Tables

TYPOLOGY OF GRASSLANDS	NATURAL	DEGRADED	POTENTIALLY WELL-MANAGED	TOTAL
Herbaceous	3 408	1 761	8 123	13 292
Evergreen shrub	869	506	705	2 081
Deciduous shrub	3 089	1 824	6 488	11 402
Sparse Shrub/herbaceous	5 301	1 445	7 077	13 824

TABLE 1: **Extent of the different grassland types (1 000 ha)** *(Chapter II)*

CLIMATE	DECIDUOUS SHRUB	EVERGREEN SHRUB	HERBACEOUS	SPARSE SHRUB/ HERBACEOUS
Polar	7.7	15.0	8.2	6.3
Boreal	10.4	16.0	8.8	8.7
Temperate	5.6	9.2	5.5	4.3
Mediterranean	3.6	4.1	4.4	2.9
Subtropics	3.3	5.1	4.8	5.4
Tropics	3.8	6.0	3.8	4.3
Deserts	2.9	3.6	2.5	2.7

TABLE 2: **Average stock of organic carbon (0–30 cm) in different grassland types (kg/m^2)** *(Chapter II)*

TYPOLOGY OF GRASSLANDS	NATURAL	DEGRADED	POTENTIALLY IMPROVED
Deciduous shrub	211	76	255
Evergreen shrub	122	37	49
Herbaceous	233	77	334
Sparse Shrub/herbaceous	340	63	247

TABLE 3: **Total stock (0–30 cm) of organic carbon in different grassland types (Mt C)** *(Chapter II)*

CLIMATE	GASSLAND TYPES	NATURAL	DEGRADED	IMPROVED
Deserts	-	1.00	0.97	1.05
Tropics	-	1.14	0.97	1.17
Subtropics Humid	Shrub	1.02	0.75	1.10
	Grasses	1.14	0.85	1.17
	Sparse grasses	1.02	0.75	1.05
Subtropics Drylands	Shrub	1.02	0.56	1.07
	Grasses	1.02	0.80	1.10
	Sparse grasses	1.02	0.70	1.10
Mediterranean Humid	Shrub	1.00	0.70	1.07
	Grasses	1.05	0.56	1.06
	Sparse grasses	0.93	0.55	1.06
Mediterranean Drylands	Evergreen shrub	0.98	0.56	1.07
	Deciduous shrub	0.98	0.56	1.10
	Grasses	0.95	0.60	1.10
	Sparse grasses	0.90	0.60	1.01
Temperate Humid	Shrub	1.12	0.95	1.14
	Grasses	1.10	0.95	1.14
	Sparse grasses	1.05	0.95	1.14
Temperate Drylands	Shrub	1.12	0.95	1.09
	Grasses	1.05	0.95	1.09
	Sparse grasses	1.01	0.95	1.07
Boreal	-	1.12	0.95	1.14
Polar	-	1.00	0.71	1.05

TABLE 4: **Sequestration factors for organic carbon as a function of grassland typology, management status and climatic zones** *(Chapter II)*

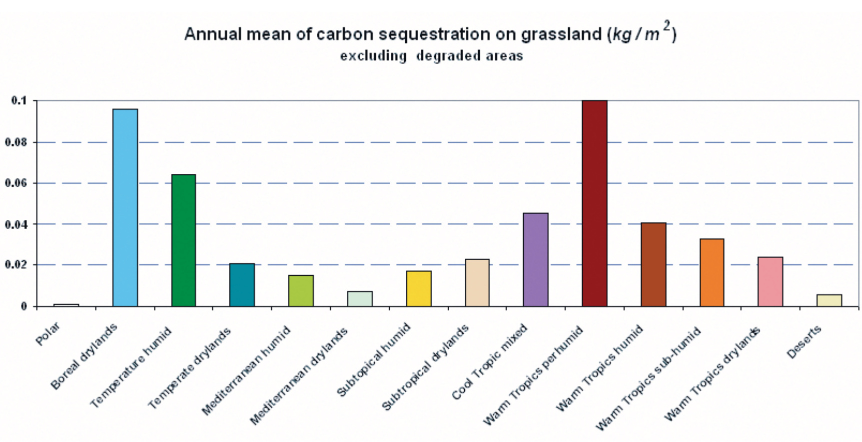
(i)

TYPOLOGY OF GRASSLANDS	NATURAL	DEGRADED	POTENTIALLY IMPROVED
Deciduous shrub	0.06	–0.02	0.03
Evergreen shrub	0.13	–0.05	0.07
Herbaceous	0.03	–0.02	0.02
Sparse Shrub/herbaceous	0.02	–0.02	0.02

(ii)

TYPOLOGY OF GRASSLANDS	NATURAL	DEGRADED	POTENTIALLY IMPROVED
Deciduous shrub	157.46	–33.30	159.29
Evergreen shrub	110.47	–22.76	37.34
Herbaceous	90.90	–37.71	190.47
Sparse Shrub/herbaceous	99.91	–27.42	105.57

TABLE 5: **(i) Mean (kg C/m²) and (ii) total (Mt C) carbon sequestration (0–30 cm) as a function of grassland typology and management level** *(Chapter II)*



LAND COVER CLASS	CLIMATE	WITHOUT MANAGEMENT (NATURAL)		MANAGED		DEGRADED	
		Stock change factor	Authors	Stock change factor	Authors	Stock change factor	Authors
11 Shrub cover, closed-open, evergreen	*Tropics humid*	**1.14** 0.8–1.2 0.85	Amézquita *et al.*, 2008 Henry *et al.*, 2009 San José & Montes, 2001	**1.17** 1.6	IPCC Guidelines, 2006 San José & Montes, 2001	**0.97**	IPCC Guidelines, 2006
	Tropics dry	**1.14**	*derived from Amézquita* et al., *2008*	**1.17**	IPCC Guidelines, 2006	**0.97**	IPCC Guidelines, 2006
	Subtropics humid	0.097 **1.02**	Abril *et al.*, 1999 Solomon *et al.*, 2007	0.17 **1.1**	Abril *et al.*, 1999 *derived*	**0.75**	*derived*
	Subtropics dry	**1.02**	Solomon *et al.*, 2007	1.05–1.1 **1.07**	Batjes, 2004 *derived*	0.39 **0.56**	Puerto *et al.*, 1990 *derived from* Bonet, 2004
	Mediterranean humid	**1**	*derived*	1.05–1.1 **1.07**	Batjes, 2004 *derived*	0.96 **0.7**	Franzluebbers & Stuedemann, 2009 *derived*
	Mediterranean drylands	0.9 **0.98**	Chan, 1997	1.38 **1.07**	Grace *et al.*, 2006	**0.56**	Bonet, 2004
	Temperate humid	**1.12**	*derived*	**1.14**	IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Temperate dry	**1.12**	*derived*	**1.09**	Wang and Chen, 1998	**0.95**	IPCC Guidelines, 2006
	Boreal dry	**1.12**	*derived*	1.07 **1.14**	Nyborg *et al.*, 1999 IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Polar	**1**	*derived*	**1.05**	*derived*	**0.71**	Wu & Tiessen, 2002

