Figure S1. Mulch layer C content (kg ha^{-1}) of an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia of Brazil. Site establishment via mulching tractor took place in June 2005 and was abandoned to secondary succession in 2007 before the second rotation was established via mulching tractor in July 2014. Treatments were assigned in a split-plot design as follows: main-plot treatment of P+K fertilization (PK+) or without (PK−), and sub-plot treatment with the inclusion the N-fixing tree *Inga edulis* in the 5 species planting mix (I+) or without (I−).

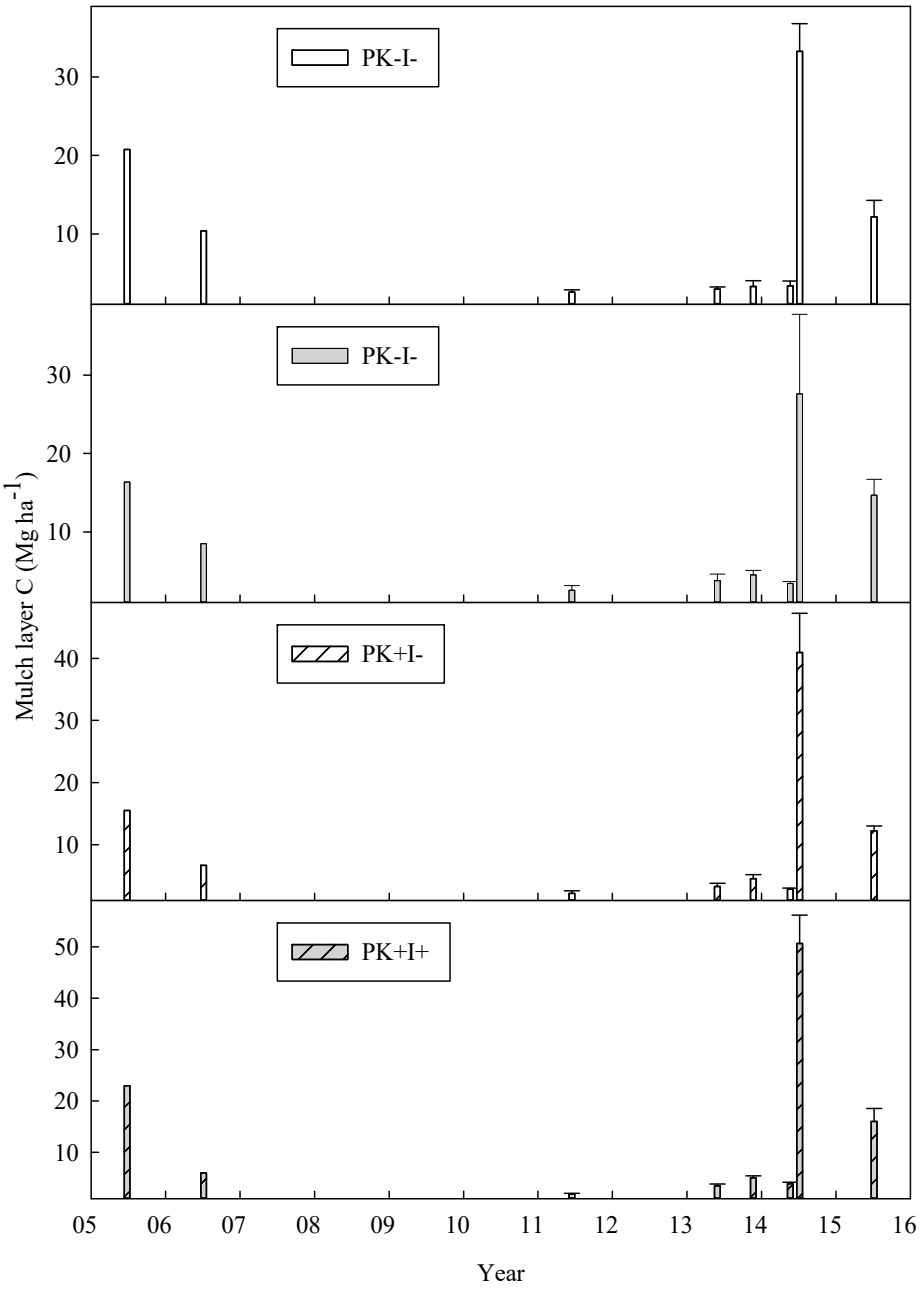

Figure S2. Soil-C content by depth increments 0 – 10 and 10 – 20 cm in an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia, Brazil. Site establishment via mulching tractor took place in June 2005 and was abandoned to secondary succession in 2007 before the 2nd Rotation was established via mulching tractor in July 2014. Treatments were assigned in a split-plot design as follows: main-plot treatment of P+K fertilization (PK+) or without (PK−), and sub-plot treatment with the inclusion the N-fixing tree *Inga edulis* in the 5 species planting mix (I+) or without (I−).

