Supplemental Materials

Table S1. The yield of forage production (grain, pasture, silage, and/or hay) in terms of the amount of dry matter (DM) of product per hectare per year (Mg ha^{-1} y^{-1}), and the energetic value of the product, in net energy of lactation (NEL), per amount of DM produced (Mcal NEL Mg /DM), in various regions with different soil types.

Authors	Region, Country	Soil type	Nº obs.	Study duration	Cropping system description	Yield	
			n	year		Mg DM ha^{-1} y^{-1}	Mcal NEL Mg DM^{-1}
Bacenetti et al. [24]	Po River Valley, Lombardy, Italy	Regional scale	1	4	A	12.8	1326
Bernas et al. [7]	Czech Republic	Sandy loam	16	4	C sil	11.7	1473
			12	4	CP sil	8.3	800
			16	4	A sil	17.4	1326
			16	4	C+A sil	17.4	1399
			16	4	C+CP+A sil	2.9	1199
			4ł	2	CP sil	16.5	800
			8	3	CP sil	15.6	800
			12	4	CP sil	11.7	800
			1	5φ	CP sil	11.7	800
			1	10φ	CP sil	11.7	800
			1	15φ	CP sil	11.7	800

			1	20^{φ}	CP sil	12.8	800
Fathollahi et al. [21]	Karaj, Alborz Province, Iran	Loam	125	5	C sil	17.1	1473
			105	5	A sil	11.8	1326
González-García et al. [17]	Calldetenes, Catalonia, Spain	Loam	5	5	So sil-B sil	20.2	1367
			5	5	So sil-O sil	16.5	1318
Herron et al. [67]	Fermoy, Co. Cork, Ireland	Sandy loam to loam	1	4	pRg pas	11.8	823
			1	4	pRg + WC pas	12.2	822
Li et al. [68]	Luancheng, China	Silt -loam	16	4	C-W	17.5	2036
			16	4	C sil-Rg sil	44.0	1215
			16	4	SS sil – Rg sil	50.8	1081
			16	4	SH sil – Rg sil	64.7	1277
Little et al. [69]	Napierville, Québec, Canada	Clay	1	5^{φ}	(A sil)^{4}- B sil	6.2	727
			1	8^{φ}	(C sil)^{4} - (pG+L hay)^{4}	7.5	680
Meyeraurich et al. [58]	Ontario, Canada	Silt loam	4	20	C	8.5	2036
			4	20	C-C-A-A	7.8	1681
			4	20	A-A-A-A	7.0	1326

Noya et al. [70]	Po Valley, Lombardy, Italy	Clay	3	1	B sil	13.0	1326
			3	1	R sil	16.2	1326
			1	1	So sil	26.2	1326
			1	1	w c sil-So sil	15.8	1399
Solinas et al. [59]	Sardinia, Italy	Silt-loam	1	1	DW-B	4.8	1987
			1	1	C sil – Rg hay	28.0	1387
			1	1	C sil – T sil	34.0	1387
Wang et al. [71]	Gansu Province, China	Sandy loam - clay	100	5	A hay	9.1	1203
Zucali et al. [19]	Landriano, Lombardy, Italy	Loam	111	1	C sil	19.3	1530
			107	1	pG hay	9.5	1147
			48	1	A hay	11.7	927
			28	1	A sil	11.4	870
			14	1	high moisture C sil	10.9	2032
			1	1	C sil/R hay	25.7	1322
			1	1	high moisture C sil/R hay	17.3	1573
Abraha etal. [72]	Hickory Corners, Michigan, US	Sand-loam (Typic Hapludalfs)	4	22	CRP grassland		1277

			4	8	CRP to 8 y continuous corn		2036
			4	8	CRP to 8 y switchgrass		1056
			4	8	CRP to 8 y restored prairie		1105

* System types are: BAU = business as usual. AS = alternative or aspirational system. DPCS= diverse perennial circular system. When the alternative or aspirational system includes the dimensions of diversity (more crop species). perenniality (a perennial crop). and circularity (legume crop. or integrated systems) as part of it.

** Crops are: A= alfalfa. Ar= artichoke for heads. B= barley. C= corn. Ca= canola. Cm= camelina. Co= cocksfoot. CP= cup plant. CRP = Conservation Reserve Program grasslands; DP= dry pea. DW= durum wheat. FB= faba beans. G= grass. L= lentil. M= mustard. O= oat. P= pea. Pe= pennycress. R= rye. Ra= rapeseed. Rg= ryegrass. RC= red clover. RW= red wheat. S= soybean. So=Sorghum. Sg= switchgrass. Su= sunflower. SH= sorghum-sudangrass hybrids. SS= sweet sorghum. T= triticale. TF= tall fescue. V= vetch. W= wheat. Wi= willow. WPM= wild plant mixture. c= cereal. l= legume. p=perennial. f=fallow. w= winter. sp= spring. s=summer. for= forage. res= residual biomass. sil=silage. hay=hay. pas=pasture. eth=ethanol. bio= biodiesel. oil= oil for human consumption. Letters joined by hyphenation indicate crop rotation. e.g., C-S = corn-soybean rotation. Letters joined by a bar indicate intercropping system. e.g., R/S = rye/soybean. Letters joined by a plus indicate a mix of crops. e.g., O+RC = oat and red clover mix. Letters in lowercase indicate the cycle. season and destination of the biomass from the crop (uppercase letters) production. e.g., C sil = corn used as silage. wW= winter wheat. pG+L hay= perennial grass and legume mix to use as hay. Letters joined by parentheses with a superscript number indicate number of years that a given crop or cropping system is repeated into the rotation system (used when the rotation cycle is greater than 4 years). e.g. $(\text{C sil})^4$ - $(\text{pG+L hay})^4$ = 4 years of corn used as silage followed by 4 years of perennial grass and lentil mix used as hay.

Table S2. Effect of cropping systems on environmental impact categories of human health as climate change and greenhouse gas emissions and ozone layer depletion, from life cycle analysis studies on forage production (grain, pasture, silage, and/or hay), per hectare per year (ha y^{-1}), per amount of dry matter of product per year (Mg DM y^{-1}), and per net energy of lactation (Mcal NEL), in various regions with different soil types.

Soil type	Nº obs.	Study duration	Cropping system description		Human health						
					Global warming potential [a]				Ozone layer depletion [b]		
	n	year			kg CO_2 eq ha^{-1} y^{-1}	kg CO_2 eq Mg DM^{-1} y^{-1}	kg CO_2 eq Mcal NEL^{-1}		kg CFC-11 eq ha^{-1} y^{-1}	kg CFC-11 eq Mg DM^{-1} y^{-1}	kg CFC-11 eq Mcal NEL^{-1}
Czech Republic Bernas et al. [7]											
Sandy loam	16	4	C sil		7450	582	0.40		-	-	-
	12	4	CP sil		4271	366	0.46		-	-	-
	16	4	A sil		2549	309	0.23		-	-	-
	16	4	C+A sil		7740	446	0.32		-	-	-
	16	4	C+CP+A sil		7290	420	0.35		-	-	-
	4ł	2	CP sil		9653	3340	4.18		-	-	-
	8	3	CP sil		9395	568	0.71		-	-	-
	12	4	CP sil		5706	366	0.46		-	-	-
	1	5[φ]	CP sil		3384	290	0.36		-	-	-
	1	10[φ]	CP sil		2147	184	0.23		-	-	-
	1	15[φ]	CP sil		1844	158	0.20		-	-	-
	1	20[φ]	CP sil		1704	146	0.18		-	-	-
Karaj, Alborz Province, Iran Fathollahi et al. [21]											