TABLE 6: **Sequestration factors for organic carbon as a function of grassland typology, management status and climatic zones** *(Chapter II)*

LAND COVER CLASS	CLIMATE	WITHOUT MANAGEMENT (NATURAL)		MANAGED		DEGRADED	
		Stock change factor	Authors	Stock change factor	Authors	Stock change factor	Authors
12 Shrub cover, closed-open, deciduous	*Tropics humid*	**1.14** 0.8–1.2 0.85	Amézquita *et al.*, 2008a,b Henry *et al.*, 2009 San José & Montes, 2001	**1.17** 1.6	IPCC Guidelines, 2006 San José & Montes, 2001	**0.97**	IPCC Guidelines, 2006
	Tropics dry	**1.14**	*derived from Amézquita* et al.*, 2008a,b*	**1.17**	IPCC Guidelines, 2006	**0.97**	IPCC Guidelines, 2006
	Subtropics humid	**1.02**	Solomon *et al.*, 2007	0.17 **1.1**	Abril *et al.*, 1999 *derived*	**0.75**	*derived*
	Subtropics dry	**1.02**	Solomon *et al.*, 2007	1.05–1.1 **1.07**	Batjes, 2004 *derived*	0.39 **0.56**	Puerto *et al.*, 1990 *derived from* Bonet, 2004
	Mediterranean humid	**1**	*derived*	1.05–1.1 **1.07**	Batjes, 2004 *derived*	0.96 0.39 **0.7**	Franzluebbers & Studemann, 2009 Puerto *et al.*, 1990 *derived*
	Mediterranean drylands	0.9 **0.98**	Chan, 1997	**1.1**	Batjes, 2004	**0.56**	Bonet, 2004
	Temperate humid	**1.12**	*derived*	**1.14**	IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Temperate dry	**1.12**	*derived*	**1.09**	Wang & Chen 1998	**0.95**	IPCC Guidelines, 2006
	Boreal dry	**1.12**	*derived*	1.07 **1.14**	Nyborg *et al.*, 1999 IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Polar	**1**	*derived*	**1.05**	derived	**0.71**	Wu & Tiessen, 2002

TABLE 6: **Sequestration factors for organic carbon as a function of grassland typology, management status and climatic zones** *(Chapter II)*

LAND COVER CLASS	CLIMATE	WITHOUT MANAGEMENT (NATURAL)		MANAGED		DEGRADED	
		Stock change factor	**Authors**	**Stock change factor**	**Authors**	**Stock change factor**	**Authors**
13 Herbaceous cover, closed-open	*Tropics humid*			**1.17**	IPCC Guidelines, 2006		
				1.2	Fisher *et al.*, 1994		
				1.27	Boddey *et al.*, 1995		
		1.14	Amézquita *et al.*, 200	1.12	Juo *et al.*, 1995		
		0.8–1.2	Henry *et al.*, 2009	1.14	Grace *et al.*, 2006		
		0.85	San Jose & Montes, 2001	3.64	San José & Montes, 2001	**0.97**	IPCC Guidelines, 2006
	Tropics dry	**1.14**	*derived from Amézquita* et al., *2008*	**1.17**	IPCC Guidelines, 2006	**0.97**	IPCC Guidelines, 2006
	Subtropics humid	**1.17**	Franzluebbers & Stuedemann, 2009	1.35			
		1.14	*derived*	**1.17**	*derived*	**0.85**	*derived*
	Subtropics dry			1.05–1.1			
		1.02	Solomon *et al.*, 2007	**1.1**	Batjes, 2004	**0.8**	*derived*
	Mediterranean humid			1.05	Franzluebbers & Stuedemann, 2009		
				2.7	Barrow, 1969		
				1.096	Rixon, 1966		
				1.063	Watson *et al.*, 1969		
				1.09	Sarathchandra *et al.*, 1988		
				1.2	Batjes, 2004	0.96	Franzluebbers & Stuedemann, 2009
				1.16	Walker & Adams, 1958	0.39	Puerto *et al.*, 1990
		1.05	*derived*	**1.06**	*derived*	**0.56**	*derived from* Bonet, 2004

	Mediterranean drylands			0.89	Oades *et al*., 1988		
		0.95	Oades *et al*., 1988	**1.1**	Batjes, 2004	**0.6**	*derived*
13 Herbaceous cover, closed-open	***Temperate humid***				Carter, Angers &		
				1.02	Kunelius, 1994		
				1.3–1.5	Soussana *et al*., 2004	0.9	Soussana *et al*., 2004
				1.2	IPCC Guidelines, 2006/	0.93–0.98	McIntosh *et al*., 1997
		1.10	Thornley & Cannell, 1997	**1.14**	Grace *et al*., 2006	**0.95**	IPCC Guidelines, 2006
	Temperate dry			1.11	Mortenson *et al*., 2004		
				1.1	Lal & Flowers, 1997		Naeth *et al*., 1991a,b
				1.09	Wang and Chen, 1998		Naeth *et al*., 1991a,b
				1.01	Steinbeiss *et al*., 2008	0.88	Smoliak, Dormaar &
				1.12	Schuman *et al*., 1999	1.05	Johnston,1972
				1.160	Malhi *et al*., 1997	1.23	Twosend *et al*., 1996
		1.05	*derived*	**1.09**	*derived*	**0.95**	IPCC Guidelines, 2006
	Boreal dry			1.07	Nyborg *et al*., 1999		
		1.12	*derived*	**1.14**	IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Polar	**1**	*derived*	**1.05**	*derived*	**0.71**	Wu & Tiessen, 2002

