Supplementary Material for

Greedy or needy? Land use and climate impacts of food in 2050 under different potential livestock futures

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S1. Regional land use and greenhouse gas results

Table S1 shows the regional results for the yearly per capita use of cropland and pasture and greenhouse gas (GHG) emissions for the projected diets (PD) and the healthy diets (HD) for the different livestock scenarios. Yield gaps assumed to be closed to 50% and waste reduced by 50% compared to current levels.

The regional results show that two regions, South Asia and Sub-Saharan Africa, will not be about to produce the food needed for the projected population in 2050 on the currently used cropland under any scenario and for East Asia only for the projected (not the healthy) diet in the case of a future based on artificial meat (ART) under the assumption that this meat will not require any cropland. For Central Asia, Latin America and North Africa currently used cropland will not suffice for INT scenario for the projected diet but for all other scenarios it will for both diet variants. For South-east and West Asia currently used cropland only suffice for the ART, PBE and EL scenarios (and the healthy diet for the IDP scenario in case of South-east Asia).

On the other hand, regions with plenty of cropland available after providing for the projected population in these regions are East Europe, North America and Oceania.

Table S1. Per capita use of cropland and pasture for the projected diet (PD) and the healthy diet (HD) for different livestock scenarios. Yield gaps assumed to be closed to 50% and waste reduced by 50% compared to current levels. Cropland area marked in red for scenarios for which currently available cropland would not suffice for that region.

		INT		IDP		IDA		ART		PBE		EL	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
East Europe													
Cropland, ha	0.79[1]	0.31	0.23	0.23	0.21	0.23	0.22	0.082	0.11	0.11	0.13	0.092	0.11
Pasture, ha	0.47[1]											0.47	0.18
GHG, ton CO_2e		0.52	0.32	0.29	0.27	0.27	0.26	0.060	0.076	0.075	0.086	0.47	0.27
Western Europe													
Cropland, ha	0.20[1]	0.20	0.13	0.17	0.13	0.17	0.13	0.058	0.065	0.085	0.081	0.073	0.070
Pasture, ha	0.13[1]											0.13	0.12
GHG, ton CO_2e		0.53	0.25	0.32	0.22	0.28	0.23	0.044	0.052	0.060	0.061	0.28	0.25
Central Asia													
Cropland, ha	0.37[1]	**0.61**	0.26	0.26	0.22	0.26	0.23	0.12	0.14	0.15	0.15	0.13	0.14
Pasture, ha	2.92[1]											2.92	0.16
GHG, ton CO_2e		1.1	0.41	0.34	0.31	0.32	0.31	0.099	0.11	0.11	0.12	2.56	0.32
East Asia													
Cropland, ha	0.08[1]	**0.22**	**0.12**	**0.21**	**0.13**	**0.21**	**0.13**	0.078	**0.082**	**0.11**	**0.096**	**0.10**	**0.091**
Pasture, ha	0.32[1]											0.31	0.027
GHG, ton CO_2e		0.57	0.26	0.25	0.23	0.21	0.21	0.15	0.17	0.17	0.18	0.51	0.25