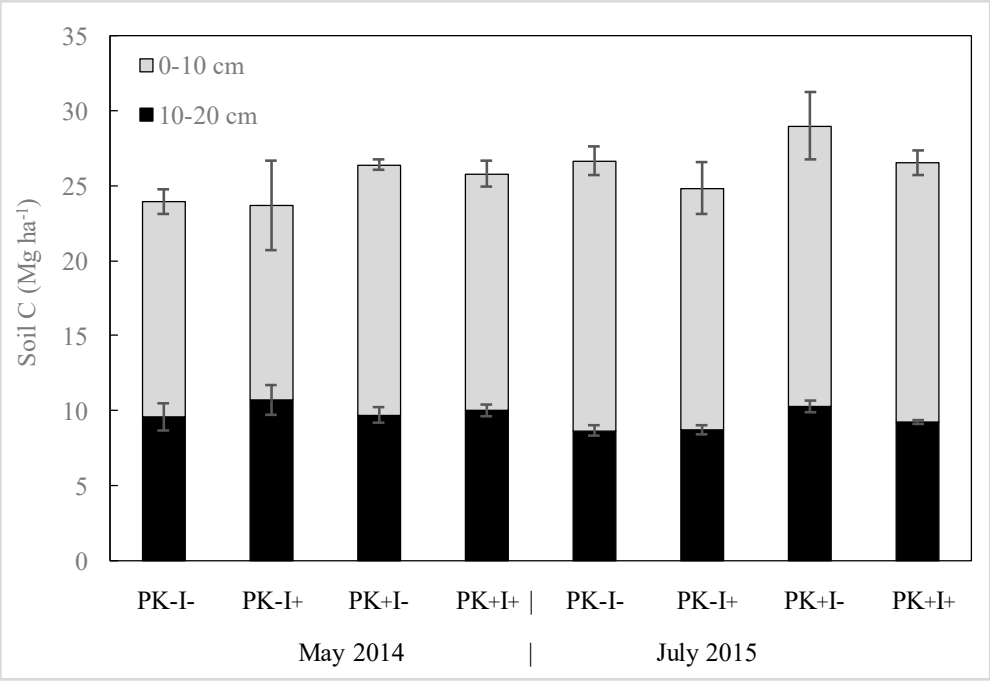

Table S1. Soil particle-size distribution at different depths in an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia, Brazil.

Depth (cm)	Sand	Silt	Clay	Soil Texture
	---------- % ----------			
0 - 10	66.9 ± 1.6	12.9 ± 1.6	20.1 ± 2.1	Sandy Clay Loam
10 - 20	58.5 ± 2.5	9.1 ± 2.4	32.4 ± 0.6	Sandy Clay Loam
20 - 50	49.0 ± 1.2	5.4 ± 0.6	45.7 ± 0.6	Sandy Clay
50 - 100	44.3 ± 2.6	4.7 ± 0.6	51.0 ± 2.4	Clay
100 - 150	41.1 ± 1.6	4.1 ± 0.6	54.8 ± 1.3	Clay
150 - 200	40.2 ± 0.7	3.5 ± 1.2	56.3 ± 1.2	Clay

Table S2. Differences in survival of five species of native trees after 24 months after planting of Rotation 1 and newly planted trees at 20 months of Rotation 2 of a crop-fallow agroforestry system in eastern Amazonia of Brazil. Trees and crops were initially planted in 2005, were abandoned to secondary succession in 2007 until 2014 when the second Rotation of the crop-fallow system was planted and subsequently abandoned to secondary succession in 2016. *indicate significant differences within species between 1st Year of Rotation 1 and 1st Year of Rotation 2.