TABLE 6: **Sequestration factors for organic carbon as a function of grassland typology, management status and climatic zones** *(Chapter II)*

LAND COVER CLASS	CLIMATE	WITHOUT MANAGEMENT (NATURAL)		MANAGED		DEGRADED	
		Stock change factor	Authors	Stock change factor	Authors	Stock change factor	Authors
14 Sparse herbaceous or sparse shrub cover	Tropics humid	**1.14** 0.8–1.2 0.85	Amézquita *et al.*, 2008 Henry *et al.*, 2009 San José & Montes, 2001	**1.17** 1.6	IPCC Guidelines, 2006 San José & Montes, 2001	**0.97**	IPCC Guidelines, 2006
	Tropics dry	**1.14**	*derived from Amézquita* et al.*, 2008*	**1.17**	IPCC Guidelines 2006	**0.97**	IPCC Guidelines, 2006
	Subtropics humid	1.02	Solomon *et al.*, 2007	**1.1**	*derived*	**0.75**	*derived*
	Subtropics dry	**1.02**	Solomon *et al.*, 2007	1.05–1.1 **1.1**	Batjes, 2004	**0.7**	*derived*
	Mediterranean humid	**0.93**		1.05–1.1 **1.06**	Batjes, 2004	0.96 0.39 **0.55**	Franzluebbers & Stuedemann, 2009 Puerto *et al.*,1990 *derived*
	Mediterranean drylands	**0.9**	Chan, 1997	1.1 **1.015**	Batjes, 2004 *derived*	**0.6**	*derived*
	Temperate humid	**1.1**	*derived from* Thornley & Cannell, 1997	1.02 **1.14**	Carter, Angers & Kunelius, 1994 IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Temperate dry	**1.01**	*derived*	**1.07**	*derived from* Wang and Chen, 1998	**0.95**	IPCC Guidelines, 2006
	Boreal dry	**1.12**	*derived*	1.07 **1.14**	Nyborg *et al.*, 1999 IPCC Guidelines, 2006	**0.95**	IPCC Guidelines, 2006
	Polar	**1**	*derived*	**1.05**	*derived*	**0.71**	Wu & Tiessen, 2002
Arid areas	—	**1**	***derived***	**1.05**	***Batjes, 2004***	**0.97**	***derived from IPCC Guidelines, 2006***

TABLE 6: **Sequestration factors for organic carbon as a function of grassland typology, management status and climatic zones** *(Chapter II)*

LAND USE	AREA	
	million ha	%
Grazing	430.0	56.0
Minimal use (mostly desert)	121.0	15.7
Protected areas	102.6	13.4
Nature conservation	49.9	6.5
Dryland and irrigated agriculture (incl. ~50 percent sown pasture)	42.4	5.5
Forestry	15.2	2.0
Built environment	2.4	0.3

TABLE 7: **Area of land uses in Australia** *(Chapter III)*

Source: from *Australian Natural Resources Atlas* (http://www.anra.gov.au/topics/land/landuse/index.html, last update 7 june 2009)

		AREA IN CLASS (MILLION HA)			FRACTION IN CLASS		
Pasture type	**Area (million ha)**	**Class A**	**Class B**	**Class C**	**A**	**B**	**C**
Aristida/ Bothriochloa	31.9	15 923	10 381	5 593	0.50	0.33	0.18
Mitchell grass	29.8	17 128	9 977	2 728	0.57	0.33	0.09
Black speargrass	22.9	7 167	11 986	3 743	0.31	0.52	0.16
Spinifex	19.2	9 927	6 631	2 619	0.52	0.35	0.14
Mulga	18.4	3 672	9 355	5 331	0.20	0.51	0.29
Schizachyrium	8.7	1 900	5 729	1 035	0.22	0.66	0.12
Brigalow	8.5	3 430	3 156	1 923	0.40	0.37	0.23
Seasonal riverine plains	5.4	2 170	2 170	1 085	0.40	0.40	0.20
Bluegrass-browntop	4.9	991	3 718	248	0.20	0.75	0.05
Gidgee	2.7	939	866	879	0.35	0.32	0.33
Queensland bluegrass	2.4	617	854	901	0.26	0.36	0.38
Bladygrass	2.0	326	1 253	415	0.16	0.63	0.21
Georgina gidgee	1.6	1 119	320	160	0.70	0.20	0.10
Plume sorghum	0.9	835	46	46	0.90	0.05	0.05
Former rain forest	0.9	345	431	86	0.40	0.50	0.10
Ribbon grass	0.6	600	32	0	0.95	0.05	0.00
Saltwater couch	0.8	722	40	40	0.90	0.05	0.05
TOTAL	**161.6**	**67 811**	**66 945**	**26 832**	**0.42**	**0.41**	**0.17**

TABLE 8: **The area and fraction of Queensland pastures in each of three classes of degradation (A = no significant deterioration, B = deteriorated, C= severely degraded). The assignment to classes A, B or C was the subjective judgements of local experts (data derived from Tothill and Gillies, 1992, Table 3a)** *(Chapter III)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
A. Flux balance											
Alpine extensive pasture and hay meadow	Mount Rigi, Central Switzerland	8.4	991	–172	183	0	–355	12	eddy covariance	Rogiers *et al.* 2008	drained organic soil
Grazed peat-pasture	Waikato, New Zealand	15	1 281	–4.5	619	n.d.	–106	12	eddy covariance	Nieeven *et al.* 2005	drained peat soil
Extensive grazed pasture	East of the Missouri river, North Dakota	15	483	317*a*	n.d.	n.d.	n.d.	10 x 6 months	bowen ratio	Phillipps and Berry 2008	
Extensive grazed pasture	West of the Missouri river, North Dakota	15	390	239*a*	n.d.	n.d.	n.d.	10 x 6 months	bowen ratio	Phillipps and Berry 2008	
Extensive grazed pasture	Hungary	10.5	500	69	0	0	68	24	eddy covariance	Soussana *et al.* 2007	no N; dry steppe
Extensive grazed pasture	Italy	6.3	1 200	360	0	0	358	24	eddy covariance	Soussana *et al.* 2007	90 kg N/ha/year
Intensive grassland (grazed and cut)	The Netherlands	10	780	177	220	80	33	12	eddy covariance	Soussana *et al.* 2007	300 kg N/ha/year