Loam	125	5	C sil		6550	383	0.26		5.0E-04	3.0E-05	2.0E-08
	105	5	A sil		3717	316	0.24		3.8E-04	3.2E-05	2.4E-08
Napierville, Québec, Canada Little et al. [69]											
Clay	1	5^{φ}	(A sil)^{4}- B sil		7236	1167	1.60		-	-	-
	1	8^{φ}	(C sil)^{4} - (pG+L hay)^{4}		4887	651	0.96		-	-	-
Landriano. Lombardy. Italy Zucali et al. [19]											
Loam	111		C sil		2528	131	0.09		1.9E-04	1.0E-05	6.5E-09
	107	1	pG hay		1224	129	0.11		8.6E-05	9.0E-06	7.8E-09
	48	1	A hay		798	68	0.07		8.2E-05	7.0E-06	7.5E-09
	28	1	A sil		683	59	0.07		5.7E-05	5.0E-06	5.7E-09
	14	1	high moisture C sil		1929	177	0.09		1.1E-04	1.0E-05	4.9E-09
	1	1	C sil/R hay		3409	142	0.11		5.1E-04	2.0E-05	1.5E-08
	1	1	high moisture C sil/R hay		3773	218	0.14		1.7E-04	1.0E-05	6.4E-09
Po Valley, Lombardy, Italy Noya et al. [70]											
Clay	3	1	B sil		9914	765	0.58		2.3E-04	1.8E-05	1.3E-05
	3	1	R sil		10237	633	0.48		1.6E-04	9.6E-06	6.0E-06
	1	1	So sil		10505	401	0.30		2.4E-04	9.2E-06	3.9E-06

	1	1	w c sil-So sil		10515	664	0.47		2.4E-04	1.9E-05	1.3E-05
Calldetenes, Catalonia, Spain González-García et al. [17]											
Loam	5	5	So sil-B sil		4693	232	0.17		3.4E-04	1.7E-05	1.2E-08
	5	5	So sil-O sil		4653	282	0.21		3.3E-04	2.0E-05	1.5E-08
Luancheng, China Li et al. [68]											
Silt -loam	16	4	C-W		7656	436	0.21		-	-	-
	16	4	C sil-Rg sil		6358	144	0.12		-	-	-
	16	4	SS sil – Rg sil		6295	124	0.11		-	-	-
	16	4	SH sil – Rg sil		6291	97	0.08		-	-	-
Po River Valley, Lombardy, Italy Bacenetti et al. [24]											
	1	4	A		982	82	0.06		1.7E-03	1.2E-05	9.0E-09
Fermoy, Co Cork, Ireland Herron et al. [67]											
Sandy loam to loam	1	4	pRg pas		13417	1138	0.28		-	-	-
	1	4	pRg + WC pas		13696	1127	0.33		-	-	-
Gansu Province, China Wang et al. [71]											
Sandy loam - clay	10 0	5	A hay		1079	119	0.10		-	-	-
Ontario, Canada Meyeraurich et al. [58]											
Silt loam	4	20	C		3309	389	0.19		-	-	-
	4	20	C-C-A-A		1781	230	0.14		-	-	-

	4	20	A-A-A-A		1888	270	0.20		-	-	-
Hickory Corners, Michigan, US Abraha et al. [72]											
Sand-loam	4	8	C		20679	-	-		-	-	-
	4	8	pSg		6503	-	-		-	-	-
	4	8	WPM		4422	-	-		-	-	-
	4	22	CRP		1301	-	-		-	-	-
Sardinia, Italy Solinas et al. [10]											
Silt-loam	1	1	DW-B		8120	1692	0.85		1.0E-03	9.0E-05	4.5E-08
	1	1	C sil – Rg hay		33157	1184	0.85		4.3E-03	3.8E-04	2.7E-07
	1	1	C sil – T sil		29918	880	0.63		3.9E-03	2.3E-04	1.6E-07

[a] FEC = fossil energy consumption. [b] OLD = ozone layer depletion.

** Crops are: A= alfalfa. Ar= artichoke for heads. B= barley. C= corn. Ca= canola. Cm= camelina. Co= cocksfoot. CP= cup plant. CRP = Conservation Reserve Program grasslands; DP= dry pea. DW= durum wheat. FB= faba beans. G= grass. L= lentil. M= mustard. O= oat. P= pea. Pe= pennycress. R= rye. Ra= rapeseed. Rg= ryegrass. RC= red clover. RW= red wheat. S= soybean. So=Sorghum. Sg= switchgrass. Su= sunflower. SH= sorghum-sudangrass hybrids. SS= sweet sorghum. T= triticale. TF= tall fescue. V= vetch. W= wheat. Wi= willow. WPM= wild plant mixture. c= cereal. l= legume. p=perennial. f=fallow. w= winter. sp= spring. s=summer. for= forage. res= residual biomass. sil=silage. hay=hay. pas=pasture. eth=ethanol. bio= biodiesel. oil= oil for human consumption. Letters joined by hyphenation indicate crop rotation. e.g., C-S = corn-soybean rotation. Letters joined by a bar indicate intercropping system. e.g., R/S = rye/soybean. Letters joined by a plus indicate a mix of crops. e.g., O+RC = oat and red clover mix. Letters in lowercase indicate the cycle. season and destination of the biomass from the crop (uppercase letters) production. e.g., C sil = corn used as silage. wW= winter wheat. pG+L hay= perennial grass and legume mix to use as hay. Letters joined by parentheses with a superscript number indicate the number of years that a given crop or cropping system is repeated into the rotation system (used when the rotation cycle is greater than 4 years). e.g., $(C\ sil)^4$ - $(pG{+}L\ hay)^4$ = 4 years of corn used as silage followed by 4 years of perennial grass and lentil mix used as hay.

[φ] Modeling scenario.

Table S3. Effect of cropping system on environmental impact categories of resources consumption from life cycle analysis studies on forage production (grain, pasture, silage, and/or hay), per hectare per year (ha y^{-1}), per amount of dry matter of product per year (Mg DM y^{-1}), and per net energy of lactation (Mcal NEL) in various regions with different soil types.

Soil type	Nº obs.	Study duration	Cropping system description		Resources consumption						
					Fossil energy consumption [a]				Abiotic depletion potential [b]		
	n	year			MJ ha^{-1} y^{1}	MJ Mg DM^{-1} y^{-1}	MJ Mcal NEL^{-1}		kg Sb eq ha^{-1} y^{-1}	kg Sb eq Mg DM^{-1} y^{-1}	kg Sb eq Mcal NEL^{-1}
Czech Republic Bernas et al. **[7]**											
Sandy loam	16	4	C sil		-	-	-		594ǂ	46ǂ	3.15E-02ǂ
	12	4	CP sil		-	-	-		550 ǂ	47ǂ	5.89E-02ǂ
	16	4	A sil		-	-	-		386ǂ	47ǂ	3.53E-02ǂ
	16	4	C+A sil		-	-	-		809ǂ	47ǂ	3.33E-02ǂ
	16	4	C+CP+A sil		-	-	-		812ǂ	47ǂ	3.90E-02ǂ
	4ł	2	CP sil		-	-	-		673ǂ	41ǂ	5.09E-02ǂ
	8	3	CP sil		-	-	-		1154ǂ	70ǂ	8.73E-02ǂ
	12	4	CP sil		-	-	-		734ǂ	47ǂ	5.89E-02ǂ
	1	5φ	CP sil		-	-	-		450ǂ	39ǂ	4.83E-02ǂ
	1	10φ	CP sil		-	-	-		312ǂ	27ǂ	3.34E-02ǂ
	1	15φ	CP sil		-	-	-		278ǂ	24ǂ	2.98E-02ǂ
	1	20φ	CP sil		-	-	-		261ǂ	22ǂ	2.80E-02ǂ

