Supporting Information. Jennifer Blesh. 2019. Feedbacks between nitrogen fixation and soil organic matter increase ecosystem functions in diversified agroecosystems. *Ecological Applications.*

Appendix S1

Detailed methods for carbon (C) mineralization and *B*-value determination to estimate vetch N_2 fixation.

Short-term C mineralization

C mineralization (C-min) was determined by a short-term aerobic incubation of rewetted soil (i.e., the flush of CO_2 during a 1-day incubation). In brief, 10 g of air-dried soil was weighed into 50mL centrifuge tubes with lids fitted with airtight, rubber septa. Deionized water was added to each tube to bring the samples to approximately 50% water-filled pore space (WFPS). The CO_2 concentration was measured by sealing tubes, and then immediately removing 0.5mL of headspace gas (time zero) with a syringe and injecting it into a Li-Cor LI-820 infrared gas analyzer (Li-Cor Biosciences, Lincoln, NE). Sealed tubes were then incubated for 24 hours in the dark at 25 °C. At 24 hours, tubes were removed and one-day CO_2-C was determined as the difference between the time zero and day one CO_2 concentrations.

B-value determination

The *B* value quantifies the ^{15}N fractionation that occurs during legume N_2 fixation, which is affected by both rhizobial strains and internal translocation of N from roots to shoots. Vetch seeds were surface sterilized in 70% (*v*/*v*) ethanol for three minutes and rinsed three times with deionized water. Seeds were then soaked for an additional three minutes in 3% (*v*/*v*) NaOCl and rinsed three more times with deionized water. The seeds were coated with 1g of the recommended N-Dure® inoculant. Four replicates of each variety were planted (16 seeds/pot, thinned to four plants per pot) in a N-free, autoclaved perlite/sand media (1:5 perlite: sand) in pots that had been soaked in 3% NaOCl. Pots were arranged in a randomized complete block design on a greenhouse bench with 16-hr day length, a daytime temperature of 25°C, and nighttime temperature of 15°C. Plants were watered with deionized water, and were fertilized with a N-free nutrient solution. Whole plants were harvested when almost all plants were flowering, separated into roots and shoots, dried, finely ground, and analyzed for $\delta^{15}N$.

Table S1. Regression coefficients for regression analysis of total fixed N in legume aboveground biomass (in kg N ha^{-1}) in 2016, in mixture (vetch-mix) and monoculture (sole vetch), using baseline soil properties as predictors. Coefficients in bold font are significant*, and the estimated model fit is indicated by the R^2 and adjusted R^2.

Model 1

	Intercept	ln(free POM N) mg kg $soil^{-1}$	ln(protected POM N) mg kg $soil^{-1}$	Bray-1 P mg kg $soil^{-1}$	R^2	Adjusted R^2	N	Model *P*-value
Vetch-mix	170.44	7.08	**-44.16****	**0.47****	0.47	0.43	40	<0.0001
Sole vetch	159.00	12.63	**-41.39***	**0.80*****	0.42	0.37	40	0.0002

Model 2

	Intercept	C:N protected POM	Bray-1 P mg kg $soil^{-1}$	R^2	Adjusted R^2	N	Model *P*-value
Vetch-mix	-126.5	**9.32*****	**0.50****	0.54	0.51	40	<0.0001
Sole vetch	66.7	5.47†	**0.87*****	0.38	0.35	40	0.0001

*Significance: **P*< 0.05, ***P*<0.01, ****P*<0.001
†Marginally significant (P=0.05)

Figure S1. Mean $\delta^{15}N$ signature of the reference plant (rye), and of the vetch grown alone (sole vetch) and in mixture with rye (vetch-mix), with standard error, across 10 farms in 2016, and nine farms in 2017.

