Mitigación de emisiones de gases de efecto invernadero en el sistema suelo-planta en España: Estado del conocimiento y posibilidades

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REMEDIA Workshop. Bilbao, 8-9 marzo 2012



Estado del conocimiento sobre GEI en sistemas agrícolas y forestales en España

Búsqueda bibliográfica WEB OF KNOWLEDGE℠

- Topic: *Carbon sequestration*
- Address: *Spain*

Filtrado* → **38** artículos

→ Bosques: **21** artículos

→ Agricultura: **17** artículos

→ Pastos / praderas: **1** artículos

Criterios de búsqueda$	Total	Bosques	Agricultura	Pastos /praderas
Soil AND "Carbon dioxide"	19	8	13	3
Soil AND "Nitrous oxide"	31	3	20	11
Soil AND "Methane"	4	2	3	1

* Datos sobre mitigación en España

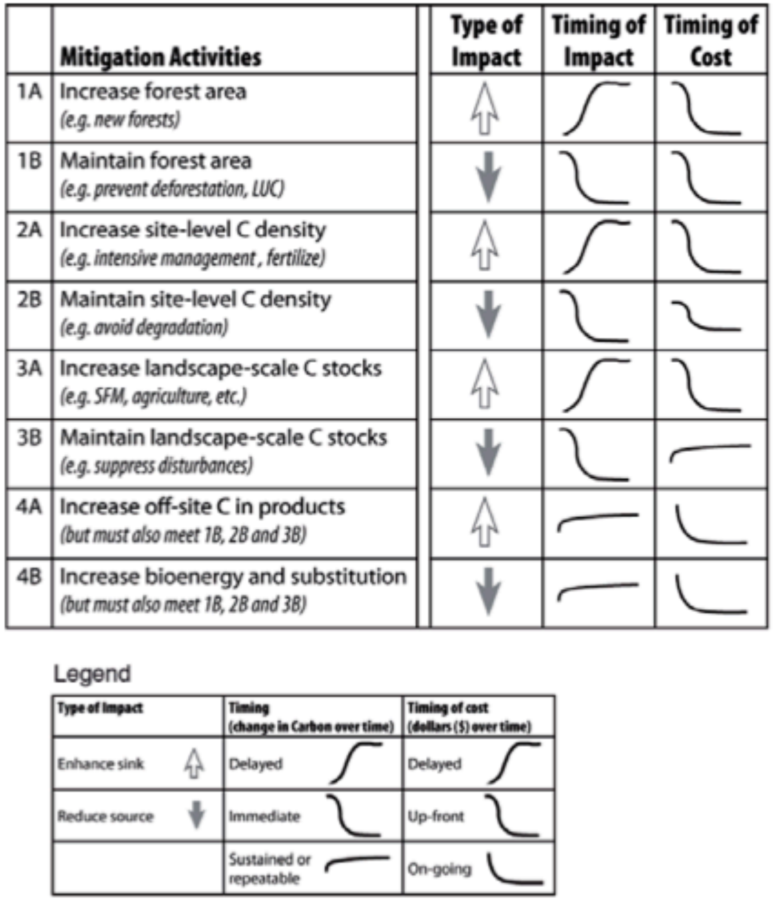
$ Datos de medidas en campo en España

Medidas de mitigación en sistemas agrícolas

		Mitigative effects[a]			Net mitigation[b] (confidence)	
Measure	**Examples**	**CO_2**	**CH_4**	**N_2O**	**Agreement**	**Evidence**
Cropland management	Agronomy	+		+/-	***	**
	Nutrient management	+		+	***	**
	Tillage/residue management	+		+/-	**	**
	Water management (irrigation, drainage)	+/-		+	*	*
	Rice management	+/-	+	+/-	**	**
	Agro-forestry	+		+/-	***	*
	Set-aside, land-use change	+	+	+	***	***
Grazing land management/ pasture improvement	Grazing intensity	+/-	+/-	+/-	*	*
	Increased productivity (e.g., fertilization)	+		+/-	**	*
	Nutrient management	+		+/-	**	**
	Fire management	+	+	+/-	*	*
	Species introduction (including legumes)	+		+/-	*	**
Management of organic soils	Avoid drainage of wetlands	+	-	+/-	**	**
Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments	+		+/-	***	**

(IPCC, 2007)