Karaj, Alborz Province, Iran Fathollahi et al. [21]											
Loam	125	5	C sil		31050	4215	2.86		0.068	0.004	2.72E-06
	105	5	A sil		21455	4251	3.21		0.012	0.001	7.54E-07
Landriano. Lombardy. Italy Zucali et al. **[19]**											
Loam	111	1	C sil		21288	1101	0.72		0.003	0.0002	1.02E-07
	107	1	pG hay		9195	968	0.84		0.003	0.0003	2.75E-07
	48	1	A hay		9127	781	0.84		0.003	0.0003	2.76E-07
	28	1	A sil		8980	768	0.88		0.002	0.0002	2.02E-07
	14	1	high moisture C sil		12653	1163	0.57		0.003	0.0003	1.35E-07
	1	1	C sil/R hay		30440	1272	0.96		0.006	0.0002	1.77E-07
	1	1	high moisture C sil/R hay		30413	1758	1.12		0.005	0.0003	1.84E-07
Po Valley, Lombardy, Italy Noya et al. [70]											
Clay	3	1	B sil		-	-	-		480[‡]	37[‡]	2.78E+01
	3	1	R sil		-	-	-		420[‡]	26[‡]	1.61E+01
	1	1	So sil		-	-	-		543[‡]	21[‡]	8.77E+00
	1	1	w c sil-So sil		-	-	-		556[‡]	35[‡]	2.46E+01
Calldetenes, Catalonia, Spain González-García et al. [17]											
Loam	5	5	So sil-B sil		39131	1934	1.41		-	-	-
	5	5	So sil-O sil		38548	2336	1.77		-	-	-

Luancheng, China Li et al. [68]											
Silt -loam	16	4	C-W		103088	5876	2.89		0.025	0.0014	6.97E-07
	16	4	C sil-Rg sil		94012	2136	1.76		0.023	0.0006	4.66E-07
	16	4	SS sil – Rg sil		94154	1855	1.72		0.022	0.0005	4.54E-07
	16	4	SH sil – Rg sil		94808	1466	1.15		0.022	0.0004	3.02E-07
Po River Valley, Lombardy, Italy Bacenetti et al. [24]											
	1	4	A		-	-	-		0.169	0.0153	1.15E-05
Fermoy, Co Cork, Ireland Herron et al. [67]											
Sandy loam to loam	1	4	pRg pas		21326	1809	2.20		-	-	-
	1	4	pRg + WC pas		21563	1774	2.16		-	-	-
Gansu Province, China Wang et al. [11]											
Sandy loam - clay	100	5	A hay		13520	1490	1.24		3076086[‡]	339[‡]	2.82E-01[‡]
Ontario, Canada Meyeraurich et al. [58]											
Silt loam	4	20	C		6424	756	0.37		-	-	-
	4	20	C-C-A-A		4292	554	0.33		-	-	-
	4	20	A-A-A-A		2621	374	0.28		-	-	-
Sardinia, Italy Solinas et al. [59]											
Silt-loam	1	1	DW-B		-	-	-		52	11	5.40E-03
	1	1	C sil – Rg hay		-	-	-		202	7	5.20E-03

	1	1	C sil – T sil		-	-	-		184	5	3.91E-03

[a] FEC = fossil energy consumption. [b] ADP = abiotic depletion potential, in kg Sb eq (metal depletion) or [‡] kg oil eq (fossil depletion) or [‡‡] kg water (water depletion).

* System types are: BAU = business as usual. AS = alternative or aspirational system. DPCS= diverse perennial circular system. When the alternative or aspirational system includes the dimensions of diversity (more crop species). perenniality (a perennial crop). and circularity (legume crop. or integrated systems) as part of it.

** Crops are: A= alfalfa. Ar= artichoke for heads. B= barley. C= corn. Ca= canola. Cm= camelina. Co= cocksfoot. CP= cup plant. CRP = Conservation Reserve Program grasslands; DP= dry pea. DW= durum wheat. FB= faba beans. G= grass. L= lentil. M= mustard. O= oat. P= pea. Pe= pennycress. R= rye. Ra= rapeseed. Rg= ryegrass. RC= red clover. RW= red wheat. S= soybean. So=Sorghum. Sg= switchgrass. Su= sunflower. SH= sorghum-sudangrass hybrids. SS= sweet sorghum. T= triticale. TF= tall fescue. V= vetch. W= wheat. Wi= willow. WPM= wild plant mixture. c= cereal. l= legume. p=perennial. f=fallow. w= winter. sp= spring. s=summer. for= forage. res= residual biomass. sil=silage. hay=hay. pas=pasture. eth=ethanol. bio= biodiesel. oil= oil for human consumption. Letters joined by hyphenation indicate crop rotation. e.g., C-S = corn-soybean rotation. Letters joined by a bar indicate intercropping system. e.g., R/S = rye/soybean. Letters joined by a plus indicate a mix of crops. e.g., O+RC = oat and red clover mix. Letters in lowercase indicate the cycle. season and destination of the biomass from the crop (uppercase letters) production. e.g., C sil = corn used as silage. wW= winter wheat. pG+L hay= perennial grass and legume mix to use as hay. Letters joined by parentheses with a superscript number indicate the number of years that a given crop or cropping system is repeated into the rotation system (used when the rotation cycle is greater than 4 years). e.g., (C sil)^{4} - (pG+L hay)^{4} = 4 years of corn used as silage followed by 4 years of perennial grass and lentil mix used as hay.

[φ] Modeling scenario.

Table S4. Effect of cropping system on environmental impact categories of ecosystem quality from life cycle analysis studies on forage production (grain, pasture, silage, and/or hay per hectare per year (ha y^{-1}), per amount of dry matter of product per year (Mg DM y^{-1}), and per net energy of lactation (Mcal NEL), in various regions with different soil types.

