

Supplementary Information

Accompanying Data

Table S1. Material Intensity of EU energy mix and truck [1].

Flows	Unit	Abiotic material	Biotic material	Water	Air	Moved soil
Electrical power, EU	kg/kWh	1.72	0	32.53	0.44	0
Truck	kg/km·t	0.218	0	1.91	0.209	0

Table S2. Data on materials inputs for crops production along the supply chain [2–5].

Crop	Agr. Practice	Average yield (1)	sEed amount	N-fert.	P-fert.	K-fert.	Pesticides/herbicides (active ingredient)	Diesel for field operation and drying	Water	Harvest factor
		kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	m ³ /ha	kg/kg
<i>Cereals</i>										
Wheat *	O	4,258	280	0	0	0	0	158	0	1.7
Barley	C	6,000	125	260	222	250	0.8	169	0	1.84
Barley	O	4,500	126	0	0	0	0	144	0	1.84
Oats	C	5,000	175	260	222	250	0.7	169	0	1.84
Oats	O	3,750	175	0	0	0	0	144	0	1.84
Rye	C	4,000	140	130	222	250	0.7	169	0	1.84
Rye	O	3,000	140	0	0	0	0	144	0	1.84
Maize (dried)	C	8,680	20	598	222	167	2.4	490	4,500	2.4
Sorghum (dried)	C	7,172	12.5	326	222	167	1.2	378	0	2.4
Sorghum (dried)	O	5,379	12.5	0	0	0	0	378	0	2.4
<i>Dried pulses</i>										
Field bean	C	3,000	200	109	200	208	0.65	155	0	1.84
Field bean	O	2,250	200	0	0	0	0	155	0	1.84
Bean (dried)	C	2,500	70	56	200	125	0.65	423	0	1.84
Bean (dried)	O	1,875	70	0	0	0	0	423	0	1.84
Peas (dried)	C	3,750	180	56	156	0	0.65	418	0	1.84
Peas (dried)	O	2,812	180	0	0	0	0	418	0	1.84
<i>Silages, hay and green fodders</i>										
Lucern hay	C	10,000	35	60	278	317	0.6	390	667	4.5
Lucern hay	O	7,500	35	0	0	0	0	390	0	4.5
Clover hay	C	11,000	7	60	222	167	0.6	376	2,000	4.5
Clover hay	O	8,250	7	0	0	0	0	376	0	4.5
Maize silage	C	55,000	25	598	222	167	2.4	371	4,500	1
Sorghum silage	C	40,000	30	239	222	167	1.2	371	3,375	1
Sorghum silage	O	30,000	30	0	0	0	0	371	3,375	1
Barley grass	C	30,000	135	260	222	250	0.8	187	0	1
<i>Silages, hay and green fodders</i>										
Meadows grass	C	5,000	0	0	0	0	0	238	0	1.5
Sorghum grass	C	55,000	30	543	244	167	1.2	177	3,375	1

Table S2. Cont.

Crop	Agr. Practice	Average yield (1)	sEed amount	N-fert.	P-fert.	K-fert.	Pesticides/herbicides (active ingredient)	Diesel for field operation and drying	Water	Harvest factor
		kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	m ³ /ha	kg/kg
<i>Vegetables</i>										
Tomato (crop cycle of 90 days)	CG	100,000	25,000	498	231	312	6.79	618	2,900	1
	CF	90,000	25,000	413	244	292	6.1	618	2,610	1
	IF	90,000	25,000	0	0	0	3.05	618	2,610	1
Lettuce (crop cycle of 90 days)	CG	40,000	10,000	217	375	267	2.7	655	1,160	1
	CF	25,000	10,000	174	292	214	1.7	655	725	1
	IF	25,000	10,000	0	0	0	0.85	655	725	1

Notes: C: conventional; O: organic; G: greenhouse production; I: integrated agriculture; F: open field production; (1) for polyannual crops, *i.e.*, lucern and clover hay, yield is intended in annual production per ha; * Material intensity of conventional wheat has been calculated in Mancini *et al.* [6].

Table S3. Data on materials and energy consumption for greenhouse construction and management [4].

Flows	Weight (kg)	Lifespan (years)	Use
Stainless steel	15,937	20	Windows structure, intern pillars, channels for water gathering
Polyvinyl chlorid	188	10	Pipes
Concrete	110	20	Structure
Low density polyethylene	1,256	3	Plastic cover
Polycarbonate	12	12	Cover plate, door
Distance of materials' transport (km)		400	
Energy for building up (MJ/m ²)		0.128	
Diesel for air conditioning (L/m ³ ·month)		1.6	

Table S4. Data on materials and energy inputs used for milk production [7].

Flows	Unit	Amount
Annual milk production	kg	2,717,550
Weaning female calves		
Duration	days	90
Milk	kg/head·day	32
Milk powder	kg/head·day	4
Water	kg/head·day	48.33
Lucerne hay	kg/head·day	1
Weaning male calves		
Duration	days	20
Milk	kg/head·day	48
Yearlings nutrition		
Duration	days	750
Lucerne hay	kg/head·day	10.91
Concentrate fodder	kg/head·day	4.1
Water	kg/head·day	150

Table S4. *Cont.*

Flows	Unit	Amount
Cows nutrition		
Duration	days	1,372
Lucerne hay	kg/head·day	17
Concentrate fodder	kg/head·day	16.5
Water	kg/head·day	150
Milking		
Duration	Hours/year	5,490
Natural gas	kg/year	2,247
Electricity	kWh/year	34,009
Water	kg/year	1,647,000
Stable maintenance		
Water	kg/year	2,869
Electricity	kWh/year	64,706
Heating oil	kg/year	1,373

Table S5. Data on materials and energy inputs used for Parmesan production [7].