South Asia													
Cropland, ha	0.10[1]	**0.24**	**0.24**	**0.20**	**0.20**	**0.20**	**0.21**	**0.12**	**0.12**	**0.14**	**0.14**	**0.13**	**0.17**
Pasture, ha	0.03[1]											0.034	0.034
GHG, ton CO_2e		0.54	0.50	0.39	0.38	0.39	0.37	0.19	0.17	0.20	0.28	0.32	0.28
South-east Asia													
Cropland, ha	0.14[1]	**0.19**	**0.15**	**0.16**	0.14	**0.17**	**0.15**	0.090	0.10	0.11	0.11	0.11	0.11
Pasture, ha	0.02[1]											0.022	0.009
GHG, ton CO_2e		0.54	0.35	0.31	0.28	0.29	0.27	0.26	0.24	0.27	0.25	0.36	0.29
West Asia													
Cropland, ha	0.11[1]	**0.22**	**0.18**	**0.16**	**0.15**	**0.16**	**0.16**	0.090	0.084	0.11	0.10	0.093	0.091
Pasture, ha	0.61[1]											0.61	0.11
GHG, ton CO_2e		0.49	0.36	0.26	0.25	0.25	0.24	0.087	0.078	0.098	0.088	0.74	0.25
Latin America													
Cropland, ha	0.24[1]	**0.25**	0.18	0.18	0.16	0.18	0.17	0.069	0.086	0.095	0.11	0.077	0.095
Pasture, ha	0.72[1]											0.72	0.082
GHG, ton CO_2e		0.69	0.37	0.27	0.27	0.25	0.26	0.091	0.10	0.11	0.12	0.92	0.26
North America													
Cropland, ha	0.47[1]	0.26	0.18	0.20	0.15	0.21	0.17	0.075	0.066	0.11	0.087	0.088	0.075
Pasture, ha	0.60[1]											0.60	0.27
GHG, ton CO_2e		0.62	0.38	0.30	0.24	0.28	0.23	0.057	0.055	0.073	0.066	0.46	0.26
Sub-Saharan Africa													
Cropland, ha	0.11[1]	**0.32**	**0.26**	**0.18**	**0.20**	**0.18**	**0.20**	**0.15**	**0.16**	**0.16**	**0.17**	**0.15**	**0.17**
Pasture, ha	0.35[1]											0.35	0.013
GHG, ton CO_2e		0.54	0.36	0.20	0.19	0.19	0.19	0.14	0.14	0.15	0.15	0.60	0.20
North Africa													
Cropland, ha	0.16[1]	**0.20**	0.16	0.14	0.13	0.14	0.14	0.086	0.084	0.10	0.098	0.089	0.088
Pasture, ha	0.53[1]											0.53	0.089
GHG, ton CO_2e		0.51	0.38	0.25	0.24	0.24	0.24	0.086	0.080	0.094	0.087	0.67	0.23
Oceania													
Cropland, ha	0.88[1]	0.50	0.31	0.31	0.27	0.32	0.29	0.12	0.14	0.16	0.17	0.12	0.15
Pasture, ha	6.5[1]											6.5	0.17
GHG, ton CO_2e		0.94	0.46	0.41	0.36	0.35	0.35	0.090	0.12	0.11	0.13	5.3	0.32

1 Per capita available cropland and pasture land in the region

S2. Calculations of land use

S2.1 Livestock-As-Usual

The land use results for the Livestock-As-Usual (LAU) scenario was taken from Bajželj et al. (2014). The scenarios in the Bajželj et al. (2014) were adjusted to yield gap closure of 50% and to exclude fallow land and cultivation of crops for non-food uses (biofuel, cotton *etc.*) hence showing only the land needed to produce the food for the projected population in 2050.

S2.2 Intensive Livestock

A detailed description of how land use was calculated is given for the IDP scenario in section S2.3. Steps [1]-[22] apply to the Intensive Livestock (INT) scenario as well. The amount of projected beef meat not supplied by the dairy system is assumed to be produced in a suckler cow/calf system described in section S3.1. Production of pig and poultry meat, egg and farmed seafood (deducted by the amount of seafood from wild fisheries) is also described in section S3.1. From the total amounts of animal products needed per year, the total amount of animals needed was calculated and from this the yearly amounts of feed needed. By using the yields for different feed crops for different regions the amount of land needed for feed production was calculated (see section 2.3 for more details).