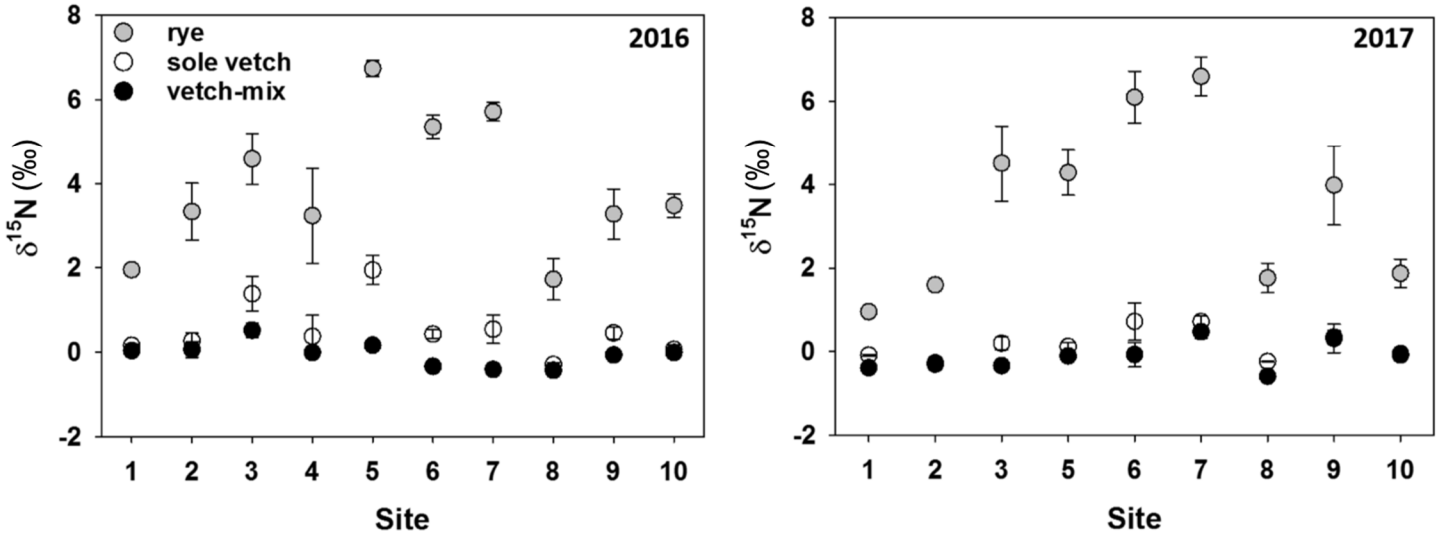
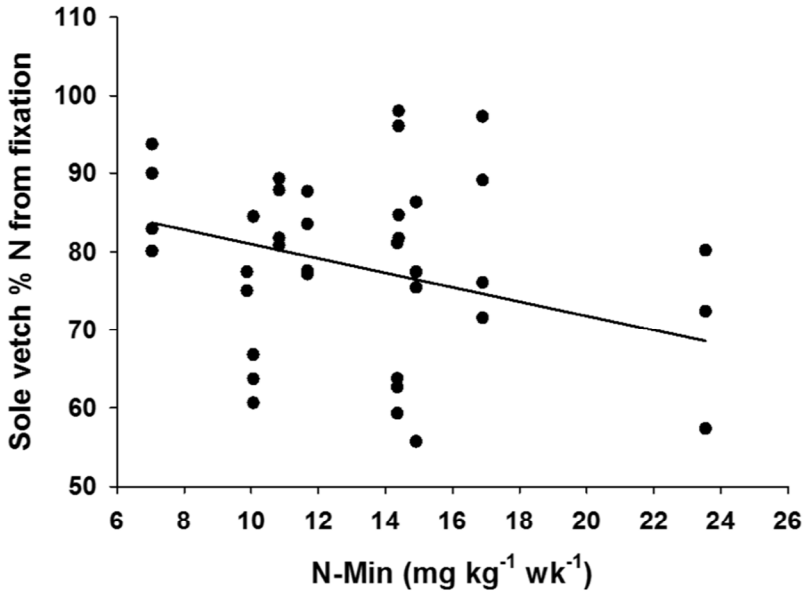
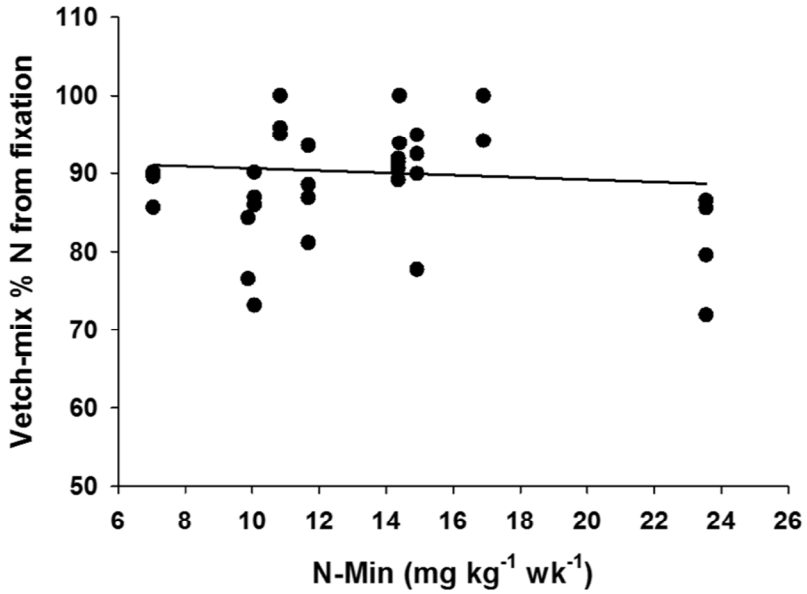


Figure S2. Regression relationships for N mineralization potential and the % of vetch shoot N derived from fixation, for sole vetch (left) and vetch grown in mixture with rye (right).



$R^2 = 0.11$
P = 0.0401
$y = 90.15 – 0.92x$



$R^2 = 0.01$
P = 0.6177
$y = 92.04 – 0.14x$

Figure S3. Regression relationships between plant-available soil P concentration and the % of vetch shoot N derived from fixation (top panel), and between soil P and the total amount of fixed N in vetch shoots (bottom panel), for sole vetch (left) and for vetch grown in mixture with rye (right).