Medidas de mitigación en sistemas forestales



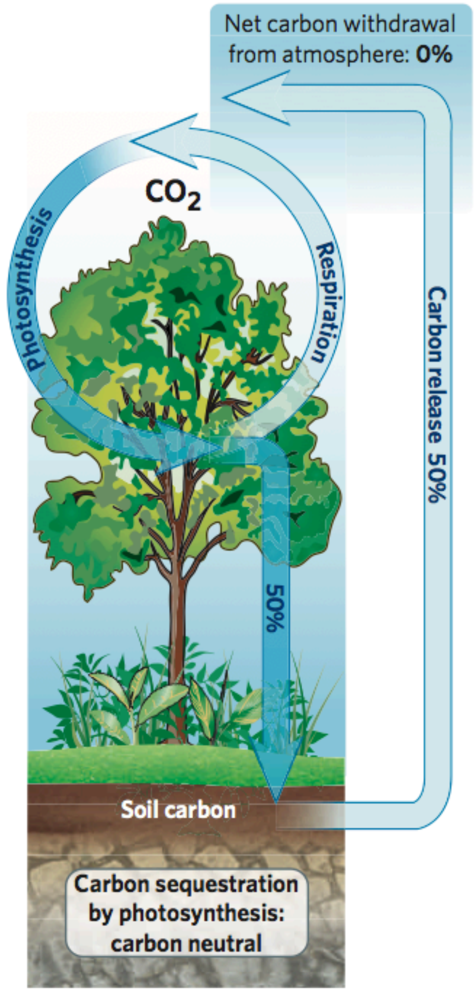
(IPCC, 2007)

- Incrementar la superficie forestal
  (evitar deforestación, reforestar)
- Incrementar la densidad forestal y/o stock de C del sistema suelo-planta
- Extracción de C en productos de madera
- Bioenergía

Oportunidades para mitigar GEI en sistemas agrícolas y forestales (IV Informe Evaluación, IPCC, 2007)

Incremento de sumideros ⟶ **Secuestro de C** (suelo – vegetación), oxidación CH_4

Reducción de fuentes ⟶ Manejo más **eficiente** del **C y N**



(Lehmann, 2007)

Efecto de los condicionantes edafo-climáticos en el potencial de mitigación

Sistemas agrícolas: *Intensificación de los sistemas de cultivo*

- Córdoba, Vertisol, 584 mm, varios cultivos secano

Table 4. Relationship between time (1986–2006) and total soil organic carbon (SOC) content (0–90 cm depth) for tillage system and crop rotation.

Crop rotation	Tillage system: Conventional tillage	Tillage system: No-tillage
	Mg ha⁻¹	
Continuous wheat	$y = 0.33x - 614$ $r = 0.64$ns† $SOC_S = 6.1$cB‡	$y = 1.22x - 2387$ $r = 0.81$* $SOC_S = 27.0$aA
Wheat–fallow	$y = 0.71x - 1379$ $r = 0.85$* $SOC_S = 16.4$abA	$y = 0.80x - 1554$ $r = 0.77$* $SOC_S = 16.2$bA
Wheat–chickpea	$y = 0.66x - 1286$ $r = 0.69$ns $SOC_S = 16.7$abA	$y = 1.03x - 2014$ $r = 0.85$* $SOC_S = 19.6$abA
Wheat–faba-bean	$y = 0.60x - 1165$ $r = 0.91$** $SOC_S = 10.3$bcB	$y = 1.28x - 2521$ $r = 0.97$*** $SOC_S = 25.4$aA
Wheat–sunflower	$y = 0.99x - 1928$ $r = 0.93$** $SOC_S = 19.3$aA	$y = 1.20x - 2349$ $r = 0.85$* $SOC_S = 22.1$abA

* Significant at the 0.05 probability level.

** Significant at the 0.01 probability level.

*** Significant at the 0.001 probability level.

† ns, not significant.

‡ SOCS (soil organic carbon sequestered) means followed by the same letter are not significantly different at $P < 0.05$ according to LSD. Lowercase is for comparisons within a tillage system and uppercase for between tillage systems.