S2.3 Intensive Dairy and Poultry

Figure S1 illustrates the steps in calculating the land use for the Intensive Dairy and Poultry scenario. The steps are explained and data sources are given here:

[1] Plant based foods; vegetables, fruits, sugar, vegetable oil, wheat, rice, maize, other grains, roots, pulses and other crops, in the per capita diet given in energy units (kcal/day). The diet is based on current diets from FAO 2009 statistics; (FAO, 2015) and projected changes according to FAO (Alexandratos & Bruinsma, 2012). For diets consumed see Table S10-S33 in section S6.
[2] The energy content of individual food items is used to translate the food in the diet in energy units (kcal/day) to mass of food consumed per day (kg/day). Energy content was calculated based on data in FAO Food Balance Sheets for the different regions (FAO, 2015).
[3] Amount of different plant-based foods in the per capita diet in kg/day. Calculated with [2].
[4] Wastes and losses in agricultural production, postharvest handling and storage, processing and packaging, distribution and retail and consumption. Weight percentages according to Annex 4 in FAO (2011).
[5] Per capita needed supply of different plant-based foods (kg/day) after accounting for wastes and losses, calculated with [4].

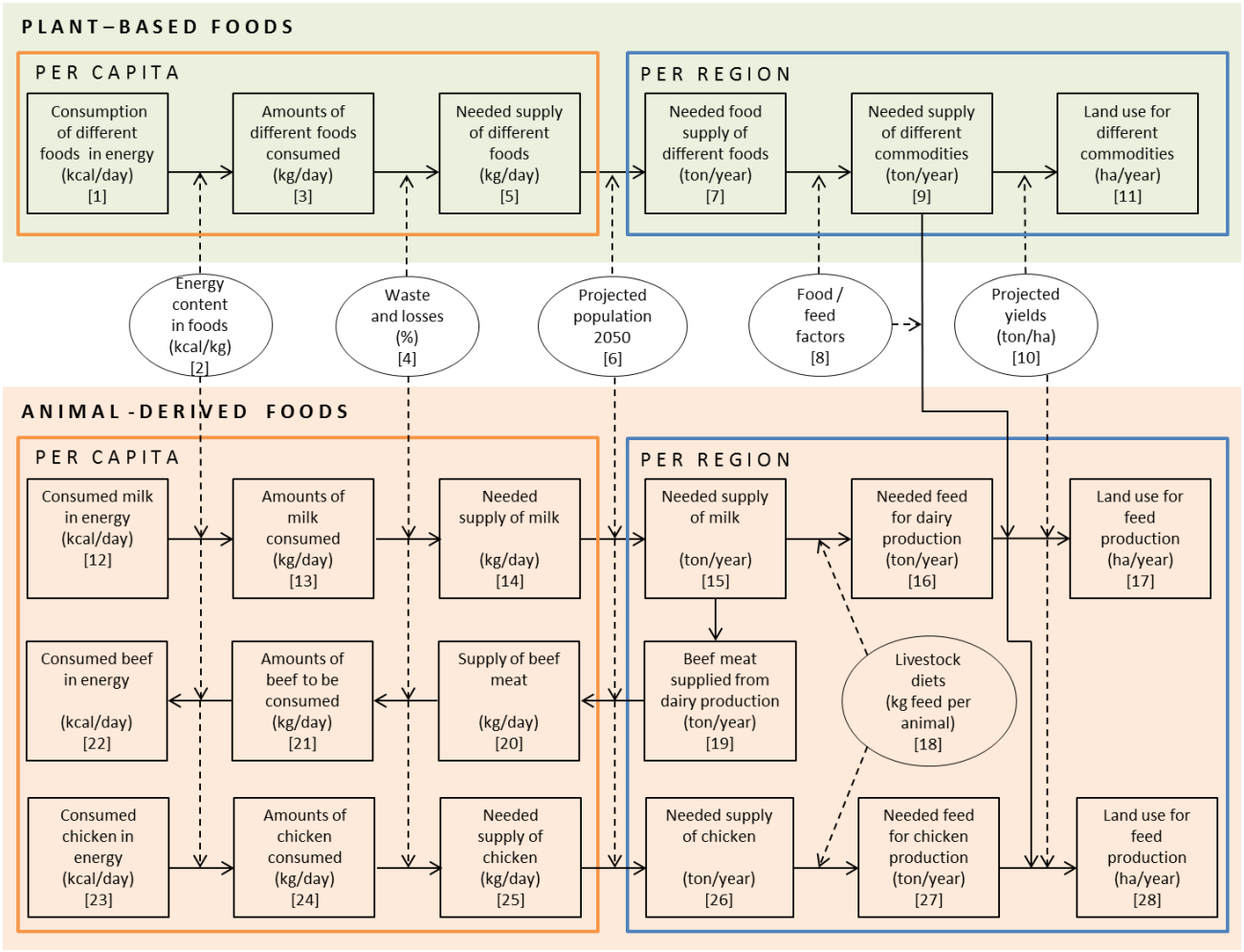

Figure S1. Illustration of the steps in calculating the land use for the Intensive Dairy and Poultry scenario.

[6] Populations in 2050 as projected by UN (2012).

[7] Needed plant-based food supplies for the whole region in ton/year. Calculated by multiplying the per capita food supplies for different foods in [5] with [6] and 365.

[8] Part of agricultural commodity that is used for food and feed respectively *e.g.* for wheat 78% is used for food and 22% as feed. Data from Annex 3 FAO (2011). It is assumed that all that is not used for food is used for feed (waste of feed in livestock production is accounted for, but assumed to be cut by 50% as all other waste).

[9] Calculated amounts of agricultural commodities needed to supply the food items in [7]. Calculated with [8].

[10] Yields for different commodities and regions in 2009 and assuming that yield gaps are closed to 50%. Data from Supplementary Table 8 in Bajželj et al. (2014).

[11] Land use for different commodities, calculated by dividing [9] by [10]. Allocation of land use for crops for food and feed was made on a mass basis *e.g.* 35% of the land use for soy was allocated to the category 'plant-based foods' to represent the land use for the oil, while 65% of the land use was allocated to feed (oil seed cake).

[12] Per capita milk consumed in kcal/day.

[13] Per capita milk consumed in kg/day, calculated with [2].