Soil type	Nº obs.	Study duration	Cropping system description		Ecosystem Quality										
					Ecotoxicity Potential [a]				Acidification Potential [b]				Eutrophication Potential [c]		
	n	year			Mg 1.4-DB eq ha^{-1} y^{-1}	Mg 1.4-DB eq Mg DM^{-1} y^{-1}	Mg 1.4-DB eq Mcal NEL^{-1}		kg SO_2 eq ha^{-1} y^{-1}	kg SO_2 eq Mg DM^{-1} y^{-1}	kg SO_2 eq Mcal NEL^{-1}		kg PO_4 eq ha^{-1} y^{-1}	kg PO_4 eq Mg DM^{-1} y^{-1}	kg PO_4 eq Mcal NEL^{-1}
Czech Republic Bernas et al. **[7]**															
Sandy loam	16	4	C sil		0.025[ǂ]	0.002[ǂ]	1.4E-06[ǂ]		23	1.8	1.2E-03		3	0.02	1.5E-05
	12	4	CP sil		0.023[ǂ]	0.002[ǂ]	2.4E-06[ǂ]		21	1.8	2.3E-03		3	0.03	3.3E-05
	16	4	A sil		0.022[ǂ]	0.003[ǂ]	2.0E-06[ǂ]		8	1.0	7.7E-04		2	0.02	1.5E-05
	16	4	C+A sil		0.040[ǂ]	0.002[ǂ]	1.6E-06[ǂ]		24	1.4	1.0E-03		3	0.02	1.5E-05
	16	4	C+CP+A sil		0.038[ǂ]	0.002[ǂ]	1.8E-06[ǂ]		27	1.5	1.3E-03		4	0.02	1.9E-05
	4[ł]	2	CP sil		0.041[ǂ]	0.014[ǂ]	1.8E-05[ǂ]		45	15.4	1.9E-02		5	0.18	2.3E-04
	8	3	CP sil		0.044[ǂ]	0.003[ǂ]	3.3E-06[ǂ]		45	2.8	3.4E-03		6	0.04	4.5E-05
	12	4	CP sil		0.030[ǂ]	0.002[ǂ]	2.4E-06[ǂ]		29	1.8	2.3E-03		4	0.03	3.3E-05
	1	5[φ]	CP sil		0.020[ǂ]	0.002[ǂ]	2.1E-06[ǂ]		18	1.5	1.9E-03		2	0.02	2.8E-05
	1	10[φ]	CP sil		0.015[ǂ]	0.001[ǂ]	1.6E-06[ǂ]		12	1.0	1.3E-03		2	0.02	2.1E-05
	1	15[φ]	CP sil		0.014[ǂ]	0.001[ǂ]	1.5E-06[ǂ]		11	0.9	1.1E-03		2	0.02	1.9E-05
	1	20[φ]	CP sil		0.014[ǂ]	0.001[ǂ]	1.5E-06[ǂ]		10	0.9	1.1E-03		476	4.34	5.4E-03

Karaj, Alborz Province, Iran Fathollahi et al. [21]															
Loam	125	5	C sil		15707	919	6.2E-01		80	4.7	3.2E-03		55	3.24	2.2E-03
	105	5	A sil		10195	867	6.5E-01		46	3.9	2.9E-03		26	2.22	1.7E-03
Landriano. Lombardy. Italy Zucali et al. [19]															
Loam	111	1	C sil		357	19	1.2E-02		92	4.8	3.1E-03		47	2.46	1.6E-03
	107	1	pG hay		293	31	2.7E-02		84	8.9	7.7E-03		21	2.18	1.9E-03
	48	1	A hay		270	23	2.5E-02		24	2.1	2.2E-03		7	0.57	6.1E-04
	28	1	A sil		202	18	2.0E-02		22	2.0	2.3E-03		6	0.54	6.2E-04
	14	1	high moisture C sil		313	29	1.4E-02		90	8.3	4.1E-03		48	4.38	2.2E-03
	1	1	C sil/R hay		895	35	2.6E-02		123	4.8	3.6E-03		50	1.96	1.5E-03
	1	1	high moisture C sil/R hay		412	24	1.5E-02		144	8.3	5.3E-03		65	3.77	2.4E-03
Po Valley, Lombardy, Italy Noya et al. [70]															
Clay	3	1	B sil		0.028ǂ	0.002	1.6E-03		294	23	1.7E+01		0.14	0.011	8.0E-03
	3	1	R sil		0.026ǂ	0.002	9.9E-04		340	21	1.3E+01		0.13	0.008	5.1E-03
	1	1	So sil		0.040ǂ	0.002	6.5E-04		614	23	9.9E+00		0.19	0.007	3.1E-03
	1	1	w c sil-So sil		0.040ǂ	0.003	1.8E-03		627	40	2.8E+01		0.19	0.012	8.4E-03
Calldetenes, Catalonia, Spain González-García et al. [17]															
Loam	5	5	So sil-B sil		-	-	-		210	10	7.6E-03		55	2.74	2.0E-03

	5	5	So sil-O sil		-	-	-		210	13	9.6E-03		55	3.36	2.5E-03
Luancheng, China Li et al. [68]															
Silt -loam	16	4	C-W		5567	317	1.6E-01		44	2.5	1.2E-03		7	0.420	2.1E-04
	16	4	C sil-Rg sil		4819	110	9.0E-02		40	0.9	7.4E-04		7	0.170	1.4E-04
	16	4	SS sil – Rg sil		4782	94	8.7E-02		39	0.8	7.1E-04		7	0.140	1.3E-04
	16	4	SH sil – Rg sil		4778	74	5.8E-02		39	0.6	4.8E-04		7	0.110	8.6E-05
Po River Valley, Lombardy, Italy Bacenetti et al. [24]															
	1	4	A		0.006ǂ	0.001	3.9E-07		0.29	0.02	1.8E-05		0.10	0.008	6.4E-06
Fermoy, Co Cork, Ireland Herron et al. [67]															
Sandy loam to loam	1	4	pRg pas		-	-	-		3.23	0.27	3.3E-04		0.17	0.014	1.8E-05
	1	4	pRg + WC pas		-	-	-		3.33	0.27	3.3E-04		0.17	0.014	1.7E-05
Gansu Province, China Wang et al. [71]															
Sandy loam - clay	10 0	5	A hay		-	-	-		65	7.2	6.0E-03		0.06	0.007	5.4E-06
Sardinia, Italy Solinas et al. [59]															
Silt-loam	1	1	DW-B		1494	128	6.4E-02		68	14.2	7.1E-03		29	6.10	3.1E-03
	1	1	C sil – Rg hay		5774	506	3.7E-01		213	7.6	5.5E-03		52	1.87	1.4E-03
	1	1	C sil – T sil		5415	313	2.3E-01		208	6.1	4.4E-03		60	1.75	1.3E-03

[a] ECP = ecotoxicity potential (terrestrial. freshwater. marine). [ǂ]only ecotoxicity terrestrial was evaluated. [b]AP = acidification potential. [c] EUP = eutrophication potential (fresh water and marine).

** Crops are: A= alfalfa. Ar= artichoke for heads. B= barley. C= corn. Ca= canola. Cm= camelina. Co= cocksfoot. CP= cup plant. CRP = Conservation Reserve Program grasslands; DP= dry pea. DW= durum wheat. FB= faba beans. G= grass. L= lentil. M= mustard. O= oat. P= pea. Pe= pennycress. R= rye. Ra= rapeseed. Rg= ryegrass. RC= red clover. RW= red wheat. S= soybean. So=Sorghum. Sg= switchgrass. Su= sunflower. SH= sorghum-sudangrass hybrids. SS= sweet sorghum. T= triticale. TF= tall fescue. V= vetch. W= wheat. Wi= willow. WPM= wild plant mixture. c= cereal. l= legume. p=perennial. f=fallow. w= winter. sp= spring. s=summer. for= forage. res= residual biomass. sil=silage. hay=hay. pas=pasture. eth=ethanol. bio= biodiesel. oil= oil for human consumption. Letters joined by hyphenation indicate crop rotation. e.g., C-S = corn-soybean rotation. Letters joined by a bar indicate intercropping system. e.g., R/S = rye/soybean. Letters joined by a plus indicate a mix of crops. e.g., O+RC = oat and red clover mix. Letters in lowercase indicate the cycle. season and destination of the biomass from the crop (uppercase letters) production. e.g., C sil = corn used as silage. wW= winter wheat. pG+L hay= perennial grass and legume mix to use as hay. Letters joined by parentheses with a superscript number indicate number of years that a given crop or cropping system is repeated into the rotation system (used when the rotation cycle is greater than 4 years). e.g., $(C\ sil)^4$ - $(pG+L\ hay)^4$ = 4 years of corn used as silage followed by 4 years of perennial grass and lentil mix used as hay.