(López-Bellido et al., 2007)

- Zaragoza, Aridisol, 340mm, cebada secano

Cropping system	Tillage	Measured SOC sequestration rate (Mg C ha^{-1} yr^{-1})
CB	CT	0.18 ± 0.07[a]
	RT	0.24 ± 0.13
	NT	0.46 ± 0.07
BF	CT	−0.004 ± 0.06
	RT	0.003 ± 0.08
	NT	0.15 ± 0.05

(CB, continuous barley and BF, barley-fallow rotation).
(CT, conventional tillage; RT, reduced tillage; NT, no-tillage)

(Álvaro-Fuentes et al., 2009)

0,83 vs. 0,29 Mg ha año

0,82 vs. 0,05 Mg ha año

Efecto de los condicionantes edafo-climáticos en el potencial de mitigación

Sistemas forestales: ***Manejo del bosque***

- Noroeste español, principalmente *Fagus sylvatica*

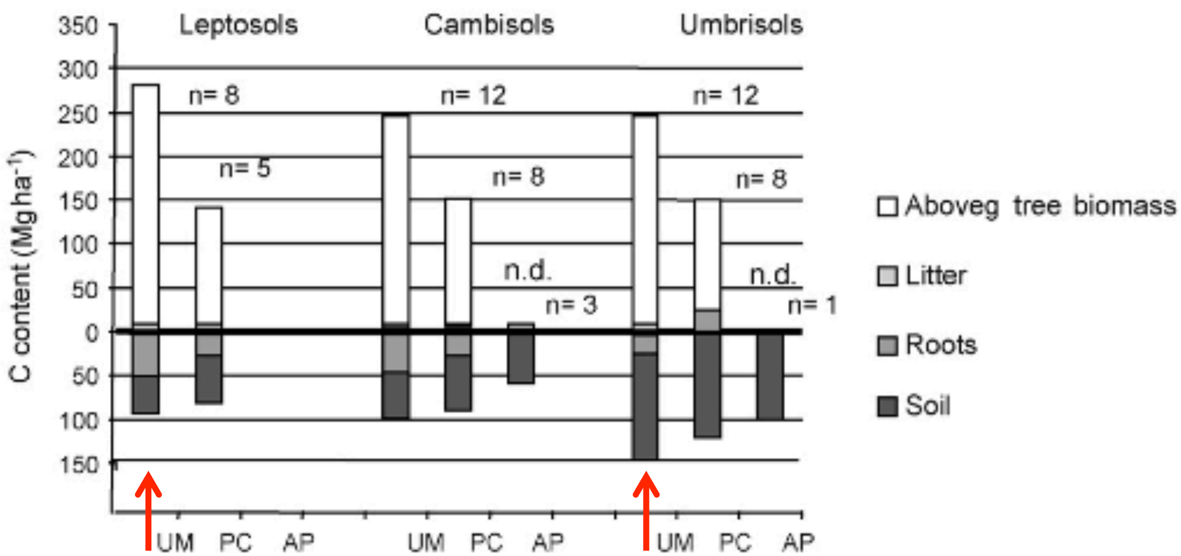


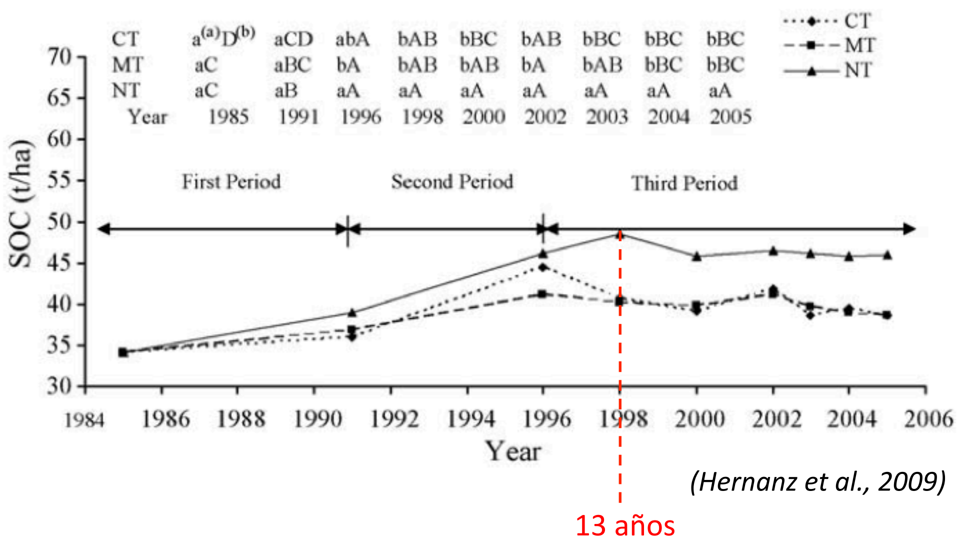
Fig. 3. Mean amounts of C (Mg ha^{-1}) in biomass and soils for different soil types. (UM) Unmanaged mature stands; (PC) partially cut stands; (AP) abandoned pollard stands. Since the allometric equations were not suitable for pollard trees, they were not applied for calculating the tree biomass in these stands.