[14] Per capita needed supply of milk (kg/day) after accounting for wastes and losses, calculated with [4].
[15] Needed milk for the whole region in ton/year. Calculated by multiplying the per capita milk [14] with [6] and 365.
[16] The yearly amount of feed needed in dairy production to supply the milk in [15].
[17] Land use for feed for dairy production, calculated by dividing [16] by [10]. By-products supplied from the production of plant-based foods are also used as feed and decreases the land use for feed.
[18] Livestock diets, see section S3 for more information on animal production.
[19] The yearly amount of beef meat (ton carcass weight) supplied from the dairy cows and their off-spring.
[20] Yearly supply of beef meat per capita from dairy production, calculated by dividing [19] by [6].
[21] Yearly per capita amount of beef meat available for consumption after losses [4] in kg/day.
[22] Yearly per capita amount of beef meat available for consumption after losses [4] in kcal/day, calculated from [21] with [2].
[23] Per capita amount of poultry in kcal/day. This amount is calculated as total kcal in animal derived foods in the INT scenario (red meat, poultry, egg, milk and fish) minus the amount of kcal supplied through milk, wild seafood and beef meat from the dairy production in this scenario [22]
[24] Amount of poultry in the per capita diet in kg carcass weight/day. Calculated with [2].
[25] Per capita needed supply of poultry (kg/day) after accounting for wastes and losses, calculated with [4].
[26] Needed poultry for the whole region in ton/year. Calculated by multiplying the per capita poultry needed [25] with [6] and 365.
[27] The yearly amount of feed needed in poultry production.
[28] Land use for feed for poultry production, calculated by dividing [27] by [10]. By-products supplied from the production of plant-based foods are also used as feed and decreases the land use for feed.

S2.4 Intensive Dairy and Aquaculture

The land use for the Intensive Dairy and Aquaculture scenario is calculated as for the Intensive Dairy and Poultry scenario described in section S2.3 with the following exception starting from step [23]: Instead of poultry, seafood is produced out of which 20% is from filter feeders and the rest from the cultivation of Tilapia (see section S3.1 for details). However, since seafood has considerably lower energy content per kg than meat the same amount in kg of seafood as chicken in the Intensive Dairy and Poultry scenario is included in the diet but not more, in order not to supply very large quantities of seafood and hence protein. In order to supply the same amount of energy in the diet some vegetable oil is additionally supplied.