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Intensive grassland (grazed and cut)	Scotland	8.8	638	343	110	3	231	24	eddy covariance	Soussana *et al.* 2007	200 kg N/ha/year
Intensive grassland (grazed and cut)	Ireland	9.4	824	293	374	0	–170	24	eddy covariance	Soussana *et al.* 2007	200 kg N/ha/year
Intensive meadow (cut)	Denmark	9.2	731	152	333	1 400**	1 100**	24	eddy covariance	Soussana *et al.* 2007	200 kg N/ha/year
Extensive pasture (grazed)	France	7	1 200	75	0	0	69	36	eddy covariance	Allard *et al.* 2007	no fertilizer
Intensive pasture (grazed)	France	7	1 200	99	0	0	87	36	eddy covariance	Allard *et al.* 2007	175 kg N/ha/year
Extensive meadow (cut)	Swiss	9.5	1 100	254	311	0	–57	36	eddy covariance	Ammann *et al.* 2007	no fertilizer
Intensive meadow (cut)	Swiss	9.5	1 100	467	368	67.5	147	36	eddy covariance	Ammann *et al.* 2007	200 kg N/ha/year
Intensive wetland meadow (grazed and cut)	UK	12.9	750	169	228	0	–34	12	eddy covariance	Lloyd 2006	wet grassland; corrected for animal intake

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Intensive grassland (Site A)	County Cork, southern Ireland	10	1 470	15	0	n.d.	15**	12	chamber measurements	Byrne *et al.* 2005	300 kg N/ha/year. New pasture
Intensive grassland (Site B)	County Cork, southern Ireland	10	1 470	38	0	n.d.	38**	12	chamber measurements	Byrne *et al.* 2005	300 kg N/ha/year. Permanent pasture
Native tallgrass prairie	north-central Oklahoma, USA	14	1 868.5	8	0	0	n.d.	20	eddy covariance	Suyker and Verma 2001	not grazed, prescribed burn
Sparse tussock dry grassland	South Island, New Zealand	9.9	446	–9	0	0	n.d.	24	eddy covariance	Hunt *et al.* 2004	dry year, no N, no burning
Sparse tussock dry grassland	South Island, New Zealand	9.2	933	41	0	0	n.d.	24	eddy covariance	Hunt *et al.* 2004	wet year, no N, no burning
Abandoned moist mixed grassland	Alberta, Canada	15.3	482	109	0	0	n.d.	12	eddy covariance	Flanagan *et al.* 2002	1998, wet summer
Abandoned moist mixed grassland	Alberta, Canada	13.2	341	21	0	0	n.d.	12	eddy covariance	Flanagan *et al.* 2002	1999, average summer
Abandoned moist mixed grassland	Alberta, Canada	14.5	275.5	–18	0	0	n.d.	12	eddy covariance	Flanagan *et al.* 2002	2000, dry summer

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Mixed grass	Southeastern Arizona, USA	17	356	–135	0	0	n.d.	48	bowen ratio	Emmerich 2003	
Species-rich grassland	UK	n.a.	n.a.	n.a.	n.a.	n.a.	120	48	chamber measurements	Fitter *et al.* 1997	4-5 cuts per year
Grazed peat-pasture	California, USA	16.2	1180	28	0	0	n.d.	24	eddy covariance	Xu *et al.* 2004	
Mixed grass	Mandan ND, USA	n.d.	478	94	0	0	n.d.	4 x 7 months	bowen ratio	Frank and Dugas 2001	No fertilizer, no burning, last grazed: 4 years
B. Soil inventories											
Permanent grassland	England, Wales						–5	25 years	soil C concentration change 0-15 cm	Bellamy *et al.* 2005	
Upland grassland	England, Wales						–37.5	25 years	soil C concentration change 0-15 cm	Bellamy *et al.* 2005	

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Rotational grass	England, Wales						–2.1	25 years	soil C concentration change 0-15 cm	Bellamy *et al*. 2005	
Grassland	Belgium						44	50 years	soil C concentration change 0-30 cm	Goidts and van Wesemael, 2007	
Grassland	Belgium						22	40 years	soil C concentration change 0-30 cm	Lettens *et al*. 2005a	
Grassland	Belgium						–90 (70)	10 years	soil C concentration change 0-100 cm	Lettens *et al*. 2005b	
Grassland	China						101	18 years	soil C concentration change	Piao *et al*. 2009	

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
C. Management change											
Perennial grassland converted from arable	Central Texas, USA						45	for 6–60 years	soil C stock change 0-60 cm	Potter *et al*. 1999	
Cultivated site to restored grassland	Missouri coteaux, Canada	0.7	320				30 to 290	8 years	soil C stock change 0-30 cm	Nelson *et al*. 2008	
Heavy to light grazing grassland	Cheyenne, WY, USA	n.d.	384				13.8	21 years	soil C stock change 0-5 cm	Ganjegute *et al*. 2005	
Exclosure to light grazing	Cheyenne, WY, USA	n.d.	384				14.3	21 years	soil C stock change 0-5 cm	Ganjegute *et al*. 2005	
nutrients addition via fertilizer	Forty-two data points						30*b*		soil C stock change	Conant *et al*. 2001	
Converting cultivated land to grassland	Twenty-three data points						101*b*		soil C stock change	Conant *et al*. 2001	
improved grazing management	Forty-five data points						35*b*		soil C stock change	Conant *et al*. 2001	