(Merino et al., 2007)

Duración del efecto de mitigación

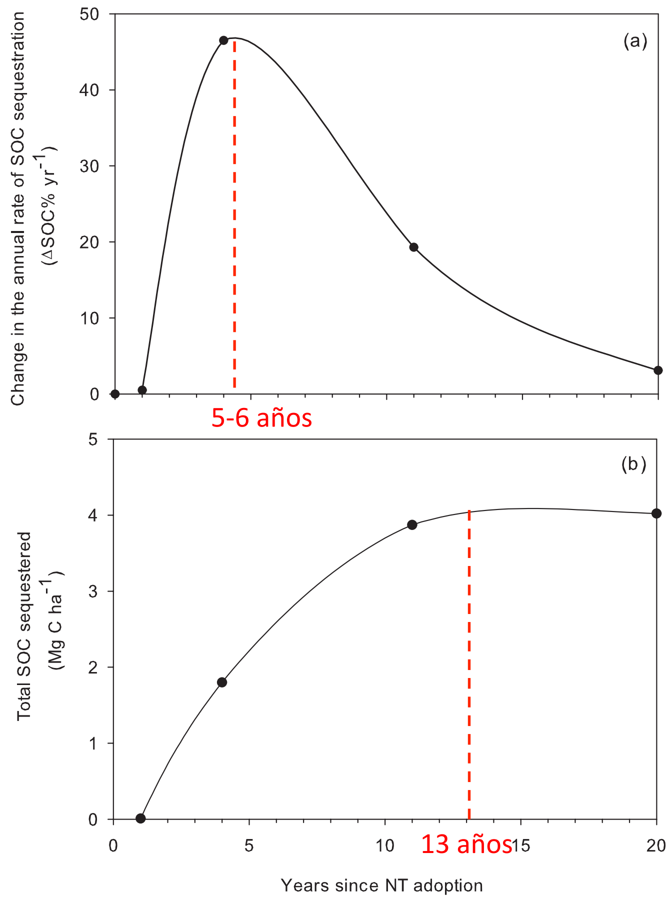
Sistemas agrícolas: ***Laboreo y gestión del residuo***

- Madrid, cereal-leguminosa secano



(Hernanz et al., 2009)

- Lleida, monocultivo de cereal

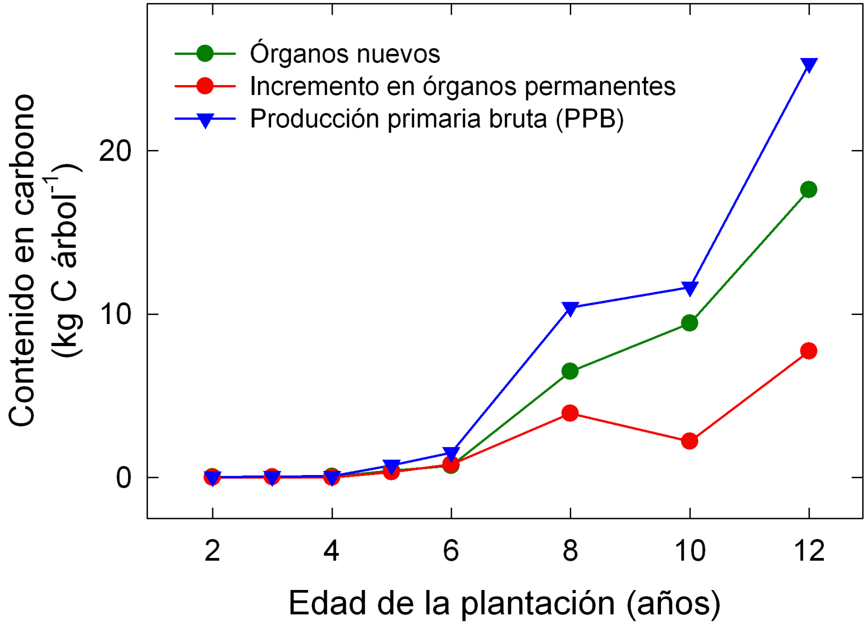


(Álvaro-Fuentes et al., en prensa)

Duración del efecto de mitigación

Sistemas agrícolas: ***Secuestro de C en plantaciones frutales***

- Valencia, cítricos



(Iglesias et al., en prep.)