Species	Fert[1]		Nfix[2]	
	F Value	Pr > F	F Value	Pr > F
Cedrela odorata	43.6	<.0001*	2.5	0.12
Ceiba pentandra	17.6	<.0001*	1.2	0.3
Inga edulis	21.3	<.0001*	---	---
Parkia multijuga	14.7	0.0003*	---	---
Schizolobium amazonicum	0.8	0.4	0.6	0.4

[1]Main-plot treatment with or without P+K fertilization

[2]Sub-plot treatment with or without *Inga edulis* or *Parkia multijuga* in planting mix

Table S3. Statistical contrasts of Height, DBH, and GLD of five species of native trees grown in mixed-culture, crop-fallow agroforestry system in eastern Amazonia of Brazil. Trees and crops were initially planted in 2005, abandoned to secondary succession in 2007 until 2014, when the second Rotation of the crop-fallow system was planted and subsequently abandoned to secondary succession in 2016. Contrast statements compare growth during Year 9 of Rotation1 and again during Year 2 of Rotation 2.

	All Species						*Cedrela odorata*						*Ceiba pentandra*						*Inga edulis*						*Parkia multijuga*						*Schizolobium amzonicum*					
	GLD		DBH		Height		GLD		DBH		Height		GLD		DBH		Height		GLD		DBH		Height		GLD		DBH		Height		GLD		DBH		Height	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Rotation 1	0.1	0.7	0.9	0.4	0.1	0.7	.	.	.	.	.	.	0.4	0.5	0.3	0.6	0.2	0.7	0.0	>0.9	.	.	0.0	0.9	0.2	0.6	.	.	0.2	0.6	.	.	.	.	.	.
Rotation 2	3.9	0.06+	1.3	0.3	0.4	0.5	0.4	0.7	.	.	2.6	0.01*	2.0	0.16	3.1	0.11	0.1	0.7	0.8	0.4	.	.	4.9	0.04*	0.9	0.4	.	.	0.1	0.8	2.4	0.13	.	.	6.6	0.01*

*indicates significant difference at the p<0.05 level

+indicates significant difference at the p<0.10 level

Table S4. Sum of estimated total planted-tree aboveground biomass (kg) by plot and total biomass-N of planted-trees (g), and Percent (%) by Species of Total Biomass and Total N, at four different dates. Five species of native trees were grown in a mixed-culture, crop-fallow agroforestry system in eastern Amazonia of Brazil. Trees and crops were initially planted in 2005, abandoned to secondary succession in 2007 until 2014, when the second Phase of the crop-fallow system was planted and subsequently abandoned to secondary succession in 2016.

