

Supplementary Materials: Assessment of Agronomic Feasibility of Bioenergy Crops Cultivation on Marginal and Polluted Land: A GIS-Based Suitability Study from Sulcis Area, Italy

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Table S1. Overview of agronomic characteristics of annual biomass crops inventoried in Sardinia.

Crop	Biomass Yield Mg·ha ⁻¹	Humidity	Ferment. Sugar	Fertilizers kg·ha ⁻¹	Mean Irrigation	Soil Detail	Growing Season	Location	Ref.
Globe artichoke ¹	5.6–29.9 * (residual biomass)	~20% (~88% dry organic matter)	n.a.	as conventional practice	as conventional practice	sandy-clay-loam pH 8.3	2014–2015 2 years	Ottava, SS 80 m a.s.l.	[1]
Globe artichoke ²	4.1 (residual heads and biomass)	n.a.	C 39.6% (stalks)	150 N, 80 P ₂ O ₅ , 100 K ₂ O	until first rainfall	sandy-clay-loam pH 8.3	2007 to 2010 3 years	Ottava, SS 80 m a.s.l.	[2]
Milk thistle	16.4	n.a.	C 39.3% (stalks)	35 N (only first year)	non-irrigated	sandy-clay-loam pH 8.3	2007 to 2010 3 years	Ottava, SS 80 m a.s.l.	[2]
Milk thistle	~20	~80%	n.a.	35 N, 100 P ₂ O ₅	non-irrigated	clay-loam calcareous pH 7.5	2006–2007 2 years	North-Sardinia	[3]
Milk thistle	9–16	n.a.	~450 g·kg ⁻¹ (dry matter neutral detergent fiber)	36 N, 90 P ₂ O ₅	non-irrigated	sandy-clay-loam pH 7.5	2011–2011 2 years	North-Sardinia	[4]
Rapeseed ³	1.6 ** (seed)~6 (residues)	n.a.	n.a.	132 N, 92 P ₂ O ₅	non-irrigated	alluvial, deep clay soil layers pH 6.48	2008–2010 2 years	Ottana, NU 187 m a.s.l.	[5]
Ethiopian mustard ⁴	1.1 ** (seed)~10 (residues)	n.a.	n.a.	132 N, 92 P ₂ O ₅	non-irrigated	alluvial, deep clay soil layers pH 6.48	2008–2010 2 years	Ottana, NU 187 m a.s.l.	[5]
Ethiopian mustard ⁵	0.7–4.14 (seed)	n.a.	n.a.	n.a.	non-irrigated	sandy-clay-loam pH 7.9	2008–2010 2 year	Ussana, CA 97 m a.s.l.	[6]
Rapeseed ⁶	~2.03 (seed)	n.a.	n.a.	n.a.	non-irrigated	sandy-clay-loam pH 7.9	2009–2010 1 year	Ussana, CA 97 m a.s.l.	[6]
Maize ⁷	~24 (above-ground biomass–silage) ~7.91	n.a.	n.a.	~290 N (slurry + urea)	4140 m ³ ·ha ⁻¹ –1st year 5740 m ³ ·ha ⁻¹ –2nd year	sandy pH 7.4	2010–2011 2 years	Arborea, OR 7 m a.s.l.	[7]
Triticale ⁸	(above-ground biomass–silage)	n.a.	n.a.	251 N (slurry + urea)	300 m ³ ·ha ⁻¹	sandy pH 7.4	2010–2011 1 years	Arborea, OR 7 m a.s.l.	[7]
Triticale ⁹	~6.2 (grain yield)	n.a.	n.a.	n.a.	non-irrigated	n.a.	between 1995/96 and 2012/13 18 years	Sardinia (20 field experiments)	[8]

Table S1. Cont.