S2.5 Artificial Meat

The land use for the Artificial Meat scenario is calculated as for the Intensive Dairy and Poultry scenario described in section S2.3 up until and including step [11]. All animal based food calories are in this scenario supplied by artificial meat. It is assumed that no agricultural land is needed in the production of the artificial meat feedstock.

S2.6 Plant Based Eating

The land use for the Plant Based Eating scenario is calculated as for the Intensive Dairy and Poultry scenario described in section S2.3 up until and including step [11]. All animal based food calories are in this scenario supplied by pulses and cereals. Land use for these is then calculated as for the other plant-based foods.

S2.7 Ecological Leftovers

Figure S2 illustrates the steps in calculating the land use for the Ecological Leftovers scenario. Steps [1] – [21] are the same as for the Intensive Dairy and Poultry scenario described in section S2.3 with the exception that dairy production is based on 'ecological leftovers' (see section S3.2 and S5).

[22] This is the feed from 'ecological leftovers' (*i.e*. grazed biomass and byproducts) remaining after dairy production and that are hence available for beef production using suckler herds
[23] Beef meat from suckler herds that can be produced from the ecological leftovers in the region (ton carcass weight/year). In some regions all available ecological leftovers are used in dairy production and then no beef will be produced using suckler herds.
[24] Yearly supply of beef meat per capita from suckler herds, calculated by dividing [23] by [6].
[25] Yearly per capita amount of beef meat from suckler herds available for consumption after losses [4] in kg/day.
[26] Yearly per capita amount of beef meat from suckler herds available for consumption after losses [4] in kcal/day, calculated from [25] with [2].
[28] Ecological Leftovers - food waste and byproducts from the production of plant based foods - available for pig production.
[27] Land use needed to produce cereals to complement pig diets. Calculated using [10].
[29] Pig meat that can be produced from the ecological leftovers in the region (ton carcass weight/year)
[30] Per capita supply of pig meat (kg/day), calculated from [29] divided by [6]
[31] Per capita consumption of pig meat after losses (kg/day)
[32] Per capita consumption of pig meat after losses (kcal/day)