Duración del efecto de mitigación

Sistemas forestales: ***Establecimiento de plantaciones forestales***

- País Vasco, *Pinus radiata*

Table 1
Soil physical and chemical properties (and standard errors) relative to time since disturbance (0, 7 and 20 years old *Pinus radiata* D. stands), in the 0–5 cm of the soil profile ($n = 3$).

	Time since disturbance (years)		
	0	7	20
Bulk density (g cm^{-3})	1.14 (0.1)	1.21 (0.0)	0.97 (0.1)
WHC (−33 kPa)	30.4 (3.9)	39.1 (1.0)	48.0 (1.7)
Clay (%)	28.17 (3.8)	31.10 (2.2)	27.21 (1.2)
Silt (%)	38.78 (1.9)	42.11 (2.7)	48.81 (1.0)
Fine Sand (%)	23.49 (4.0)	19.58 (2.7)	21.69 (1.5)
Coarse Sand (%)	9.56 (2.0)	7.21 (2.2)	2.29 (0.4)
Texture class	Clay loam	Clay loam	Clay loam
pH (H_2O)	4.68 (0.0)	4.61 (0.1)	4.31 (0.2)
pH (KCl)	3.76 (0.0)	4.14 (0.3)	3.76 (0.4)
C (mg kg^{-1})	44.50 (10.8)	46.30 (6.2)	109.01 (12.4)
N (mg kg^{-1})	2.15 (0.4)	2.70 (0.4)	5.74 (0.3)
C/N	20.45 (3.1)	17.39 (1.6)	18.90 (1.2)
P (mg kg^{-1})	6.74 (1.1)	5.52 (0.2)	5.31 (0.5)
Ca (meq 100 g^{-1})	9.09 (2.0)	4.02 (1.7)	5.01 (2.4)
Mg (meq 100 g^{-1})	0.97 (0.1)	0.67 (0.1)	0.56 (0.1)
Na (meq 100 g^{-1})	0.13 (0.0)	0.16 (0.0)	0.24 (0.0)
K (meq 100 g^{-1})	0.02 (0.0)	0.02 (0.0)	0.02 (0.0)
Al (meq 100 g^{-1})	0.75 (0.2)	4.91 (1.0)	9.34 (1.2)
CECe (meq 100 g^{-1})	10.95 (1.9)	9.79 (0.8)	15.16 (1.5)

(Gartzia-Bengoetxea et al., 2011)

Considerar la totalidad de GEIs

Sistemas agrícolas: ***Manejo de la fertilización nitrogenada***

- Madrid, cebada secano

Table 3 Cumulative CO_2–C emissions over the crop and fallow periods

Treatments	CO_2–C emissions (kg C ha^{-1})		
	Crop period (23 Jan–9 Jun)	Fallow period (23 Oct–28 Nov)	Total studied period
Control (C)	349.7±27.8ab	61.2±15.5a	410.9±33.1a
Untreated pig slurry (UPS)	398.1±16.9ab	48.5±28.3a	446.5±35.9a
Digested pig slurry (DPS)	447.9±56.4b	17.4±10.3a	465.2±61.5a
Composted organic waste (COW)	439.4±47.5ab	26.1±4.4a	465.5±51.9a
Composted crop residues + sludge (CCR+S)	282.3±93.9a	51.2±11.5a	333.5±104.8a
Urea (U)	401.2±34.0ab	57.0±17.9a	458.2±41.9a

Cumulative N_2O-N and NO-N emissions and denitrification losses over the crop and fallow periods and N_2O and NO emission indexes. N_2O and NO fluxes and denitrification rate data are the averages of means from three repetitions ± standard deviation.

