Wheat varietal replacement as a driver of the degradation of Spanish rainfed Mediterranean agroecosystems throughout the 20th century

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Supplementary material

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Table S1. Harvest Index (HI) of modern varieties cultivated in rainfed Mediterranean environment under industrialized management.

Authors	Country	Cultivar	Year of release	HI
[82]	Italy	Quadrato (wheat) and Ponente (barley)		0.428
[83]	Jordania	Cham 1, Acsad665, Ammon	1988, 1988, 2004	0.303
[84]	Italy	Iride		0.430
[44]	Algeria	Hebda/Gerardo, Bidi/Waha/Bidi/GTA Dur, Eider, Chen's, Sahel 77, Mexicali 75, Kebir, Om Rabi 9, Belikh 2, Waha, INRAT 69, Ardente, Vitrón, B.Dur 1.94, Ofanto, Simeto, Duilio		0.411
[85]	Spain			0.390
[86]	Italy	Creso, Simeto and Svevo		0.330
[87]	Spain	Kilopondio and Bologna in 2013, Ingenio, Sublim and Nogal in 2014 and Ingenio, Nogal, Botticelli and Idalgo in 2015		0.318
[88]	Turkey	112 RILs derived from the cross Lahn×Cham1 using the single seed descent (SSD) method from the cross identification number ICDMN91–0015		0.252
[89]	Algeria	Vitrón, Waha, Chen	1993, 1987, 1990	0.293
[90]	Italy			0.361
[91]	Turkey	Bayraktar		0.290
[92]	Chipre	Hekabe, purified variety enlisted in the national catalogue of varieties of Cyprus		0.359
[6]	Italy	Duilio, Simeto, Ofanto	1984-1990	0.400
[93]	Italy	Gargano		0.273
[94]	Italy	Appio and Creso		0.300
[95]	Italy	Claudio, Creso, Duilio, Simeto and Svevo		0.420
[96]	Italy	Matt, Karalis, Pablo, San Carlo, and Saragolla)		0.280
[97]	Australia	Halberd, Heron, Insignia and Gabo		0.315
[98]	Spain	Anton		0.330

[99]	Australia	Gutha		0.400
[7]	Italy	Marzotto, Libellula, Irnerio, Manital, Centauro, Eridano, Lampo	1969-1994	0.499
[100]	Pakistan	Tijaban-10	2010	0.30-0.38
[101]	Lebanon	Waha and Haurani		0.365
[102]	Turkey and Syria	Bread: Chinese Spring (origin: China), Norin 61 (Japan), Thatcher (UK) and Selkirk (UK)]; Durum: [Pentad (Russia), Golden Ball (UK or France), Langdon (USA) and AC Navigator (Canada)]		0.267
[103]	Turkey	Dicle-74, Gediz-75, Balcali-85, Ege-88, Cham-1, Diyarbakır-81		0.320
[104]	Spain	Gazul		0.440
[105]	Spain	Gazul		0.380
[106]	Algeria	56 genot durum		0.359
[107]	Serbia	Libellula, Sava, Zlatna Dolina, Partizanka, NS rana 2, KG 56, Balkan, Yugoslavia, Skpljanka, Lasta, Evropa 90, Pobeda, NS rana 5, Renesansa, Pesma, Ljljiljana, Cipovka, Dragana, Simonida, NS 40	1962-2006	0.422
[108]	Turkey	Kırik, Tir, Doğu'88, Gerek'79, Hawk, Karasu'90, Lancer, Palandöken'97		0.490
[109]	Australia	Falcon, Gamenya, Darkan, Halberd, Bokal, EgretA, MaddenA, WarimbaA, TincurrinA, Miling		0.354
[35]	Spain	Bokaro, García		0.505
[110]	Australia			0.385
[111]	Italy	Capeiti 8, Creso, Simeto, Valbelice, Iride, Claudio	1955-1998	0.326
[58]	Australia	Heron (1958), Gamenya (1960), Halberd (1969), Condor (1973), Warigal (1978), Spear (1984), Machete (1985), Janz (1989), Frame (1994), Krichauff (1997), Yitpi (1999), Wyalkatchem (2001) and Gladius (2007).	1958-2007	0.390
[112]	Australia	Gamenya, Halberd, Tincurrin, Miling, Gutha, Eradu, Kulin	1960-1984	0.354

[113]	Australia	Gamenya, Condor, Tincurrin, Miling, Aroona, Bodallin, Gutha, Kulin	from 1960	0.361
[23]	Australia	Gamenya, Condor, Miling, Kulin, 79W783, KCD0, KCD1, KCD2	from 1960	0.346
[114]	Spain	https://www.researchgate.net/publication/307473993_S1_Table		0.430
[115]	Turkey	Sardary		0.310
[116]	Turkey	Karahan		0.351
[117]	Italy			0.473
[118]	Turkey	Karatopak		0.308
[119]	Australia			0.370
[120]	Syria	Flk/Hork, Katya, Maya/Sap, Mexipak, Nesser, Rbs/Anza,Seri 82, Vulture		0.341
[121]	Spain	Spanish (Vitrón, Regallo, Gallareta, Bolo, Don Pedro, Sula, Bólido, Dorondón, Murgos, Pelayo, Don Sebastian, Don Ricardo and Kiko Nick) and three European (Simeto, Claudio and Iride from Italy		0.417
[122]	Syria	Cham 4 and Goman, for the first and second growing season		0.340
MEAN				**0.364±0.061**

Table S2. Aerial weed biomass (kg ha^{-1}) of MV under industrialized management.