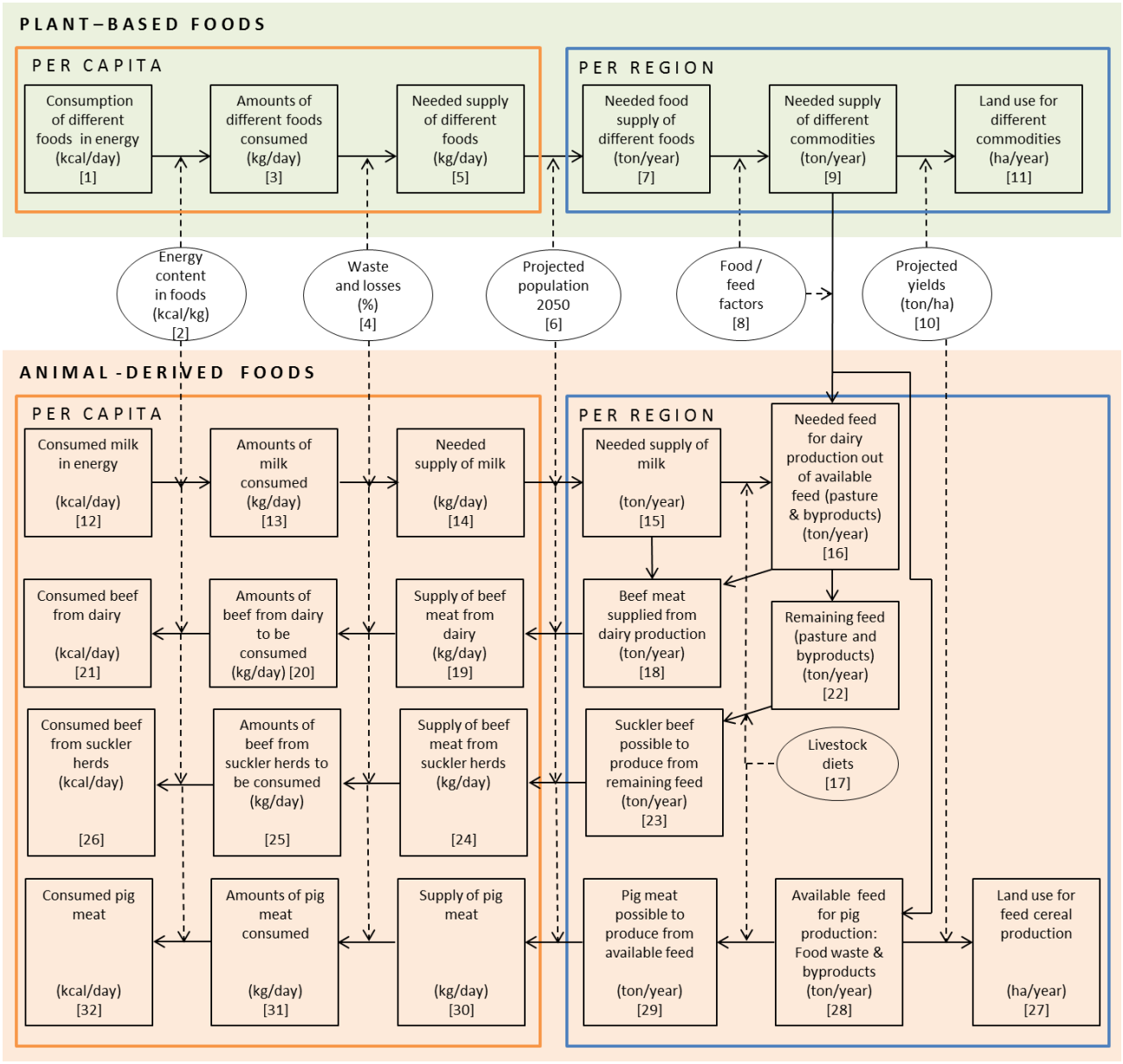

Figure S2. Illustration of the steps in calculating the land use for the Ecological Leftovers scenario.

S3. Animal production systems

S3.1 Intensive livestock production systems

In the INT, IDP and IDA scenarios, terrestrial livestock production were assumed to be intensified to a level that they resemble highly intensive systems currently used in industrialized countries, but without the use of hormone implants or use of antibiotics or other similar substances for growth promoting reasons. Current actual or modelled best practice systems in Sweden were used to represent these systems based on Cederberg et al. (2009), Bertilsson et al. (2014) and Spörndly (2003). Production parameters such as fertility and mortality rates, losses of milk in stables etc. were assumed to be improved by 50% from current levels.

For aquaculture, 80% of production is assumed to be low trophic-level finfish produced in high yielding closed recirculating systems (calculations are based on Nile tilapia) (Little et al., 2008). 20% is supplied by mussels, oysters and other filter feeding, extractive bivalve species which do not require feed inputs.

Production parameters for monogastric animal production is summarized in Table S2.

Table S2. Production parameters for monogastric livestock production in the INT, IDP and IDA scenarios. Data for terrestrial livestock are based Cederberg et al. (2009) and Bertilsson et al. (2014) unless otherwise stated. For aquaculture production (Tilapia) data is estimated based on Pelletier et al. (2010).