Treatment	Crop period			Fallow period		Total	
	N_2O (g N_2O-N ha^{-1})	NO (g NO-N ha^{-1})	Denitrification rate (g N_2O-N ha^{-1})	N_2O (kg N_2O-N ha^{-1})	NO (g NO-N ha^{-1})	N_2O (g N_2O-N ha^{-1})	NO (g NO-N ha^{-1})
Control (C)	150 ± 56a	2.18 ± 2.55a	3340 ± 1629b	52 ± 12a	11.60 ± 2.07b	202 ± 47a	13.78 ± 3.95a
Untreated pig slurry (UPS)	264 ± 52b	37.62 ± 3.38c	7507 ± 2894c	51 ± 98a	6.86 ± 4.22ab	316 ± 137ab	44.48 ± 6.18c
Digested pig slurry (DPS)	275 ± 72b	65.27 ± 6.36e	8350 ± 2813c	76 ± 109a	3.65 ± 1.65a	351 ± 25b	68.92 ± 5.41d
Municipal solid waste (MSW)	219 ± 82ab	29.55 ± 10.20bc	2114 ± 1116b	48 ± 116a	7.31 ± 1.46ab	266 ± 19ab	36.86 ± 9.31bc
Composted crop residues + sludge (CCR + S)	290 ± 84b	23.01 ± 3.69b	1946 ± 1106a	82 ± 20a	5.51 ± 1.68a	373 ± 99b	28.82 ± 2.37b
Urea (U)	302 ± 14b	58.43 ± 2.63d	425 ± 159a	43 ± 30a	3.42 ± 3.42a	345 ± 109b	61.86 ± 5.25d

Different letters within columns indicate significant differences applying Fisher's Unprotected Least Significant Difference (LSD) test at $P < 0.05$.

(Meijide et al., 2009, 2010)

Factores que determinan el papel de los suelos como emisores o consumidores de metano y óxido nitroso

Sistemas forestales: ***Incendios forestales***

- Madrid, *Quercus ilex, Quercus pyrenaica* y *Pinus sylvestris*

Fig. 3 Nitrous oxide flux (N_2O-N µg $m^{-2}h^{-1}$) over time at a *Quercus ilex* stand (**a**), a *Quercus pyrenaica* (**b**) and a *Pinus sylvestris* stand (**c**) in Madrid, Spain (December 2007–September 2009). Gas flux values represent means (±SE) of four replicates. *B* burned site, *NB* unburned site

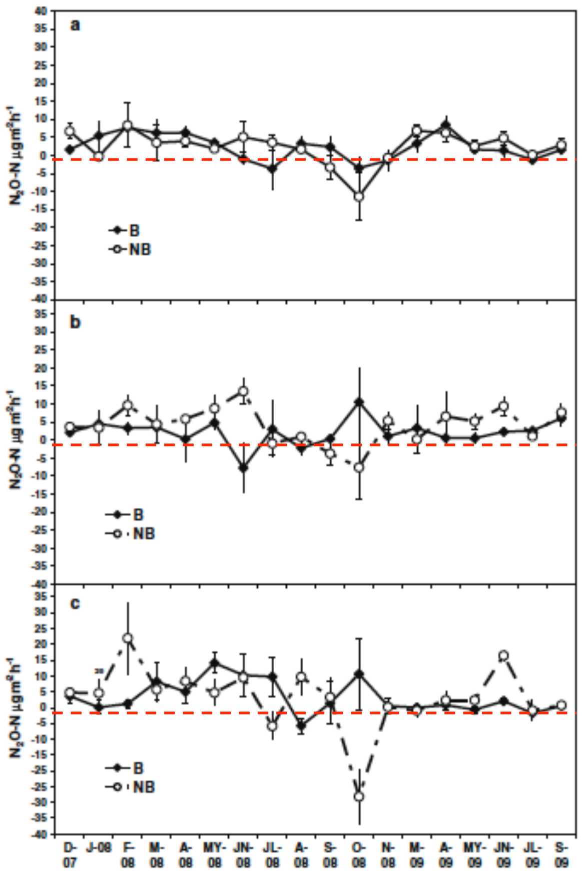
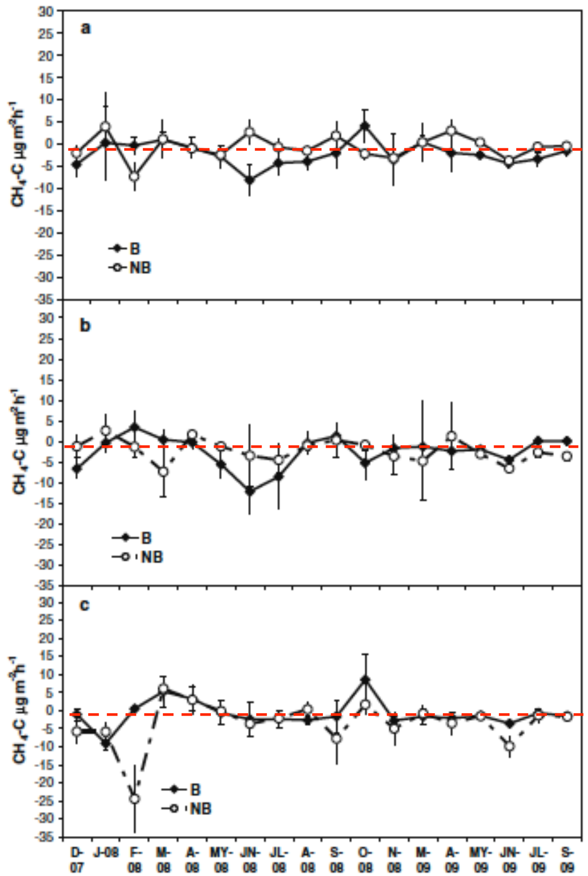