Input	Unit	Amount
Skimmed milk	kg/kg of Parmesan	6.25
Whole milk	kg/kg of Parmesan	6.95
Diesel	kg/kg of Parmesan	0.153
Salt	kg/kg of Parmesan	5.54×10^{-5}
Polyethylene film	kg/kg of Parmesan	4.94×10^{-4}
Deionised water	kg/kg of Parmesan	7.31×10^{-5}
Tap water	kg/kg of Parmesan	5.54×10^{-5}
Electricity	kWh/kg of Parmesan	0.42
Natural gas	kg/kg of Parmesan	0.03

Table S6. Data on the production of organic and conventional beef.

Feature	Organic beef	Conventional beef
Italian geographic area	North-West (Liguria, Val Bormida), mountain	North-East (Veneto), plain
Livestock density	0.68 LAU/ha	9 LAU/ha
Stabulation	summer pasture	permanent
Reproductive cycle	close	open
Agricultural practice	organic	conventional
		maize silage
	lucerne hay	maize grain
Fodders	grass meadows hay	soybean from Brazil
	pastures	wheat straw and bran
		pulps from sugar beet
Main literature reference	Montanari <i>et al.</i> [8]	Borsotto <i>et al.</i> [9]

Table S7. Data on consumptions for stable maintenance and slaughtering [10].

Process	Unit	Amount
Electricity consumption for 50 head stable	kWh/year	1800
Diesel consumption for stable	kg/LAU	42
Water consumption for slaughtering	kg/tons of carcass	5500
Electricity consumptions for slaughtering	kg/tons of carcass	350

Table S8. Data on materials and energy inputs used for pasta production and packaging [11].

Inputs	Unit	Amount
Water	kg/kg of semolina	0.2
Natural gas	kg/kg of semolina	0.00021
Pasta production		
Semolina	kg/kg of pasta	0.99
Electricity	kWh/kg of pasta	0.18
Water	kg/kg of pasta	1.53
Natural gas	kg/kg of pasta	0.027
Packaging		
PVC (Polyvinyl chloride)	kg/kg of pasta	2.7×10^{-7}
PP (Polypropylene)	kg/kg of pasta	0.067
Electricity	kWh/kg of pasta	0.01

Table S9. Outputs obtained by 1 ha of polycultural land. Data have been directly acquired through questionnaires to the UPM farmers.

Outputs	Species	Annual yields (kg/ha)
Fruits	Hazelnut (<i>Corylus avellana</i>)	20
	Raspberry (<i>Rubus idaeus</i>)	15
	Strawberry tree (<i>Arbutus unedo</i>)	10
	Blackberry (<i>Rubus ulmifolius</i>)	5
	Apple (<i>Malus domestica</i>)	550
	Pear (<i>Pyrus communis</i>)	490
	Plum (<i>Prunus domestica</i>)	420
	Peach (<i>Prunus persica</i>)	250
	Apricot (<i>Prunus armeniaca</i>)	170
	Walnut (<i>Juglans regia</i>)	75
Vegetables	Melon (<i>Cucumis melo</i>)	197
	Artichoke (<i>Cynara cardunculus</i>)	30
	Edible herbs	540
	Carrots (<i>Daucus carota</i>)	1,494
	Lettuce (<i>Lactuca sativa</i>)	615
	Onion (<i>Allium cepa</i>)	976
	Headed cabbage (<i>Brassica oleracea</i>)	797
	Celery (<i>Apium graveolens</i>)	108
	Chard (<i>Beta vulgaris</i>)	316
	Parsley (<i>Petroselinum crispum</i>)	17.5
Radish (<i>Raphanus sativus</i>)	163	

Table S9. *Cont.*

Outputs	Species	Annual yields (kg/ha)
Vegetables	Cucumber (<i>Cucumis sativus</i>)	196
	Pumpkin (<i>Cucurbita</i> spp.)	178
	Zucchini (<i>Cucurbita pepo</i>)	850
	Cauliflower (<i>Brassica oleracea</i>)	230
	Leek (<i>Allium porrum</i>)	170
	Chicory (<i>Chicorium intybus</i>)	497
	Cabbage (<i>Brassica oleracea</i>)	994
Grain legumes	Beans (<i>Phaseolus vulgaris</i>)	100
	Peas (<i>Pisum sativum</i>)	300
	Green beans (<i>Phaseolus vulgaris</i>)	200
Cereals	Barley (<i>Hordeum vulgare</i>)	135
Total		11,111

Table S10. Yields of main crops and sub-products in Ma-Pi polyculture. Data have been directly acquired through questionnaires to the UPM farmers.

Crop/Foodstuff	Yield of main crop (kg/ha)	Intercropped plants	Yield (kg/ha)
Whole rice	3400	Horsetail	-
		Willow	2500 (firewood)
		Reeds	-
Wheat for couscous	2300	Almond	600
		Olives	700
Millet	1800	Chickpea	45
Barley	1560	Apple trees	1500
		Pear trees	900
		Grapes	600
		walnut	220
		artichoke	80
Beans	1800	Maize	1400
		Pumpkins	3000
		Wild edible herbs	230

Table S11. Data on material and energy inputs used for products from Ma-Pi polyculture. Data have been directly acquired through questionnaires to the UPM farmers.

Crop/Foodstuff	Diesel consumptions (kg/ha)	Water consumptions (kg/kg)	Maximum ploughing depth (cm)	Electricity consumptions (kWh/kg)
Whole rice	84.15	285	20	-
Cous-cous	34.85	0.18	15	1.13
Millet	10.2	-	25	82
Barley	63.75	-	25	-
Beans	85.85	186	30	-

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