[φ] Modeling scenario.

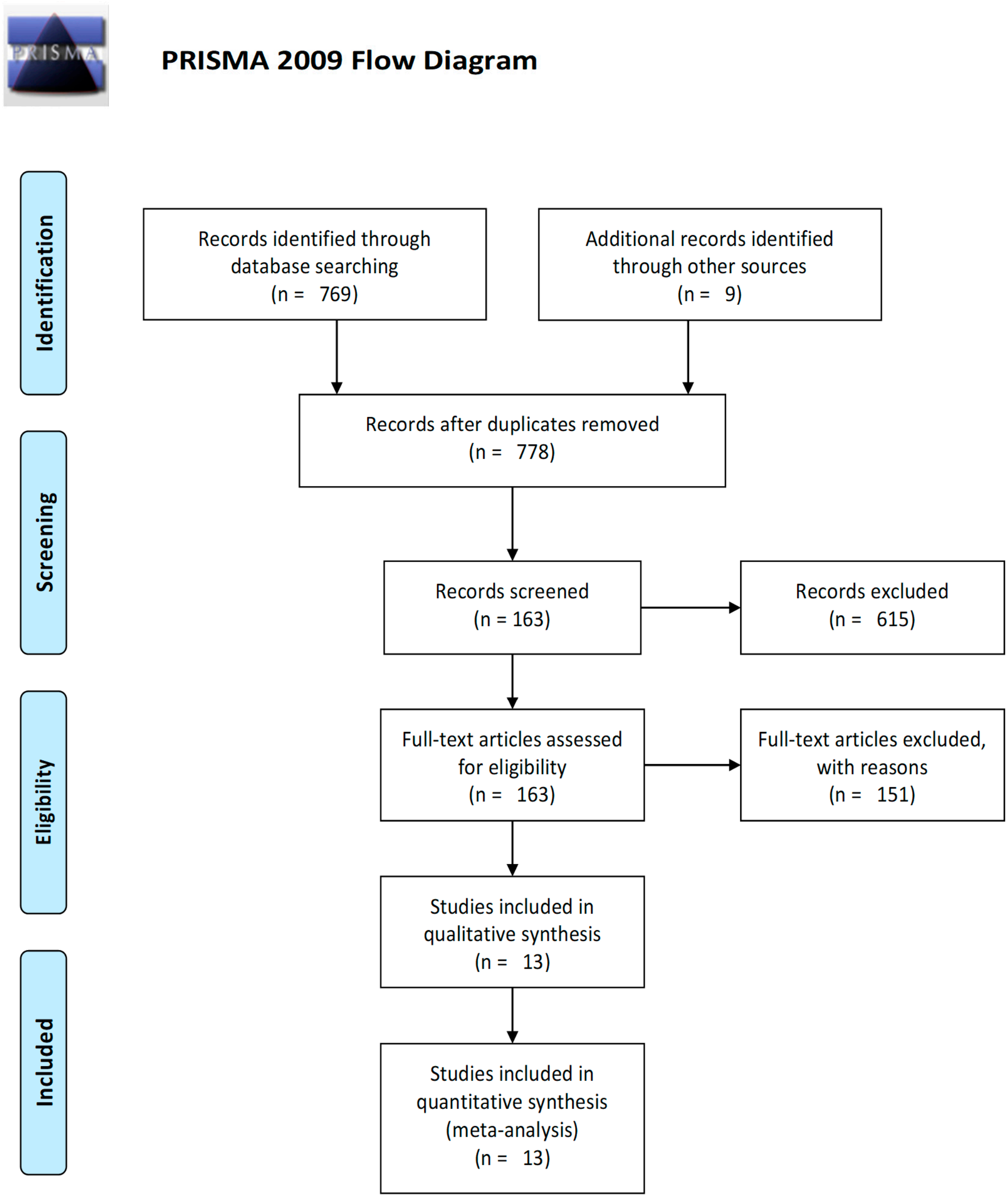

Figure S1: PRISMA flow diagram for data inclusion in the meta-analysis.

Table S5. General overview of the selected studies and their key parameters.

Reference	Region, Country	Goal and Scope	Impact assessment	Functional unit
[24]	Po River Valley, Lombardy, Italy	To assess the environmental impact of alfalfa hay production in the Lombardy region, northern Italy, which is the most important Italian region for dairy production.	ILCD (International Reference Life Cycle Data System) midpoint method	1 Mg of alfalfa hay (at moisture of 14%)
[7]	Czech Republic	To quantify the environmental impacts of the life cycle of cup plant, silage maize, and alfalfa and compare them with each other and within the selected silage ratio (33:33.5:33.5%).	SimaPro 9.0.0.40 softwares, ReCiPe Midpoint (H) V1.13/Europe Recipe H, Ecoinvent v3.5 database.	1 Mg of dry matter (DM) of silage, and 1 ha of monoculture
[21]	Karaj, Alborz Province, Iran	To quantify and compare the environmental impacts of forage products from the raw material extraction up to the delivery of corn silage and alfalfa hay for animal feed in dairy farms	SimaPro 8.3.0; CML-IA baseline V3.01/world 2000 and ReCiPe 1.09.	1 Mg of DM of forage
[17]	Calldetenes, Catalonia, Spain	To evaluate the life cycle environmental profile of three different fodder crops widely cultivated in Spain under double cropping systems to produce feed for dairy cows	SimaPro 8 / ReCiPe Midpoint	1 Mg of DM of silage, 1 ha, 1 ton of crude protein, and 1 MJ of metabolizable energy
[67]	Fermoy, Co Cork, Ireland	To update and improve a pasture-based dairy systems LCA model, to evaluate the effect of the inclusion of white clover on the environmental impact of intensive pasture-based dairy systems, to undertake an uncertainty analysis on key LCA variables, and to conduct a sensitivity	IPCC (2013) characterization factors for a 100-y time horizon, and ReCiPe 2016.	1 ha, and 1 ton of FPCM (fat and protein-corrected milk)

		analysis using a range of allocation methods.		
[68]	Luancheng, China	To evaluate the economic feasibility of the four crop-forage production systems; to compare the energy use of the maize-wheat cropping system with other forage production systems; and to assess the potential environmental impacts of the studied crop-forage production systems.	SimaPro 8.3.0.0/CML-IA baseline V3.01/World 2000, Ecoinvent LCA database (v.3), ReCiPe Midpoint (H) V1.13/World	1 ha, and 1 ton of grain or DM of forage
[69]	Napierville, Québec, Canada	To compare GHG emissions from corn silage- and alfalfa silage-based dairy systems, using whole-farm analyses, including effects on soil carbon.	GHG emissions from Holos Model v2. Carbon changes from ICBM (Introductory Carbon Balance Model)	1 kg of FPCM; 1 kg meat (live weight), 1 kg meat (carcass weight), 1 kg of protein, 1 MJ of energy ha of farmland, 1 kg of manure N
[58]	Ontario, Canada	To examine the cost-effectiveness of Eastern Canadian cropping systems to reduce GHG emission levels.	Estimating GHG emissions by measuring soil organic matter content and N_2O emissions for the soil, based on IPCC methodology.	1 ha
[70]	Po Valley, Lombardy, Italy	To focus on the environmental analysis of three different cereal crops typically cultivated in the Po Valley, Italy for animal feed purposes: barley, rye, and sorghum. To identify the main hotspots together with barley and rye and the cropping system of sorghum with the most environmental-friendly results.	SimaPro v.8.2 / ReCiPe Midpoint (H) v.1.12	1 kg of crude protein in biomass silage
[59]	Sardinia, Italy	To compare the environmental sustainability of some traditional vs alternative cropping systems (i.e., for energy or integrated energy and food	SimaPro 7.3.3 / CML2 baseline 2000 methodology	1 ha, and 1 kg of product (grain and straw, heads, oilseeds, and residual biomass in general)