Crop	Biomass Yield Mg·ha ⁻¹	Humidity	Ferment. Sugar	Fertilizers kg·ha ⁻¹	Mean Irrigation	Soil Detail	Growing Season	Location	Ref.
Durum wheat ¹⁰	~5.7 (grain yield)	n.a.	n.a.	n.a.	non-irrigated	n.a.	between 1995/96 and 2012/13 18 years	Sardinia (20 field experiments)	[8]
Durum wheat ¹¹	8.48 (no-tillage) 6.74 (conventional)	13% humidity	n.a.	80 N, 72 P ₂ O ₅	non-irrigated	clay-loam pH 8.5	2013–2014 1 years	Benatzu, CA 80 m a.s.l.	[9]
Durum wheat ¹¹	4 (no-tillage) 4.81 (conventional)	13% humidity	n.a.	80 N, 72 P ₂ O ₅	non-irrigated	sandy-clay-loam pH 7.9	2013–2014 1 years	Ussana, CA 80 m a.s.l.	[9]
Sweet sorghum	16–20 (dry matter) 60 (fresh weight)	n.a.	n.a.	n.a.	n.a.	alfisols, petrocalcic palexeralfs pH 7.8	n.a.	Ussana, CA 97 m a.s.l.	[10]
Globe artichoke	2.7 (dry matter) 4.4 (fresh weight)	n.a.	n.a.	n.a.	n.a.	alfisols, petrocalcic palexeralfs pH 7.8	n.a.	Ussana, CA 97 m a.s.l.	[10]
Milk thistle	1,4	n.a.	n.a.	n.a.	n.a.	alfisols, petrocalcic palexeralfs pH 7.8	n.a.	Ussana, CA 97 m a.s.l.	[10]
Sweet sorghum	36–42 (silage)	n.a.	n.a.	150 N	n.a.	n.a.	2012	S. Nicolò d'Arcidano (OR) 13 m a.s.l.	[11]
Maize ¹²	62 (silage)	n.a.	n.a.	200 N	n.a.	n.a.	2012	S. Nicolò d'Arcidano (OR) 13 m a.s.l.	[11]
Triticale ¹³	4.7	n.a.	n.a.	105 N, 90 P ₂ O ₅	non-irrigated	sandy-clay-loam pH 8.3	2012–2013	Ottava, SS 80 m a.s.l.	[12]
Triticale ¹³	3.8	n.a.	n.a.	100 N, 92 P ₂ O ₅	non-irrigated	alfisols, petrocalcic palexeralfs pH 7.8	2012–2013	Ussana, CA 97 m a.s.l.	[12]
Maize ¹⁴	19.62 (dry matter) 56.06 (fresh weight)	~63%	n.a.	200 N, 110 P ₂ O ₅	as conventional practice	clay	2003	Arborea, OR 7 m a.s.l.	[13]

Notes: ¹ Field trial of 5 varieties: 'Madrigal', 'Spinoso sardo', 'C3', 'Tema', 'Violetto'; ² Field trial of 'Spinoso sardo' variety; ³ Field trial of 4 varieties; ⁴ Field trial of 2 varieties; ⁵ Field trial of 5 varieties; ⁶ Field trial of 34 varieties; ⁷ Field trial of 'FAO class 700' in 2010, and 'FAO class 600' in 2011; ⁸ Field trial of 'Agrano' variety; ⁹ Field trial (long term) of 85 varieties; ¹⁰ Field trial (long term) of 131 varieties; ¹¹ Field trial of 26 varieties; ¹² Field trial of 'FAO class 600'; ¹³ Field trial of 28 varieties; ¹⁴ Field trial of 16 'FAO class 700, 600 and 500'; * Results for the best performing cultivar 'Madrigal'; ** Results affected by adverse weather conditions.

Table S2. Overview of agronomic characteristics of perennial biomass crops inventoried in Sardinia.

