropping regimes on maize yield and soil
472 quality, and greenhouse gas emission effects on blacks soil region of Northeast China
[D].
Nanjing Agricultural University, 2015.

Cui,X.L. Studies on the effects of previous crops on yield and quality of tobacco[D]. Hunan
473 Agricultural University, 2009.

Li, H.Y. Evaluation of nutrient utilization efficiency and soil fertility quality in different
474 planting patterns of double-cropping region in southern part of north china
plain[D]. Henan Normal University, 2018.

Li, W.B. Effects of different double-cropping-rice-based rotations on rice yield and nutrient
475 runoff loss in paddy field [D]. Hunan Agricultural University, 2018.

Liang, Z.T. Characteristics of soil microbial communities and soil nutrients under different
476 forage-crop rotations in the longdong loess plateau[D]. Lanzhou University,
2018.