		purposes) in the context of irrigated and rainfed Mediterranean cropping systems.		
[71]	Gansu Province, China	To evaluate the environmental impacts including water consumption of alfalfa production with different production systems in Northwest China, using LCA methodology coupled with the CropWat model; to investigate improvement measures for reducing environmental impacts of alfalfa production systems and evaluate their potential of environmental improvement to develop optimal measures; and to assess the variability of environmental impacts of different production systems.	SimaPro 9.0 / ReCiPe 2016 method / IPCC 2013 GWP 100a / CML-IA non baseline 3.04. / Cumulative Energy Demand 1.11 / CropWat 8.0 model	1 kg DM of alfalfa hay
[72]	Scotland	An unconverted CRP field (CRPRef) was maintained as a historical reference. Ecosystem C balance was assessed using adjusted net ecosystem carbon exchange (NEEadj) calculated by adding C removed in harvested biomass to NEE measured using eddy covariance method.	EdiRe software (University of Edinburgh, v 1.5.0.32, 2012) to determine 30-min net ecosystem carbon exchange (NEE).	harvested dry mass (g C m^{-2})
[19]	Landriano, Lombardy, Italy	To assess the impact of most common home-grown fodder crops considering a pool of different functional units able to better appreciate their characteristics in terms of dry matter, net energy, and protein digestibility; and, to evaluate how the changes on farm cropping systems affect the environmental impact of milk	SimaPro 2014 / CML-IA baseline 3.01 / Cumulative Energy Demand 1.08 method	1 ha; 1 kg of feed DM; 1 MJ of Net Energy for lactation (NEL); and 1 kg of digestible protein in the small intestine when rumen-fermentable nitrogen is the limiting factor (PDIN)

Table S6. Methods and conversion factors used to convert environmental impacts units reported in the literature to the functional units (FU) of interest in this study such as per hectare per year (ha y^{-1}), per amount of dry matter of product per year (Mg DM y^{-1}), and per net energy of lactation (Mcal NEL), when necessary.

Impact category	Units in the original literature	Conversion factor or formulae used to obtain FU of interest in this study			
		Impact category unit	FU		
			1 ha^{-1} y^{-1}	1 Mg DM^{-1} y^{-1}	1 Mcal NEL
Fossil energy consumption					(*Impact category*) Mcal NEL^{-1} = (*Impact category*) Mg DM^{-1} y^{-1} x yield, Mcal NEL Mg DM^{-1} y^{-1} [a] Feed or diet: Mcal NEL kg DM^{-1} = 0.0245 x TDN*, % - 0.12 [a] Milk: Mcal NEL kg DM^{-1} = 0.0929 x fat, % + 0.0547
	MJ ha^{-1} y^{-1}	MJ	-	MJ Mg DM^{-1} y^{-1} = MJ ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	
	kg CO_2 eq ha^{-1} y^{-1}	MJ	MJ ha^{-1} y^{-1} = (kg CO_2 eq ha^{-1} y^{-1} x 1.43 KWh) ÷ 0,278 KWh; 1 MJ = 0,278 KWh; 1 kg CO_2 eq = 1.43 KWh of fossil energy;		
	MJ kg DM^{-1} y^{-1}	MJ	MJ ha^{-1} y^{-1} = (MJ kg DM^{-1} y^{-1} x 1000) x yield, Mg DM ha^{-1} y^{-1}	MJ Mg DM^{-1} y^{-1} = MJ kg DM^{-1} y^{-1} x 1000	
Abiotic depletion potential					
metal depletion					

	kg Sb eq ha^{-1} y^{-1}	kg Sb eq	-	kg Sb eq Mg DM^{-1} y^{-1} = kg Sb eq ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	x crude protein, % + 0.193
	kg Sb eq Mg DM^{-1} y^{-1}	kg Sb eq	kg Sb eq ha^{-1} y^{-1} = kg Sb eq Mg DM^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	g Sb eq kg DM^{-1} y^{-1}	kg Sb eq	1 g kg^{-1} = 1 kg Mg^{-1}	1 g kg^{-1} = 1 kg Mg^{-1}	
Fossil depletion					
	kg oil eq Mg DM^{-1} y^{-1}	kg oil eq	kg oil eq ha^{-1} y^{-1} = kg oil eq Mg DM^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	kg oil eq kg of crude protein of silage^{-1}	kg oil eq	kg oil eq ha^{-1} y^{-1} = kg oil eq kg of crude protein of silage^{-1} x	kg oil eq Mg DM^{-1} y^{-1} = (kg oil eq kg of crude protein of silage^{-1} x	
			1000 x yield, Mg crude protein ha^{-1} y^{-1}	1000 x yield, Mg crude protein ha^{-1} y^{-1}) ÷ yield, Mg DM ha^{-1} y^{-1}	
Global warming potential					
	kg CO_2 eq ha^{-1} y^{-1}	kg CO_2 eq	-	kg CO_2 eq Mg DM^{-1} y^{-1} = kg CO_2 eq ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	

	kg CO_2 eq Mg DM^{-1} y^{-1}	kg CO_2 eq	kg CO_2 eq ha^{-1} y^{-1} = kg CO_2 eq Mg DM^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	g CO_2 eq kg DM^{-1} y^{-1}	kg CO_2 eq	kg CO_2 eq ha^{-1} y^{-1} = g CO_2 eq kg DM^{-1} x yield, Mg DM ha^{-1} y^{-1} 1 g kg^{-1} = 1 kg Mg^{-1}	1 g kg^{-1} = 1 kg Mg^{-1}	
	kg CO_2 eq kg of crude protein of $silage^{-1}$	kg CO_2 eq	kg CO_2 eq ha^{-1} y^{-1} = kg CO_2 eq kg of crude protein of silage $^{-1}$ x 1000 x yield, Mg crude protein ha^{-1} y^{-1}	kg CO_2 eq Mg DM^{-1} y^{-1} = (kg CO_2 eq kg of crude protein of silage $^{-1}$ x 1000 x yield, Mg crude protein ha^{-1} y^{-1}) ÷ yield, Mg DM ha^{-1} y^{-1}	
Ozone layer depletion					
	kg CFC-11 eq ha^{-1} y^{-1}	kg CFC-11 eq	-	kg CFC-11 eq Mg DM^{-1} y^{-1} = kg CFC-11 eq ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	
	kg CFC-11 eq Mg DM^{-1} y^{-1}	kg CFC-11 eq	kg CFC-11 eq ha^{-1} y^{-1} = kg CFC-11 eq Mg DM^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	mg CFC-11 eq Mg DM^{-1} y^{-1}	kg CFC-11 eq	kg CFC-11 eq ha^{-1} y^{-1} = (mg CFC-11 eq Mg DM^{-1} ÷ 1000000) x yield, Mg DM ha^{-1} y^{-1}	kg CFC-11 eq Mg DM^{-1} y^{-1} = mg CFC-11 eq Mg DM^{-1} ÷ 1000000	