	Egg	Chicken	Pig	Aquaculture (Tilapia)
Feed conversion ratio	2[1] 20 kg egg per hen	1.8[2]	3[2]	1.7[2]
Feed composition	70% cereals 10% oil cake[3] 20% f.f. bean/seed[4]	70% cereals 30% mix of fishmeal, oil cake[3] and f.f. bean/seed[4] depending on availability in the region	90% cereals 3% oil cake[3] 7% f.f. bean/seed[4]	70% cereals 30% mix of fishmeal, oil cake[3] and f.f. bean/seed[4] depending on availability in the region
Carcass weight of live weight	na	70%	75%	35%
Live weight, kg	na	1.9	115	0.30
Human edible offal,% of live weight	na	3	3	0
Mortality rate,%	Incl. in egg yield	1.8	0.8	2.5
Rejected at slaughter,%	na	0.7	0.15	Na

1) kg feed per kg egg
2) kg feed per kg live weight (including feed for parent animals)
3) By-product from vegetable oil production (soy, rape seed, palm oil etc. depending on the local availability)
4) Full fat beans and seed.

Table S3 and S4 show data used for ruminant production in the INT, IDP and IDA scenarios. Feed rations differ between Projected Diets (PD) and Healthy Diets (HD) and across regions due to to varying amounts of by-products available from the production of the plant-based food products. Fibre-rich by-products are assumed to replace both cereals and forage (1 kg of fibre-rich by-products replace 0.5 kg cereals and 0.5 kg forage). However to ensure sufficient fibre content in the rations, the percentage of forage of the total dry matter intake was set to a minimum of 30%. Table S4 show milk yield and other production parameters for ruminant production in the INT, IDP and IDA scenarios.

Table S3. Feed, slaughter age and weight for ruminant production in the INT, IDP and IDA scenarios. Availability of oil cake and fibre-rich by-products vary between regions and the amount of forage is adjusted to account for that. Data from Cederberg et al. (2009), Bertilsson et al. (2014) and Spörndly (2003).

DAIRY PRODUCTION (for the dairy cow feed consumption per year, for heifers and bulls consumption per lifetime)			
	Dairy cow	Heifer, dairy breed	Bull, dairy breed
Forage, kg d.m.	5000 minus half amount of fibre-rich by-products	4200 minus total amount of fibre-rich by-products	1800 minus half amount of fibre-rich by-products
Cereals, kg	1900 minus half amount of fibre-rich by-products	400	1400 minus half amount of fibre-rich by-products
Legumes, kg	1200	0	0
Oil cake[1], kg	400	40	200
Fibre-rich by-products[2], kg	600-2000 depending on availability	600-1000 depending on availability	700
Slaughter age, month	87	24	18
Slaughter weight, kg	280	270	325
SUCKLER PRODUCTION (for the suckler cow feed consumption per year, for heifers and steers consumption per lifetime)			
	Suckler cow	Heifer, beef cattle	Bull, beef cattle
Forage, kg d.m.	3300 minus total amount of fibre-rich by-products	3200 minus half amount of fibre-rich by-products	3200 minus half amount of fibre-rich by-products
Cereals, kg	0	600 minus half amount of fibre-rich by-products	600 minus half amount of fibre-rich by-products
Legumes, kg	0	600 minus total amount of oil cake	600 minus total amount of oil cake
Oil cake	0	0-600 depending on availability	0-600 depending on availability
Fibre-rich by-products, kg	0-2000 depending on availability	0-600 depending on availability	0-600 depending on availability
Slaughter age, month	144	18	18

Slaughter weight, kg	340	300	340

1) By-product from vegetable oil production (soy, rape seed, palm oil etc. depending on the local availability)
2) By-products from flour production (bran), from sugar production and from inedible parts of fruits and vegetables depending on local availability

Table S4. Production parameters for cattle production in the INT, IDP and IDA scenarios. Based on data from Cederberg et al. (2009) and Bertilsson et al. (2014).