Fig. 5 Methane flux (CH_4–C µg $m^{-2}h^{-1}$) over time at a *Quercus ilex* stand (**a**), a *Quercus pyrenaica* (**b**) and a *Pinus sylvestris* stand (**c**) in Madrid, Spain (December 2007–September 2009). Gas flux values represent means (±SE) of four replicates. *B* burned site, *NB* unburned site



(Inclán et al., 2012)

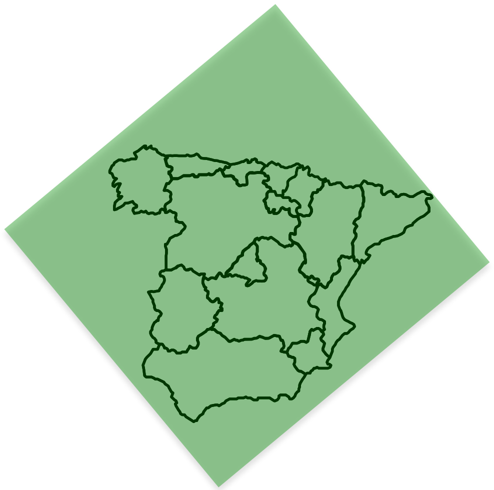
Aplicación de inhibidores de la nitrificación

- País Vasco, pradera sembrada con aplicación de DCD (Diciandiamida) y DMPP (2,3-Dimetilpirazol fosfato)

	Emisiones de N_2O (Kg N_2O-N ha^{-1})	Reducción (%)
Experimento 1	20 días	
Control	0.32	-
M (NAC)	1.24	-
M + DCD	0.71	42
Purín	1.22	-
Purín + DCD	0.49	60
Experimento 2	60 días	
Control	1.05	-
M (NAC)	7.52	-
M + DMPP	3.17	58
Purín	2.94	-
Purín + DMPP	1.14	61

(Merino et al., 2002)