Ecotoxicity potential (terrestrial, freshwater, marine)					
	kg 1.4-DB eq ha^{-1} y^{-1}	Mg 1.4-DB eq	Mg 1.4-DB eq ha^{-1} y^{-1} = kg 1.4-DB eq ha^{-1} y^{-1} ÷ 1000	Mg 1.4-DB eq Mg DM^{-1} y^{-1} = (kg 1.4-DB eq ha^{-1} y^{-1} ÷ 1000) ÷ yield, Mg DM ha^{-1} y^{-1}	
	kg 1.4 -DB eq Mg DM^{-1} y^{-1}	Mg 1.4-DB eq	Mg 1.4 -DB eq ha^{-1} y^{-1} = (kg 1.4 -DB eq Mg DM^{-1} ÷ 1000) x yield, Mg DM ha^{-1} y^{-1}	Mg 1.4-DB eq Mg DM^{-1} y^{-1} = kg 1.4-DB eq Mg DM^{-1} ÷ 1000	
	kg 1.4-DB eq kg of crude protein of $silage^{-1}$	Mg 1.4-DB eq	Mg 1.4-DB eq ha^{-1} y^{-1} = kg 1.4-DB eq kg of crude protein of silage $^{-1}$ x yield, Mg crude protein ha^{-1} y^{-1}	Mg 1.4-DB eq Mg DM^{-1} y^{-1} = (kg 1.4-DB eq kg of crude protein of silage $^{-1}$ x yield, Mg crude protein ha^{-1} y^{-1}) ÷ yield, Mg DM ha^{-1} y^{-1}	
	CTUe Mg DM^{-1} y^{-1}	Mg 1.4-DB eq	Mg 1.4 -DB eq ha^{-1} y^{-1} = [(CTUe Mg DM^{-1} ÷ 983) ÷ 1000] x yield, Mg DM ha^{-1} y^{-1} 1 kg 1.4-DB eq = 983 CTUe;	Mg 1.4-DB eq Mg DM^{-1} y^{-1} = (CTUe Mg DM^{-1} ÷ 983) ÷ 1000	
Acidification potential					
	kg SO_2 eq ha^{-1} y^{-1}	kg SO_2 eq	-	kg SO_2 eq Mg DM^{-1} y^{-1} = kg SO_2 eq ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	

	molc H^+ eq ha^{-1} y^{-1}	kg SO_2 eq	kg SO_2 eq ha^{-1} y^{-1} = molc H^+ ha^{-1} y^{-1} x 0.032 1 molc H^+ = 0.032 kg SO_2 eq	kg SO_2 eq Mg DM^{-1} y^{-1} = (molc H^+ ha^{-1} y^{-1} x 0.032) ÷ yield, Mg DM ha^{-1} y^{-1}	
	kg SO_2 eq Mg DM^{-1} y^{-1}	kg SO_2 eq	kg SO_2 eq ha^{-1} y^{-1} = kg SO_2 eq Mg DM^{-1} y^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	g SO_2 eq Mg DM^{-1} y^{-1}	kg SO_2 eq	kg SO_2 eq ha^{-1} y^{-1} = (g SO_2 eq Mg DM^{-1} y^{-1}÷ 1000) x yield, Mg DM ha^{-1} y^{-1}	kg SO_2 eq Mg DM^{-1} y^{-1} = (g SO_2 eq Mg DM^{-1} y^{-1} ÷ 1000) ÷ yield, Mg DM ha^{-1} y^{-1}	
	molc H^+ eq Mg DM^{-1} y^{-1}	kg SO_2 eq	kg SO_2 eq ha^{-1} y^{-1} = (molc H^+ eq Mg DM^{-1} y^{-1} x 0.032) x yield, Mg DM ha^{-1} y^{-1} 1 molc H^+ = 0.032 kg SO_2 eq	kg SO_2 eq Mg DM^{-1} y^{-1} = molc H^+ eq Mg DM^{-1} y^{-1} x 0.032 1 molc H^+ = 0.032 kg SO_2 eq	
	kg SO_2 eq kg of crude protein of $silage^{-1}$	kg SO_2 eq	kg SO_2 eq ha^{-1} y^{-1} = kg SO_2 eq kg of crude protein of silage $^{-1}$ x yield, Mg crude protein ha^{-1} y^{-1}	kg SO_2 eq Mg DM^{-1} y^{-1} = (kg SO_2 eq kg of crude protein of silage $^{-1}$ x yield, Mg crude protein ha^{-1} y^{-1}) ÷ yield, Mg DM ha^{-1} y^{-1}	
Eutrophication potential (fresh water and marine)					

	kg PO_4 eq ha^{-1} y^{-1}	kg PO_4 eq	-	kg PO_4 eq Mg DM^{-1} y^{-1} = kg PO_4 eq ha^{-1} y^{-1} ÷ yield, Mg DM ha^{-1} y^{-1}	
	kg PO_4 eq Mg DM^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = kg PO_4 eq Mg DM^{-1} y^{-1} x yield, Mg DM ha^{-1} y^{-1}	-	
	kg P eq Mg DM^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = (kg P eq Mg DM^{-1} y^{-1} x 0,3261) x yield, Mg DM ha^{-1} y^{-1} 1 kg P eq = 0.3261 kg PO_4 eq	kg PO_4 eq Mg DM^{-1} y^{-1} = kg P eq Mg DM^{-1} y^{-1} x 0,3261 1 kg P eq = 0.3261 kg PO_4 eq	
	kg P eq kg of crude protein of $silage^{-1}$	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = (kg P eq kg of crude protein of $silage^{-1}$ x 0.3261) x yield, Mg crude protein ha^{-1} y^{-1}	kg PO_4 eq Mg DM^{-1} y^{-1} = [(kg P eq kg of crude protein of $silage^{-1}$ x 0.3261) x yield, Mg crude protein ha^{-1} y^{-1}] ÷ yield, Mg DM ha^{-1} y^{-1}	
	g PO_4 eq kg DM^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = g PO_4 eq kg DM^{-1} y^{-1} x yield, Mg DM ha^{-1} y^{-1} 1 g kg^{-1} = 1 kg Mg^{-1}	1 g kg^{-1} = 1 kg Mg^{-1}	
	g P eq ha^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = (g P eq ha^{-1} y^{-1} x 0.3261) ÷ 1000	kg PO_4 eq Mg DM^{-1} y^{-1} = [(g P eq ha^{-1} y^{-1} x 0,3261) ÷ 1000] ÷ yield, Mg DM ha^{-1} y^{-1}	

			1 kg P eq = 0.3261 kg PO_4 eq	1 kg P eq = 0.3261 kg PO_4 eq	
	g P eq Mg DM^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = [(g P eq Mg DM^{-1} y^{-1} x 0.3261) ÷ 1000] x yield, Mg DM ha^{-1} y^{-1} 1 kg P eq = 0.3261 kg PO_4 eq	kg PO_4 eq Mg DM^{-1} y^{-1} = (g P eq Mg DM^{-1} y^{-1} x 0.3261) ÷ 1000 1 kg P eq = 0.3261 kg PO_4 eq	
	g P eq kg DM^{-1} y^{-1}	kg PO_4 eq	kg PO_4 eq ha^{-1} y^{-1} = (g P eq kg DM^{-1} y^{-1} x 0.3261) x yield, Mg DM ha^{-1} y^{-1} 1 g kg^{-1} = 1 kg Mg^{-1} 1 kg P eq = 0.3261 kg PO_4 eq	kg PO_4 eq Mg DM^{-1} y^{-1} = g P eq kg DM^{-1} y^{-1} x 0,3261 1 g kg^{-1} = 1 kg Mg^{-1}	

[a] Linn et al., (2003); *TDN = total digestible nutrients of feed or diet (forage, silage, hay, or concentrates). When the TDN data was not mentioned in the paper we used the standard table from Preston (2010), considering the specific feedstuff.