Treatment	Species	March 2006		March 2014		November 2014		March 2016		March 2006		March 2014		November 2014		March 2016	
		Sum Biomass	% of Total	Sum Biomass	% of Total	Sum Biomass	% of Total	Sum Biomass	% of Total	Mass N	% of Total N	Mass N	% of Total	Mass N	% of Total	Mass N	% of Total
		(kg)		(kg)		(kg)		(kg)		(g)		(g)		(g)		(g)	
PK-I-	*Cedrela odorata*	0.3	9.4	27.9	27.3	15.8	76.1	17.0	65.9	4.2	23.2	133.8	25.3	70.6	46.3	68.6	42.1
	Ceiba pentandra	2.6	83.7	17.6	17.2	4.8	23.3	5.1	19.8	13.6	74.8	296.1	56.0	81.7	53.5	85.9	52.6
	Parkia multijuga					0.1	0.3	1.8	7.1					0.2	0.1	5.4	3.3
	Schizolobium amazonicum	0.2	6.9	56.5	55.4	0.1	0.3	1.8	7.2	0.4	2.1	98.5	18.6	0.1	0.1	3.2	2.0
	Planted-Trees Sum	3.1		101.9		20.8		25.7		18.2		528.4		152.7		163.1	
PK-I+	*Cedrela odorata*	0.2	2.9	7.7	3.6	6.9	4.9	6.6	3.5	2.1	7.4	41.7	4.6	62.1	13.3	27.7	4.7
	Ceiba pentandra	1.3	24.5	4.0	1.9	0.3	0.2	0.8	0.4	6.5	22.4	67.1	7.3	4.8	1.0	13.1	2.2
	Inga edulis	3.2	62.7	35.9	16.9	0.4	0.3	1.5	0.8	19.1	65.9	174.5	19.1	3.2	0.7	11.2	1.9
	Parkia multijuga	0.3	6.0	165.3	77.6	133.3	94.6	179.0	94.9	0.9	3.1	630.2	69.0	396.7	85.0	532.9	90.9
	Schizolobium amazonicum	0.2	3.9			0.03	0.02	0.7	0.4	0.3	1.2			0.1	0.01	1.3	0.2
	Planted-Trees Sum	5.1		212.9		140.9		188.7		29.0		913.5		466.9		586.2	
PK+I-	*Cedrela odorata*	0.1	0.6	12.3	2.0	18.7	14.3	11.6	5.8	1.2	3.9	43.4	1.2	53.6	2.8	38.6	1.7
	Ceiba pentandra	1.9	13.8	162.4	27.0	111.3	85.2	129.6	65.3	9.6	31.3	2739.1	77.7	1876.6	97.2	2186.0	93.7
	Parkia multijuga					0.1	0.04	7.2	3.7					0.2	0.01	21.6	0.9
	Schizolobium amazonicum	11.5	85.5	427.3	71.0	0.5	0.4	50.0	25.2	20.0	64.9	744.8	21.1	0.9	0.05	87.1	3.7
	Planted-Trees Sum	13.4		602.0		130.5		198.4		30.8		3527.2		1931.4		2333.3	
PK+I+	*Cedrela odorata*	0.0	0.3			0.1	0.04	0.3	0.2	0.5	1.1			0.9	0.04	4.5	0.3
	Ceiba pentandra	0.9	7.8	97.7	17.0	115.9	71.7	77.1	48.8	4.5	10.6	1647.0	55.4	1955.6	93.4	1299.8	0.0
	Inga edulis	4.0	36.0	109.2	19.0	0.3	0.2	3.4	2.2	26.9	62.8	584.3	19.6	2.6	0.1	25.3	1.6
	Parkia multijuga	0.0	0.4	82.0	14.3	45.3	28.0	63.3	40.1	0.1	0.3	244.2	8.2	134.9	6.4	188.4	12.2
	Schizolobium amazonicum	6.2	55.5	285.7	49.7	0.1	0.04	13.8	8.7	10.8	25.3	498.0	16.7	0.1	0.005	24.0	1.6
	Planted-Trees Sum	11.2		574.6		161.7		157.8		42.9		2973.5		2094.1		1541.9	

Table S5. Statistical output of *Manihot esculenta* biomass and N content (kg ha^{-1}) by root, stem, leaf compartments, and sum of all compartments, measured at Year 1 after establishment of Rotation 2 (2015) of crop-fallow system in Eastern Amazonia of Brazil. The site was established as an improved-fallow slash-and-mulch agroforestry system with a split-plot design with the main-plot treatment of P+K fertilization or without (Fert), and the sub-plot treatment with the N-fixing tree *Inga edulis* in the 5-species planting mix, or without (Nfix).

Variable	Treatment	Type III SS	F Value	Pr > F
Root Mass	Fert[1]	0.634	7.4	0.07
	Nfix[2]	0.001	0.01	0.94
Stem Mass	Fert	0.864	6.3	0.09
	Nfix	0.004	0.1	0.83
Leaf Mass	Fert	0.625	6.4	0.09
	Nfix	0.029	0.1	0.79
Sum Mass	Fert	0.693	8.0	0.07
	Nfix	0.000	0.0	1.00
Root N	Fert	0.435	6.8	0.08
	Nfix	0.000	0.0	0.98
Stem N	Fert	1.020	11.6	0.04
	Nfix	0.012	0.1	0.77
Leaf N	Fert	0.564	6.4	0.08
	Nfix	0.011	0.02	0.89
Sum N	Fert	0.658	15.1	0.03
	Nfix	0.000	0.0	0.98

Table S6. Statistical output of Mulch layer Mass, N and C concentration, and N and C content of an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia of Brazil. Site establishment via mulching tractor took place in June 2005 and was abandoned to secondary succession in 2007 before the second rotation was established via mulching tractor in July 2014.