Authors	Country	Aerial weed biomass
[123]	Australia	373
[124]	Italy	606
[96]	Australia	2420
[97]	Spain	60
[125]	Spain	252
[126]	Spain	149,6
[127]	Turkey	1336
[36]	Spain	1966
MEAN		**895±893**

Table S3. Share of burned residues for wheat (1900-2000).

1900	1910	1922	1933	1940	1950	1960	1970	1980	1990	2000
0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	1.0%	2.2%	3.0%	3.4%	1.1%

Table S4. Field trials soil physic-chemical proprieties at the beginning of the experiment in 2013. Mean values and standard deviation of the mean.

	Sierra de Yeguas (Wheat-faba bean rotation)	**Ronda (One-third rotation)**
CEC*	31.19±2.09	10.55±1.82
Ca exchange *	21.94±1.79	8.23±1.26
Mg exchange*	5.8±1.21	1.76±0.67
Na echange*	1.34±0.16	0.34±0.01
K echange*	2.12±0.11	0.21±0.03
Carbonate (%)	12.27±7.09	2.07±0.31
Limestone (%)	4.61±3.82	0.12±0.14
Assimilable P (ppm)	33.76±9.92	3.98±1.19
MO (%)	2.39±0.24	1.03±0.23
N org (%)	0.16±0.01	0.07±0.01
pH	8.18±0.04	7.66±0.19
ph in ClK	7.46±0.04	6.53±0.23
Assimilable K (ppm)	927±60.93	76.2±3.77
Clay (%)	42.22±2.54	14.28±2.33
Sand (%)	18.66±3.12	75.6±2.91
Silt (%)	39.12±1.89	10.12±1.88
Texture	Clay	Sandy-loam

Different letters in the same raw represent significant differences for each propriety at a significant level of 0.05 (Tukey test)

CEC=cation exchange capacity; OM=organic matter; *(meq/100g).

Table S5. Evolution of Net Primary Productivity (NPP) and partitioning indices of wheat fields in Spain throughout the 20th century

	1900	**1910**	**1922**	**1933**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**2000**
Yield (kg f.m. ha^{-1})	825	885	846	906	651	755	950	1.203	1.538	2.219	2.472
Harvest index	0.232	0.232	0.232	0.232	0.232	0.232	0.298	0.331	0.364	0.364	0.364
Aboveground wheat residues (kg f.m. ha^{-1})	2730	2929	2799	2999	2155	2501	2238	2431	2687	3878	4320
Yield (kg d.m. ha^{-1})* (a)	725	778	743	796	572	664	835	1057	1352	1951	2173
Aboveground wheat residues (kg d.m. ha^{-1}) ** **(b)**	2367	2539	2427	2600	1868	2168	1940	2108	2330	3362	3745
Root:shoot ratio	0.36	0.36	0.36	0.36	0.42	0.40	0.24	0.19	0.20	0.14	0.13
Root biomass (c)	1113	1194	1141	1223	1025	1133	676	587	736	744	754
Aerial weed biomass (d)	562	562	562	562	562	562	729	812	895	895	895
Net Primary Productivity (kg d.m. ha^{-1}) (a+b+c+d)	4768	5073	4874	5180	4028	4527	4180	4565	5313	6952	7568

*87.9% grain dry matter; ** 86.7% straw dry matter (Guzmán et al. 2014)

Table S6. Reconstruction of biomass destinations (kg d.m. ha^{-1}) of Spanish wheat fields (1900-2000)

	1900	1910	1922	1933	1940	1950	1960	1970	1980	1990	2000
Yield	725	778	743	796	572	664	835	1057	1352	1951	2173
Harvested residues	1078	1157	1052	1133	841	1004	1124	1188	1063	1369	1111
Aboveground Unharvested Biomass	1851	1945	1937	2029	1589	1715	1518	1668	2065	2744	3478
Belowground Unharvested Biomass	1113	1194	1141	1223	1025	1133	676	587	736	744	754
Aboveground Unharvested Biomass (without weeds)	1289	1383	1375	1467	1027	1153	789	856	1170	1848	2583
Burned residues	0	0	0	0	0	11	27	64	97	145	51
Net Primary Productivity (with weed)	4768	5073	4874	5180	4028	4527	4180	4565	5313	6952	7568