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Improved grass species	Five data points						304*b*		soil C stock change	Conant *et al*. 2001	
Restoration of degraded lands	US great plains						80–110		soil C stock change	Follett *et al*. 2001	
Sown grassland on mineral soil	France						60–80		soil C stock change (OM fractions >50 μ)	Loiseau and Soussana 1999	
Reduction of N fertilizer input	France	9	800				30	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
Conversion of short duration grass-ley to grass-legume mixture	France	9	800				30–50	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
Intensification of permanent grassland	France	9	800				20	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
Intensification of nutrient poor grassland on organic soils	France	7	1 100				–100	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
Permanent grassland to medium duration leys	France	9	800				–20	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

GRASSLAND TYPE AND MANAGEMENT	LOCATION	MAT	MAP	F_{CO2}	$F_{HARVEST}$	F_{MANURE}	NCS	DURATION	METHOD	REFERENCES	NOTES
		(°C)	(mm)	(g C/m²/year)				(month)			
Increasing the duration of grass leys	France	9	800				20 to 50	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
Short duration leys to permanent grassland	France	9	800				30 to 40	10 years	soil C stock change 0-30 cm	Soussana *et al*. 2004	
D. Farm scale											
Intensive grazed and cut grassland	County Cork, southern Ireland	10	1340	290	134	n.d.	205	12	eddy covariance, farm fluxes	Byrne *et al*. 2007	300 kg N/ha/year; cattle grazed
Intensive grassland (grazed and cut)	South West Ireland	10	1785	193	70	n.d.	24	12	eddy covariance, farm fluxes	Jacsik *et al*. 2006	wet year, 300 kg N/ha/year
Intensive grassland (grazed and cut)	South West Ireland	10	1185	258	100	n.d.	89	12	eddy covariance, farm fluxes	Jacsik *et al*. 2006	dry year, 300 kg N/ha/year

MAT = mean annual temperature; MAP = mean annual precipitation; F_{co2} = net CO_2 ecosystem exchange; F_{manure} = lateral organic C fluxes which are imported (manure application) from the system; $F_{harvest}$ = lateral organic C fluxes which are exported (harvests) from the system; n.d. = not defined.

A average of growing season.

B 87 percent of the studies were from Australia, the United Kingdom, New Zealand, Canada, Brazil and the United States of America.

**Not included in mean.

Additional studies can be found in the reviews by Conant et al.(2001) and by Ogle et al. (2004).

TABLE 9: **Literature survey of net C storage (NCS) at grassland sites using different methods: C flux balance (A), grassland soil C inventory (B), soil C change after a change in grassland management (C), and farm scale flux measurements (D). A positive F_{co2} represents a new C uptake from the ecosystem. A positive NCS denotes a new carbon accumulation in grassland ecosystems. All fluxes are in g C/m²/year.** *(Chapter VI)*

MANAGEMENT	NCS	ATT-NCS	GRASSLAND METHANE GWPCH4 FCH4	TOTAL METHANE GWPCH4 FCH4	GRASSLAND N2O GWPN2OFN2O	TOTAL N2O GWPN2OFN2O	NGHG	ATT-NGHG
Grazing	471	471	145	145	22	22	320	320
Grazing and cutting	183	268	159	476	64	81	–22	–272
Cutting	259	359	0	447	30	53	230	–141

NCS = net carbon storage in the grassland (see equation (2)); Att-NCS = attributed net carbon storage (see equation (4)); NGHG = net greenhouse gas balance (see equation (3)); Att-NGHG = attributed net greenhouse gas balance (see equation (5)); GWP = global warming potential.

Data are means of two, four and three European sites for grazed only (meat production systems), cut and grazed (meat and dairy production systems), and cut only (dairy production systems) grasslands.

A positive value of NCS, Att-NCS, NGHG and Att-NGHG denotes a sink activity of the grassland ecosystems.

TABLE 10: **Mean annual greenhouse fluxes in CO_2 equivalents/m^2/year of managed European grassland sites studied by Soussana *et al*. (2007)** *(Chapter VI)*

Site 1: Dovio

LAND-USE SYSTEM	TOTAL C IN SOIL (TONNES/ HA/1 MEQ)	%	TOTAL C IN PASTURE (TONNES/HA)	%	TOTAL C IN FINE ROOTS (TONNES /HA)	%	TOTAL C IN THICK ROOTS, TRUNKS AND LEAVES (TONNES /HA)	%	TOTAL C IN SYSTEM (TONNES /HA)
Native forest	231 a[2]	61.7[3]	-	-	4.6	1.2	138.9	37.1	374.4
B. decumbens	147 b	97.2	0.9	0.6	3.3	2.2	-	-	151.2
Forage bank	131 c	95.1	-	-	4.3	3.1	2.5	1.8	137.8
Degraded pasture	136 c	96.5	0.5	0.4	3.9	2.8	0.6	0.3	141.0
N (sampling points/ system)	24		40		24		8		
Mean, CV (%), LSD_{10}	161, 20, 18								

Site 2: Dagua

LAND-USE SYSTEM	TOTAL C IN SOIL (TONNES /HA / 1MEQ)	%	TOTAL C IN PASTURE (TONNES /HA)	%	TOTAL C IN FINE ROOTS (TONNES /HA)	%	TOTAL C IN THICK ROOTS, TRUNKS AND LEAVES (TONNES /HA)	%	TOTAL C IN SYSTEM (TONNES /HA)
Forest (40 years old)	186 a[2]	61.7[3]	-	-	2.6	0.9	112.7	37.4	301.5
Forest (15 years old)	155 ab	61.7[2]	-	-	2.2	0.9	93.9	37.4	251.2
Natural regeneration of degraded pastures	142 b	97.1	0.5	0.3	3.2	2.2	0.6	0.4	146.3
B. decumbens	136 b	93.7	0.8	0.6	8.3	5.7	-	-	145.1
Forage bank	90 c	94.7	-	-	2.5	2.6	2.6	2.7	95.1
Degraded soil	97 c	98.4	-	-	1.6	1.6	-	-	98.6
N (sampling points/ system)	24		40		24		8		
Mean, CV (%), LSD_{10}	135, 25, 30								

[1] Results of 2002-2005, C Sequestration Project - The Netherlands Cooperative Activity CO-010402", Internal Publication No. 14. June 2005.

[2] Means with different letters differ statistically, with an error probability of 0.10.

[3] The percentage obtained in the native forest of Costa Rica's subhumid tropical rain forest ecosystem was used.