Variable	Treatment	F Value	Pr > F
Litter Mass	Nfix[1]	4.5	0.04
	Date	371.1	<.0001
Litter [N]	Date	10.7	<.0001
Litter [C]	Date	14.3	<.0001
Litter N Content	Date	130.6	<.0001
	Fert[2]*Date	2.4	0.06
Litter C Content	Nfix	5.1	0.03
	Date	212.2	<.0001

[1]Sub-plot treatment inclusion of N-fixing *I. edulis* , or not

[2]Main-plot treatment of P+K fertilization, or not

Table S7. Statistical output of significant differences for plot-level soil sampling at 0–10 cm depth of an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia, Brazil. Site establishment via mulching tractor took place in June 2005 and was abandoned to secondary succession in 2007 before the second rotation was established via mulching tractor in July 2014. Sampling for plot-level soil took place in June 2013 and May 2014 prior to secondary forest conversion, and in July 2015, one year after conversion to second rotation of mixed-species agroforestry system.

Effect	Soil-C		Soil-N		Soil C:N	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Fert[1]	0.3	0.6	1.2	0.4	0.1	0.8
Nfix[2]	0.4	0.5	0.0	0.9	1.8	0.2
Fert*Nfix	0.2	0.7	0.1	0.8	0.1	0.7
Date	0.1	0.9	10.2	0.003*	24.7	<.0001*
Fert*Date	0.3	0.7	0.2	0.8	2.0	0.2
Nfix*Date	0.5	0.6	1.3	0.3	1.0	0.4
Fert*Nfix*Date	0.6	0.6	1.4	0.3	0.3	0.8

[1]Main-plot treatment of P+K fertilization or without

[2]Sub-plot treatment of *Inga edulis* in 5-species planting mix or not

Table S8. Soil N and C concentrations (%) in the 0–10 and 10–20 cm depths at three different years during the first rotation of a slash-and-mulch agroforestry system in eastern Amazonia of Brazil. Main-plot treatment with (PK+) or without (PK−) P+K fertilizer, and sub-plot treatment with (I+) or without (I−) the presence of the N-fixing *Inga edulis*.

		2005				2006		2011	
Block	Depth	N	$C_{organic}$	Treatment	Depth	N	$C_{organic}$	N	$C_{organic}$
	cm	%			cm	% (SE)		% (SE)	
A	0 - 10	0.15	1.71	PK-I-	0 - 10	0.18 (0.04)	2.29 (0.05)	0.08 (0.00)	2.55 (0.77)
	10 -20	0.1	1.03		10 -20	0.11 (0.01)	2.29 (1.27)	0.07 (0.01)	1.47 (0.26)
B	0 - 10	0.15	1.82	PK-I+	0 - 10	0.15 (0.01)	1.96 (0.20)	0.05 (0.01)	1.95 (0.14)
	10 -20	0.1	1.19		10 -20	0.11 (0.01)	1.20 (0.07)	0.07 (0.01)	1.24 (0.06)
C	0 - 10	0.17	1.92	PK+I-	0 - 10	0.13 (0.02)	3.24 (1.45)	0.04 (0.01)	2.95 (1.07)
	10 -20	0.13	0.95		10 -20	0.12 (0.01)	2.43 (1.30)	0.03 (0.00)	2.12 (0.97)
D	0 - 10	0.18	2.05	PK+I+	0 - 10	0.14 (0.01)	2.83 (1.08)	0.04 (0.02)	2.78 (0.94)
	10 -20	0.13	1.27		10 -20	0.12 (0.02)	2.66 (1.47)	0.05 (0.01)	1.95 (0.72)

Table S9. Statistical output of significant differences for plot-level soil sampling at 0–10 vs. 10–20 cm depths of an improved-fallow slash-and-mulch agroforestry system in Eastern Amazonia, Brazil. Site establishment via mulching tractor took place in June 2005 and was abandoned to secondary succession in 2007 before the 2nd Rotation was established via mulching tractor in July 2014. Sampling for soil depths took place in May 2014 prior to secondary forest conversion, and in July 2015, one year after conversion to second rotation of mixed-species agroforestry system.