Crop	Biomass Yield Mg·ha ⁻¹	Humidity	Ferment. Sugar	Fertilizers kg·ha ⁻¹	Mean Irrigation	Soil Detail	Growing Season	Location	Ref.
Eucalyptus clones ¹	20–34 (aboveground biomass)	n.a.	n.a.	n.a.	non-irrigated	sandy-clay, pH 7.88	2004–2005 2 years	Massama, OR 9 m a.s.l.	[14]
Smilo grass ²	29.9–45.5 (aboveground biomass)	n.a.	~39% cellulose ~26% hemicel. 8% lignin (leaves)	no fertilizers	non-irrigated (50 mm after transplanting)	sandy-clay-loam, pH alkaline	2013–2014 2 years	Leccari, SS 27 m a.s.l.	[15]
Tall fescue ³	26.1 (aboveground biomass)	n.a.	44.1% cellulose 21.9% hemicel. 5.8% lignin (leaves)	no fertilizers	1st year (50 mm after transplanting)	sandy-clay-loam, pH alkaline	2013–2014 2 years	Leccari, SS 27 m a.s.l.	[15]
Ryegrass ⁴	0.9–3.5 (cutted once on July 2008)	n.a.	n.a.	36 N, 92 P ₂ O ₅ (1st year)	non-irrigated	calcareous	2006–2009 3 years	Ottava, SS 80 m a.s.l.	[16]
Tall fescue ⁵	~3.6 (1st year) ~8.6 (2 nd year) ~6.7 (3 rd year)	~54% (summer leaf bases water content)	n.a.	44 N, 46 P ₂ O ₅ (before sowing) 75 N (every year)	non-irrigated	calcareous sandy-loam soil, pH 7.7	2004–2007 3 years	Ottava, SS 80 m a.s.l.	[17]
Cocksfoot ⁶	~2.1 (1st year) ~4.6 (2 nd year) ~4.8 (3 rd year)	~48% (summer leaf bases water content)	n.a.	44 N, 46 P ₂ O ₅ (before sowing) 75 N (every year)	non-irrigated	calcareous sandy-loam soil, pH 7.7	2004–2007 3 years	Ottava, SS 80 m a.s.l.	[17]
Cocksfoot ⁷	~20 (irrigated) ~16 (rainfed)	n.a.	n.a.	50 N, 150 P ₂ O ₅ , 100 K ₂ O	360 mm	clay-loam, pH 8	1996–1998 3 years	Sanluri, Ca 68 m a.s.l.	[18]
Cardoon ⁸	10.4	n.a.	C 41% (stalks)	80 N, 100 P ₂ O ₅	non-irrigated	sandy-clay-loam, pH 8.3	2007–2010 3 years	Ottava, SS 80 m a.s.l.	[2]
Cardoon	4.6	n.a.	n.a.	n.a.	n.a.	alfisols, petrocalcic palexeralfs, pH 7.8	n.a.	Ussana, CA 97 m a.s.l.	[10]
Cardoon	20–23	8%–32%	n.a.	36 N, 90 P ₂ O ₅	non-irrigated	sandy-clay-loam, pH alkaline	2013–2014 2 years	Leccari, SS 27 m a.s.l.	[19]
Cardoon	10–12	85% dry matter	n.a.	50 N 100 N	non-irrigated	fertile soil	1993–1996 2 years	Uras, OR 10 m a.s.l.	[20]
Giant red	7–10 (dry matter)	15 (fresh weight)	n.a.	n.a.	n.a.	alfisols, petrocalcic palexeralfs, pH 7.8	n.a.	Ussana, CA 97 m a.s.l.	[10]
Miscanthus	1.3 (1st year) 8.9 (2 nd year)	~47%	n.a.	36 N, 90 P ₂ O ₅	non-irrigated	sandy-clay-loam, pH alkaline	2013–2014 2 years	Leccari, SS 27 m a.s.l.	[19]
Giant reed	5.1 (1st year) 24.6 (2 nd year)	~50%	n.a.	36 N, 90 P ₂ O ₅	non-irrigated	sandy-clay-loam, pH alkaline	2013–2014 2 years	Leccari, SS 27 m a.s.l.	[19]
Giant reed	~2	~50%	C 47.3%	50 N, 130 P ₂ O ₅ , 130 K ₂ O (only first year)	350 mm only first year	sandy marginal land	1994–1998 4 years	Palmas Arborea, OR 5 m a.s.l.	[21]
Giant reed	~1.6	~47%	C 47.3%	96 P ₂ O ₅ (only first year)	40 mm only first year	fertile soil	1997–1998 1 years	Solarussa, OR 5 m a.s.l.	[21]
Giant reed ⁹	25.56	~47%	n.a.	100 N, 175 P ₂ O ₅	~500 mm	sandy loan	2013–2016 2 years	Masainas, CA 5 m a.s.l.	[22]

Table S2. Cont.

Crop	Biomass Yield Mg·ha ⁻¹	Humidity	Ferment. Sugar	Fertilizers kg·ha ⁻¹	Mean Irrigation	Soil Detail	Growing Season	Location	Ref.
Giant reed ⁹	17.45	~42%	n.a.	100 N, 175 P ₂ O ₅	600 mm	sandy-clay-loam	2013–2016 2 years	Serramanna, Ca 38 m a.s.l.	[22]
Giant reed ⁹	5.6	~52%	n.a.	100 N, 175 P ₂ O ₅	n.a.	clay	2014–2016 1 years	Tratalias, Ca 17 m a.s.l.	[22]
Switchgrass	8.44 (fresh biomass)	~50%	n.a.	100 N, 175 P ₂ O ₅	600 mm	sandy-clay-loam	2013–2016 2 years	Serramanna, Ca 38 m a.s.l.	[22]
Eucalyptus globulus	52.8 (3 × 2 plot) 68.4 (3 × 1 plot)	10%	C 47.1%	50 N, 130 P ₂ O ₅ , 130 K ₂ O (only first year)	26 mm only first year	sandy marginal land	1994–1998 4 years	Palmas Arborea, OR 5 m a.s.l.	[21]
Eucalyptus globulus	268 (wood) 92 (residual)	11%	n.a.	n.a.	non-irrigated	sandy marginal land	1977–1998 21 years	Marrubiu, OR 20 m a.s.l.	[21]

¹ Field trial of 5 clones of eucalypt compared with *Eucalyptus camaldulensis*. Detected the presence of the invaders eucalyptus gall wasps; ² Field trial of 10 autochthonous populations; ³ Field trial of cultivar Flecha; ⁴ Field trial of 11 native populations; ⁵ Field trial of 5 cultivars from Mediterranean semi-arid areas; ⁶ Field trial of 6 cultivars and 1 ecotype from Mediterranean semi-arid areas; ⁷ Field trial of 8 cultivars; ⁸ Field trial of ‘Bianco Avorio’ variety; ⁹ Field trial with local ecotype, propagated with rhizomes.

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