TABLE 11: **Carbon in soil and biomass in each land-use system in the hillsides of the Colombian Andes[1]** *(Chapter VII)*

Site 1: "La Guajira" farm (flat topography)

LAND-USE SYSTEM	TOTAL C IN SOIL (TONNES /HA/ 1MEQ)	%	TOTAL C IN PASTURE (TONNES / HA)	%	TOTAL C IN FINE ROOTS (TONNES / HA)	%	TOTAL C IN THICK ROOTS, TRUNKS AND LEAVES (TONNES /HA)	%	TOTAL C IN SYSTEM (TONNES /HA)
B. humidicola	144 a[2]	95.5	1.9	1.3	4.9	3.2	-	-	150.8
B. humidicola + legume	138 b	94.8	2.1	1.4	5.5	3.8	-	-	145.6
Natural regeneration of degraded pasture	134 b	97.3	1.3	0.9	2.4	1.7	-	-	137.7
B. decumbens + legume	128 c	96.7	1.2	0.9	3.2	2.4	-	-	132.4
B. decumbens	124 c	97.7	1.1	0.9	1.8	1.4	-	-	126.9
Native forest	107 d	61.7[3]	-	-			66.4	38.3	173.4
N (sampling points / system)	27		45		27				
Mean, CV (%), LSD_{10}	129, 10, 5								

Site 2: "Beijing" Farm (rolling hills topography)

LAND-USE SYSTEM	TOTAL C IN SOIL (TONNES / HA/1MEQ)	%	TOTAL C IN PASTURE (TONNES / HA)	%	TOTAL C IN FINE ROOTS (TONNES / HA)	%	TOTAL C IN THICK ROOTS, TRUNKS AND LEAVES (TONNES /HA)	%	TOTAL C IN SYSTEM (TONNES /HA)
Native forest	181 a[2]	61.7[3]	-	-	-	-	112.4	38.3	293.4
B. decumbens + legume	172 b	98.1	0.9	0.5	2.4	1.4	-	-	175.3
B. humidicola	159 c	96.6	1.1	0.7	4.5	2.7	-	-	164.6
Degraded pasture	129 d	97.4	0.9	0.7	2.6	1.9	-	-	132.5
N (sampling points / system)	27		45		27				
Mean, CV (%), LSD_{10}	144, 11, 7								

[1] Results of 2002-2005, C Sequestration Project - The Netherlands Cooperative Activity CO-010402", Internal Publication No. 14. June 2005.

[2] Means with different letters differ statistically, with an error probability of 0.10.

[3] The percentage obtained in the native forest of Costa Rica's subhumid tropical rain forest ecosystem was used.

TABLE 12: **Carbon in soil and biomass of tropical rain forests in Colombias's Amazon region[1]** *(Chapter VII)*

LAND-USE SYSTEM	TOTAL C IN SOIL (TONNES /HA/ 1MEQ)	%	TOTAL C IN PASTURE (TONNES / HA)	%	TOTAL C IN FINE ROOTS (TONNES / HA)	%	TOTAL C IN THICK ROOTS, TRUNKS AND LEAVES (TONNES /HA)	%	TOTAL C IN SYSTEM (TONNES /HA)
B. brizantha + A. pintoi	181 a[2]	98.4	1.5	0.8	1.5	0.8	-	-	184.6
I. ciliare grass	170 a	97.5	1.7	1.0	2.8	1.5	-	-	174.8
A. mangium + A. pintoi	165 b	90.0	1.0	0.6	4.4	2.4	12.9	7.0	183.3
B. brizantha	138 c	98.1	1.6	1.1	1.8	0.8	-	-	141.0
Native forest	134 c	61.7	-	-	-	-	83.7	38.3	218.5
Degraded pasture	95 d	95.0	1.6	1.6	3.8	3.4	-	-	100.6
N (sampling points/ system)	24		40		24				
Mean, CV (%), LSD_{10}	150, 24, 14								

[1] Results of 2002-2005, C Sequestration Project - The Netherlands Cooperative Activity CO-010402", Internal Publication No. 14. June 2005.

[2] Means with different letters differ statistically, with an error probability of 0.10.

[3] The percentage obtained in the native forest of Costa Rica's subhumid tropical rain forest ecosystem was used.

TABLE 13: **Carbon in soil and biomass in each land use system in the subhumid tropical forests of Pocora, Costa Rica[1]** *(Chapter VII)*

LAND USE	LAND AREA	CARBON STOCKS		
		ABOVE GROUND	SOIL	TOTAL
	Million/ha	-------------- Mg/ha --------------		
Tropical/temperate forests	2 800	97	113	210
Cropland	800	2	80	82
Tropical/temperate grasslands	3 500	21	160	181

TABLE 14: **Summary of C stocks in forest, cropland and grasslands** *(Chapter VIII)*

Source: IPCC, 2000

STUDY	DEPTH (cm)	CARBON STOCK (MG C/HA)			PR>F
		FOREST	GRASS	CROP	
Eastern Texas [1, 2]	30	N.D.	88 ± 18	57 ± 8	<0.01
Ten southeastern states [3]	25	31 ± 12	31 ± 16	23 ± 15	0.04
Maryland [4]	15	N.D.	32 ± 10	20 ± 7	0.01
Alabama [5,6]	25 ± 6	60 ± 21	48 ± 26	34 ± 8	0.03
Mississippi, Georgia [7,8]	25 ± 7	47 ± 2	38	22 ± 6	0.08
Mean	24 ± 6	49.9 a	47.4 a	31.1 b	

[1] Laws and Evans (1949); [2] Potter *et al*. (1999); [3] McCracken (1959); [4] Islam and Weil (2000); [5] Fesha *et al*. (2002); [6] Torbert, Prior and Runion (2004); [7] Rhoton and Tyler (1990); [8] Franzluebbers *et al*. (2000).