Treatment	N				C			
	May 2014		July 2015		May 2014		July 2015	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Fert	0.0	0.89	1.1	0.36	4.9	0.11	0.2	0.71
Nfix	2.2	0.17	3.2	0.10+	2.2	0.17	3.5	0.09+
Fert*Nfix	1.3	0.28	0.1	0.75	0.4	0.53	0.2	0.65
Depth	52.0	0.0004*	102.2	<.0001*	42.6	0.0006*	254.6	<.0001*
Depth*Fert	0.0	0.96	1.1	0.35	3.3	0.12	0.0	1.00
Depth*Nfix	0.9	0.37	4.3	0.06+	2.2	0.17	3.2	0.10+
Depth*Fert*Nfix	0.6	0.47	0.0	0.96	0.5	0.52	1.2	0.29

Table S10. Statistical significance of P and K concentrations and content of Manioc by compartment, Mulch layer, and 0–10 cm Soil horizon. Statistical significance of effects in main-plot treatment with or without P+K fertilization (Fert) and sub-plot treatment with or without N-fixing *I. edulis* (Nfix) at the p=0.05 (*) and 0.10 (†) level are indicated.

Effect	Manioc						Mulch						Soil (0 - 10 cm)					
	Leaves		Stems		Roots		2013		2014		2015		2013		2014		2015	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
	P %																	
Fert	1.56	0.3	7.12	0.8†	1.77	0.3	10.35	0.05*	0.06	0.8	0.01	0.9	24.75	0.02*	4.23	0.1	3.51	0.2
Nfix	0.01	0.9	1.12	0.3	3.25	0.1	1.16	0.3	0.37	0.5	0.58	0.5	4.17	0.09†	0.03	0.9	3.41	0.08†
Fert*Nfix	1.65	0.3	0.86	0.4	0.02	0.9	0.08	0.8	0.02	0.9	0.34	0.6	2.38	0.2	2.48	0.1	0.87	0.4
	K %																	
Fert	0.58	0.5	1.99	0.3	2.18	0.2	2.54	0.2	1.69	0.3	0.62	0.5	0.68	0.5	0.17	0.7	0.45	0.6
Nfix	0.11	0.7	0.02	0.9	0.02	0.9	1.87	0.2	0.58	0.5	0.43	0.5	0.79	0.4	0	1.0	0.07	0.8
Fert*Nfix	0.68	0.4	0.04	0.9	2.59	0.2	0.7	0.4	0.09	0.8	0.5	0.5	0.07	0.8	1.08	0.3	0.52	0.5
	P (kg ha^{-1})																	
Fert	3.95	0.14	9.87	0.05	4.95	0.11	9.1	0.06†	0.47	0.5	0.01	0.9	24.75	0.02*	4.23	0.1	3.51	0.2
Nfix	0.05	0.8	0.03	0.9	0.75	0.4	0.03	0.9	23.51	0.003	1.16	0.3	4.17	0.09†	0.03	0.9	3.41	0.08†
Fert*Nfix	0	1.0	0	1.0	0.21	0.7	1.57	0.3	3	0.13	0.24	0.6	2.38	0.2	2.48	0.1	0.87	0.4
	K (kg ha^{-1})																	
Fert	1.94	0.3	1.21	0.4	1.91	0.3	0.68	0.5	0.26	0.6	0.99	0.4	0.68	0.5	0.17	0.7	0.45	0.6
Nfix	0.19	0.7	0.04	0.8	0.04	0.8	0.33	0.6	0.57	0.5	0.17	0.7	0.79	0.4	0	1.0	0.07	0.8
Fert*Nfix	0	1.0	0.03	0.9	0.03	0.9	0.48	0.5	1.25	0.3	0.18	0.7	0.07	0.8	1.08	0.3	0.52	0.5