Table S7: Dataset for energy production

System	Reference	System description	Energy Production (Mcal NEL/Mg DM)	SE
BAU -control	[19]	high moisture ear corn	0.26	0.32
BAU -control	[7]	4 years corn silage	-0.06	0.30
BAU -control	[21]	5 years corn silage	-0.06	0.17
BAU -control	[19]	whole plant corn silage	-0.02	0.20
BAU -control	[58]	4 years continuous corn	0.26	0.53
BAU -control	[70]	barley	-0.17	0.60
BAU -control	[70]	rye	-0.17	0.60
BAU -control	[70]	sorghum single crop	-0.17	1.01
BAU -improved	[19]	High moisture ear corn/Italian ryegrass hay	0.00	1.01
BAU -improved	[19]	Whole plant corn silage/Italian ryegrass hay	-0.17	1.01
BAU -improved	[68]	corn silage-ryegrass-corn silage-ryegrass; irrigated	-0.25	0.30
BAU -improved	[68]	sorghum sudangrass-ryegrass-sorghum sudangrass-ryegrass	-0.20	0.30
BAU -improved	[68]	sweet sorghum-ryegrass-sweet sorghum-ryegrass; irrigated	-0.37	0.30
BAU -improved	[59]	corn silage-triticale	-0.12	1.01
BAU -improved	[59]	sorghum double crop (preceded by corn or other sorghum hybrids)	-0.11	1.01

BAU -improved	[68]	corn grain-wheat-corn grain-wheat; irrigated	0.26	0.30
BAU -improved	[59]	corn silage-Italian ryegrass hay	-0.12	1.01
BAU -improved	[59]	Durum wheat-barley	0.24	1.01
BAU -improved	[17]	5 years forage sorghum/barley rotation	-0.14	0.48
BAU -improved	[17]	5 years forage sorghum/oat rotation	-0.17	0.48
BAU -improved	[72]	CRP to 8 years continuous corn (annual crop)	0.26	0.53
Perennial	[7]	10 years cup plant for silage - perennial	-0.67	1.01
Perennial	[7]	15 years cup plant for silage - perennial	-0.67	1.01
Perennial	[7]	2 years cup plant for silage - perennial	-0.67	0.53
Perennial	[7	20 years cup plant for silage - perennial	-0.67	1.01
Perennial	[7]	3 years cup plant for silage - perennial	-0.67	0.39
Perennial	[7]	4 years alfalfa for silage (lucerne) - perennial	-0.17	0.30
Perennial	[7]	4 years cup plant for silage - perennial	-0.67	0.33
Perennial	[7]	4 years cup plant for silage - perennial - average	-0.67	0.33
Perennial	[7]	5 years cup plant for silage - perennial	-0.67	1.01
Perennial	[21]	5 years alfalfa hay	-0.17	0.20
Perennial	[19]	Alfalfa hay	-0.52	0.22
Perennial	[19]	Alfalfa silage	-0.59	0.24
Perennial	[19]	permanent grass hay	-0.31	0.20

Perennial	[58]	4 years continuous alfalfa	-0.17	0.53
Perennial	[72]	CRP to 8 years switchgrass (perennial crop)	-0.39	0.53
Perennial	[69]	4 years of alfalfa silage - 1 y barley silage	-0.77	1.01
Perennial	[24]	4 years alfalfa hay - average	-0.17	1.01
Perennial	[67]	4 years perennial ryegrass sward - 250 kgN/ha/year	-0.64	1.01
Perennial	[71]	5 years of alfalfa - applying fertilizer without irrigation (AFNI)	-0.26	0.20
Perennial	[7]	4 years corn + alfalfa mix	-0.11	0.30
Perennial	[7]	4 years corn + cup plant+ alfalfa	-0.27	0.30
Perennial	[69]	4 years of corn silage - 4years perennial hay mix (legume and grass mix)	-0.83	1.01
Perennial	[58]	4 years corn-corn-alfalfa-alfalfa	0.07	0.53
Perennial	[72]	CRP grassland	-0.20	0.53
Perennial	[72]	CRP to 8 years restored prairie (perennial crop)	-0.35	0.53
Perennial	[67]	4 years perennial ryegrass-white clover mix sward - 250 kgN/ha/y	-0.64	1.01

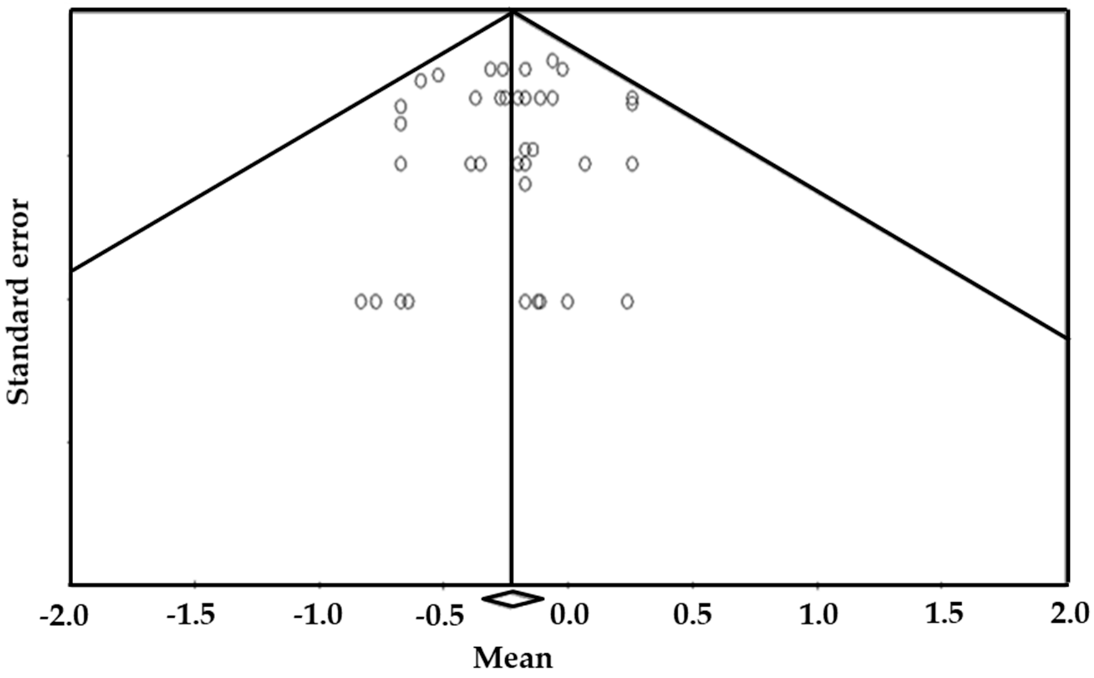

Figure S2: Funnel plot of energy production