TABLE 15: **SOC stocks in different land uses in the southeastern United States** *(Chapter VIII)*

Source: Summarized from Franzluebbers, 2005

FRACTION OF SOIL	SOIL DEPTH (cm)	LEVEL OF FERTILIZATION		
		LOW		HIGH
Total SOC (Mg/ha)	0–2.5	10.2		10.9
	2.5–7.5	11.0	<	11.8
	7.5–15	11.0	<	11.7
	15–30	12.8		13.1
	0–30	45.0	<	47.6
Particulate organic carbon (Mg/ha)	0–2.5	5.1		5.9
	2.5–7.5	4.1	<	4.6
	7.5–15	2.9		3.1
	15–30	2.7		3.6
	0–30	15.0	<	16.8
Soil microbial biomass carbon (Kg/ha)	0–2.5	822		943
	2.5–7.5	585		574
	7.5–15	621		627
	15–30	740		897
	0–30	2 769		3 041
Basal soil respiration (Kg/ha/d)	0–2.5	24.1	<	28.8
	2.5–7.5	15.0		13.8
	7.5–15	10.7		10.5
	15–30	7.7		7.2
	0–30	57.5		60.3

< between means indicates significance at $p \leq 0.05$.

TABLE 16: **Depth distribution of SOC fractions at the end of 15 years of low (134-15-56 kg N-P-K/ha/year) and high (336-37-139 kg N-P-K/ha/year) fertilization of tall fescue pasture in Watkinsville, Georgia, United States** *(Chapter VIII)*

Source: Schnabel *et al*., 2001

SOIL FRACTION	E-		E+
Whole SOC (Mg/ha)	29.3	<	31.2
Macroaggregate C (Mg/ha)	31.1	<<	33.6
Particulate-to-total C (g/g)	0.42	>	0.39
Microbial biomass-to-total C (Mg/g)	45	>	42
Mineralizable-to-total C (Mg/g)	44		41

<, > and << between means indicate significance at $p \leq 0.05$, $p \leq 0.05$, and $p \leq 0.01$, respectively.

TABLE 17: SOC and various aggregate and biologically active fractions as affected by 20 years of tall fescue pastures with either low endophyte infection (E-) or high endophyte infection (E+) *(Chapter VIII)*

Source: Franzluebbers and Stuedemann, 2005

ECOSYSTEMS	LAND USES	CARBON STOCK (tonnes/ha)			OBSERVATIONS	REFERENCES
		SOIL	TREES, AERIAL	PASTURE		
Humid tropical forest Pocora, Costa Rica	*Panicum maximum* + *Acacia mangium*	ND	3.6	4.9	SOC measured at depth 0–1 m	Andrade, 1999
	Panicum maximum + *Eucalyptus deglupta*	ND	3.4	4.4		
Volcanic highlands Cordillera, Costa Rica	*Pennisetum clandestinum* monoculture	494.0	0	12.5	SOC measured at depth 0–1 m	Mora, 2001
	Pennisetum clandestinum + trees	573.0	10.0	11.8		
	Cynodon nlemfuensis monoculture	756.0	0	11.5		
	Cynodon nlemfuensis + trees	624.0	2.6	9.1		
Dry hillsides Central Nicaragua	Naturalized grass monoculture	150.0	0	1.4	SOC measured at depth 0–1 m	Ruiz *et al.*, 2002
	Naturalized grass + trees	150.0	8.2	1.0		
	Improved grass monoculture	158.0	0	1.6		
	Improved grass + trees	155.0	12.5	2.5		
Lower montane rain forest, Moravia, Costa Rica	*Pennisetum clandestinum*	184.6	0.0	NA	SOC measured at depth 0–0.6 m, tree density 889 trees/ha, age four years	Villanueva & Ibrahim, 2002
	Pennisetum clandestinum + *Alnus acuminata*	196.7	6.2*	NA		
Subhumid tropical forest Esparza, Costa Rica	Degraded grassland	21.7	4.8	ND	Low-density trees = fewer than 30 trees/ha with 5 cm at diameter of height breadth. SOC measured at depth 0–1 m	Ibrahim *et al.*, 2007
	Improved grassland + low tree density	117.5	1.6	ND		
	Natural grassland + high tree density	121.7	7.1	ND		
	Secondary forest	116.7	90.7	ND		
Humid tropical forest Matiguás, Nicaragua	Degraded grassland	63.1	9.4	ND		
	Natural grassland + low tree density	91.0	11.9	ND		
	Secondary forest	139.2	23	ND		

ECOSYSTEMS	LAND USES	CARBON STOCK (tonnes/ha)			OBSERVATIONS	REFERENCES
		SOIL	TREES, AERIAL	PASTURE		
Tropical dry forest Cañas, Costa Rica	*Brachiaria brizantha* + *Pithecellobium saman*	10.5	0.45	3.4	SOC (Mg /ha), measured at depth 0–0.6 m, trees g C/100 g, age 17 months	Andrade, 2007
	Brachiaria brizantha + *Diphysa robinioides*	9.0	6.1	3.0		
	Hyparehnia rufa + *Pithecellobium saman*	5.0	1.6	2.5		
Humid tropical forest Pocora, Costa Rica	*Brachiaria brizantha* + *Arachis pintoi*	186.8	NA	ND	SOC measured at depth 0–1 m, age seven years	Amézquita *et al.*, 2008
	Acacia mangium + *Arachis pintoi*	160.7	12.8	ND		
	Brachiaria brizantha	153.0	NA	ND		
	Degraded weedy pasture	107.9	NA	NA		
Subhumid tropical forest Esparza, Costa Rica	*Brachiaria decumbens*	109.6	NA	ND		
	Brachiaria decumbens + trees	120.0	17.2	ND		
	Tectona grandis	222.8	92.4	ND		
	Secondary forest	226.0	58.3	ND		

*Carbon measured in trunks alone. NA = not applied, ND = not available

TABLE 18: **Carbon stocks in land uses according to ecosystems evaluated in Central America** *(Chapter X)*