Necesidad de estimaciones a varias escalas



- Andalucía, *Variación en los stocks de C en la vegetación*

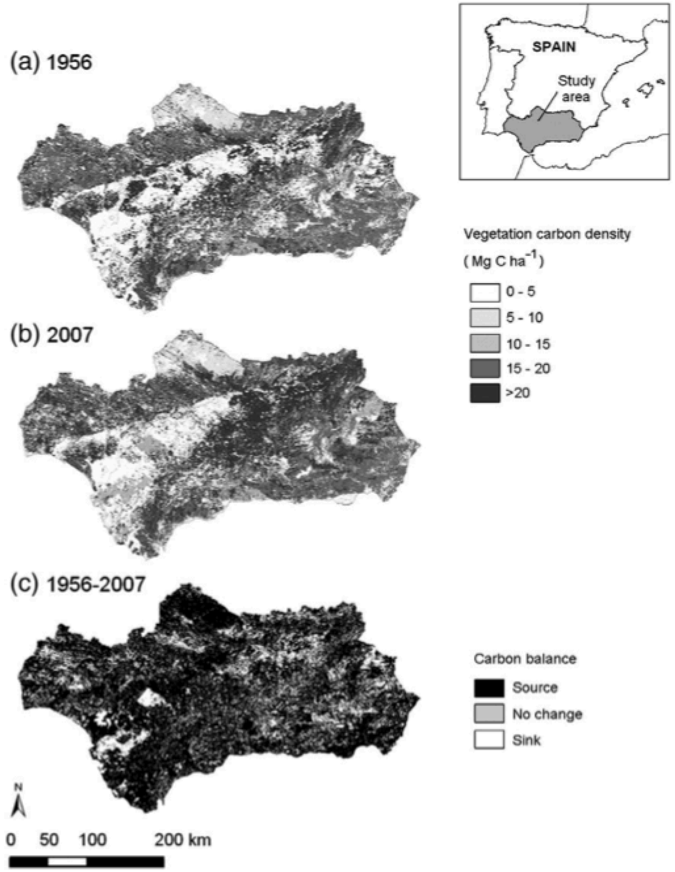


Fig. 2. Vegetation carbon stocks in Andalusia in 1956 (a), 2007 (b) and vegetation carbon balance between 1956 and 2007 (c).

(Muñoz-Rojas et al., 2011)

Impacto de la erosión en el potencial de reducción-mitigación

Cambios de usos del suelo

- Murcia, tres usos: *bosque, abandonado y olivar*

Table 3
Eroded soil organic carbon for each land use

	Date	Total OC sediments (g kg^{-1})			OC enrichment ratio			Total OC sediments (g m^{-2})			DOC runoff (mg l^{-1})			DOC runoff (mg m^{-2})	
		F	A	O	F	A	O	F	A	O	F	A	O	F	O
1	09/09/2005	26.99	*	22.17	1.02	*	2.06	0.014	*	0.075	*	*		*	*
2	15/09/2005	56.67	*	17.71	2.14	*	1.65	0.942	*	2.415	*	*		*	*
3	20/09/2005	51.76	*	16.87	1.96	*	1.57	0.215	*	0.331	*	*		*	*
4	14/11/2005	54.27	*	25.48	2.05	*	2.37	0.267	*	0.223	21.40	*	5.41	70.58	22.64
5	25/11/2005	41.73	*	27.95	1.58	*	2.60	0.003	*	0.000	11.82	*	5.76	4.150	0.328
6	10/01/2006	33.41	*	23.47	1.26	*	2.18	0.002	*	0.000	14.14	*	7.64	5.784	0.515
7	12/01/2006	37.94	*	15.14	1.43	*	1.41	0.010	*	0.001	9.08	*	5.44	15.24	2.128
8	20/01/2006	40.58	*	23.97	1.53	*	2.23	0.001	*	0.000	11.39	*	4.72	3.975	0.736
9	03/05/2006	51.03	52.12	33.81	1.93	1.66	3.15	0.005	0.007	0.001	14.56	6.25	7.97	5.403	0.573
10	17/05/2006	53.52	31.15	37.69	2.03	2.43	3.51	0.061	0.024	0.026	21.57	11.21	13.1	11.54	1.258
11	23/05/2006	55.55	25.83	12.27	2.10	2.02	1.14	0.119	0.065	0.161	14.62	3.42	2.92	15.50	3.103
12	31/05/2006	49.96	19.33	18.88	1.89	1.51	1.76	0.079	0.028	0.185	9.19	2.24	3.63	12.01	6.693
13	15/09/2006	54.35	26.27	19.57	2.06	2.05	1.82	0.300	0.269	1.369	18.06	32.77	4.28	54.24	30.27
14	23/09/2006	54.94	36.89	50.39	2.08	2.88	4.69	0.001	0.086	0.004	25.24	15.99	15.5	0.757	3.00
15	07/11/2006	65.64	37.27	38.01	3.00	2.91	3.54	0.000	0.155	0.077	16.12	5.13	6.05	33.23	17.75
16	09/11/2006	61.62	18.88	25.27	2.33	1.47	2.35	0.050	0.055	0.247	12.67	6.12	8.25	54.21	124.73

F: forest; A: abandoned, O: olive. The values given are the mean value of two plots (forest and olive) and the three sediment traps (abandoned).
*: no data.

(Martínez-Mena et al., 2008)


Gracias!