ECOSYSTEMS	LAND USES	CARBON FIXATION RATE (tonnes/ ha/year)	REFERENCES
Humid tropical forest Guapiles, Costa Rica	*Brachiaria brizantha* + *Eucalyptus deglupta*	1.8	Andrade, 1999
	Panicum maximum + *Eucalyptus deglupta*	2.3	
	Brachiaria decumbens + *Acacia mangium*	1.9	
	Panicum maximum + *Acacia mangium*	2.1	
Volcanic highlands Cordillera, Costa Rica	*Pennisetum clandestinum* monoculture	5.2	Mora, 2001
	Pennisetum clandestinum + trees	5.1	
	Cynodon nlemfuensis monoculture	4.8	
	Cynodon nlemfuensis + trees	4.9	
Humid tropical forest Costa Rica	*Brachiaria brizantha* + *Eucalyptus deglupta*	1.8	Avila *et al.*, 2001
	Brachiaria brizantha + *Acacia mangium*	2.2	
Subhumid tropical forest Esparza, Costa Rica	Natural pasture – trees	0.04	GEF, 2007
	Natural pasture + high tree density	1.2	
	Improved pasture – trees	1.0	
	Improved pasture + high tree density	4.5	
	Forest plantations	5.0	
	Secondary forest	7.5	
Subhumid tropical forest Esparza, Costa Rica	*Bracharia brizantha pasture*	3.5	Amézquita *et al.*, 2008
	Brachiaria brizantha + *Arachis pintoi pasture*	4.1	
	Hyparrhenia rufa pasture	3.7	
	Natural forest regeneration	2.0	

TABLE 19: **Carbon fixation/year (tonnes/ha) in pasture, silvopastoral and forest land-use systems** *(Chapter X)*

LAND USES	(%)			
	2004	2005	2006	2007
Degraded pasture	11.9	6.1	5.1	4.1
Natural pastures without trees	3.1	0.1	0.1	0.1
Improved pastures without trees	1.1	0.8	0.5	0.5
Natural pastures with trees	18.7	15.9	13.0	11.5
Improved pastures with trees	28.8	40.7	44.8	47.2
Fodder banks	0.4	0.4	0.6	0.6
Secondary vegetation	1.6	1.9	2.0	2.0
Forest	29.0	29.0	29.0	29.0
Other uses*	5.4	5.0	4.9	5.0
Total area = 302 ha				
Tonnes CO_2 eq	13 773.9	22 564.8	24 962.3	26 534

*Other uses include areas with different crops.

TABLE 20: **Land uses in the livestock landscape of Esparza, Costa Rica** *(Chapter X)*

INDICATOR	GROUP	2003	2006	CHANGE (%)
Productivity of milk (kg/ha/year)	Non-poor	517.1±123.2 a	550.5±43.1 a	6.5
	Poor	585.5±252.7 a	687.9±155.7 a	17.5
	Extremely poor	610.7±128.5 a	816.0±89.5 a	33.6
Family gross income per capita/household/year (USD)	Non-poor	2 639.2±590.6 a	4 921.4±1 100.0 a	86.5
	Poor	1 011.8±151.4 b	2 141.6±852.5 b	111.6
	Extremely poor	808.7±478.8 c	1 490.5±301.4 c	84.2

TABLE 21: **Productivity of milk and family gross income on farms with payment for environmental services in different poverty groups in Matiguás, Nicaragua, 2007** *(Chapter X)*

Source: Marín *et al*., 2007

INCREASING C INPUTS	DECREASING C LOSSES
1. Increasing biomass C inputs to soil by improved grazing management • Improving (reducing or increasing) stocking rates • Rotational, planned or adaptive grazing • Enclosing grassland from livestock grazing	3. Improved management of land use conversion • Converting agricultural land use to permanent grassland • Avoiding conversion of grassland to cultivation • Avoiding conversion of forest to pasture
2. Increasing biomass • Seeding fodder grasses or legumes • Improving vegetation community structure • Fertilization	4. Fire management and control 5. Alternative energy technologies to replace use of shrubs/dung as fuel

TABLE 22: **Management practices with potential to increase C sequestration or decrease C losses in rangelands** *(Chapter XII)*

Source: Tennigkeit and Wilkes, 2008

MANAGEMENT PRACTICE	NO. OF DATA POINTS*	MEAN CHANGE IN tones CO_2e/ha/yr OR TOTAL CHANGE IN %C	MIN – MAX
Vegetation cultivation	c: 31 %: 7	9.39 tonnes CO_2eq/ha 0.56%	–12.1–46.50 tonnes CO_2eq/ha/year 0.11–1.14%
Avoided land cover/land-use change	c: 65 %: 22	0.40 tonnes CO_2eq/ha 0.87%	–103.78–15.03 tonnes CO_2eq/ha/year –0.7–4.2%
Grazing management	c: 55 %: 21	2.16 tonnes CO_2eq/ha 0.13%	–12.47–33.44 tonnes CO_2eq/ha/year –2.03–5.42%
Fertilization	c: 27 %: 68	1.76 tonnes CO_2eq/ha 0.47%	–11.73–9.09 tonnes CO_2eq/ha/year –1.23–4.8%
Fire control	c: 2 %: 1	2.68 tonnes CO_2eq/ha 0%	3.67–4.11 tonnes CO_2eq/ha/year 0%

*(c = no. of studies reporting in C content; % = no. of studies reporting in %C.

TABLE 23: **C sequestration potential of rangeland management practices** *(Chapter XII)*

Source: Tennigkeit and Wilkes, 2008

PROJECT NAME	LOCATION	MAIN ACTIVITIES	REFERENCE SOURCES
CCX Rangeland Carbon Offsets	Mid-western United States of America	Stocking rate management, rotational and seasonal grazing	Chicago Climate Exchange (CCX), 2009
Caribbean Savannah Carbon Sink Project	Colombia	Silvopastoral practices	World Bank, 2007
Uchindile and Mapanda Forest Projects	United Republic of Tanzania	Afforestation	http://www.forestcarbonportal.com/inventory_project.php?item=282
The West Arnhem Fire Abatement Agreement	Australia	Fire management	http://savanna.ntu.edu.au/information/arnhem_fire_project.html
Solar cooking units in the Andes	Bolivia: (Plurinational State of)	Rural energy	http://www.actioncarbone.org/
Ducks Unlimited Avoided Grassland Conversion Project in the Prairie Pothole Region	United States of America	Avoided conversion of grasslands	Ducks Unlimited and Eco Projects Fund, 2009

TABLE 24: **Selected carbon finance projects in rangelands** *(Chapter XII)*