	Dairy	Suckler
Milk yield, kg ECM per year	8,800	Na
Losses of milk in stables,%	3.5	Na
Recruitment rate,%	19	10
Calves per cow and year,%	98	98
First calving, month	24	24
Carcass weight of live weight[1],%	53	53
Human edible offal,% of live weight	3	3
Mortality rate off-springs,%	1	1

S3.2 Livestock production systems based on ecological leftovers

In the EL scenario, pigs are raised on a diet consisting of 60% food waste, 30% cereals and 10% oil cake (see section S3.3 for more details). The food waste was complemented with cereals and oil cake to ensure high growth rates and to compensate for variable nutrient composition in the waste (Westendorf, 2000). Hence the same feed conversion ratio and other production parameters as in the intensive pig production systems were used (Table S2).

Table S6 and S7 show data used for ruminant production in the EL scenario. Forage rations are adjusted based on the availability of oil cake and fibre-rich by-products in the different scenarios and the different regions.

Table S5. Feed, slaughter age and weight for ruminant production in the EL scenario. Availability of oil cake and fibre-rich by-products vary between regions and the amount of forage is adjusted to account for that. Data from Cederberg et al. (2009), Bertilsson et al. (2014) and Spörndly (2003).

DAIRY PRODUCTION (for the dairy cow feed consumption per year, for heifers and bulls consumption per lifetime)			
	Dairy cow	Heifer, dairy breed	Steer, dairy breed
Forage, kg d.m.	4700 minus oil cake minus fibre-rich byproducts	4600 minus oil cake minus fibre-rich byproducts	4600 minus oil cake minus fibre-rich byproducts
Oil cake[1], kg	300-550 according to availability	0-600 according to availability	0-600 according to availability
Fibre-rich by-products[2], kg	500-1500 according to availability	1000-3000 according to availability	1000-3000 according to availability
Slaughter age, month	131	24	24
Slaughter weight, kg	240	270	310
SUCKLER PRODUCTION (for the suckler cow feed consumption per year, for heifers and steers consumption per lifetime)			
	Suckler cow	Heifer, beef cattle	Steer, beef cattle
Forage, kg d.m.	3300 minus fibre-rich byproducts	4600 minus oil cake minus fibre-rich byproducts	4600 minus oil cake minus fibre-rich byproducts
Oil cake	0	0-600 according to availability	0-600 according to availability
Fibre-rich by-products, kg	0-1700 according to availability	0-3400 according to availability	0-3400 according to availability
Slaughter age, month	147	24	24
Slaughter weight, kg	300	270	310

1) By-product from vegetable oil production (soy, rape seed, palm oil etc. depending on the local availability)
2) By-products from flour production (bran), from sugar production and from inedible parts of fruits and vegetables depending on local availability

Table S6. Production parameters for cattle production in the EL scenario. Based on data from Cederberg et al. (2009).

	Dairy	Suckler
Milk yield, kg ECM per year	4,100 + 15 * amount of oil cake/5 MJ	na
Recruitment rate,%	12	10
Calves per cow and year,%	98	98
First calving, month	27	27
Carcass weight of live weight,%	53	53
Human edible offal,% of live weight	3	3
Mortality rate off-springs,%	1	1

S3.3 Available resources and their use in the Ecological Leftover scenario

The amount of livestock products that can be supplied in the EL scenario depends on the availability of feed from pastures, food waste and by-products from the production of the plant-based food in the different regions and as a result of different diets. The amount of pasture in the different regions was retrieved from FAOSTAT (FAO, 2015). Using the same methodology as in Smith et al. (2008), it was determined how much of the available pasture that was located in moist cool, moist warm, dry cool and dry warm climate zones with an average above ground net primary production of 5.7, 8.2, 2.3 and 3.8 tons of dry matter per hectare (IPCC, 2003). The pasture utilization rate (grass biomass used by animals of the above ground net primary production) was set to 30% which is an improved figure from the current utilization rate that varies between 4-40% globally (Chang et al., 2016).

The EL scenario was the only scenario that used food waste as animal feed, as this practice is aligned with the principle of limiting livestock production to using non-edible food resources as feed. The quantity of food waste available in each region was calculated by the model taking into account regional food waste levels from FAO (2011). Hence, when food waste was assumed to be reduced by 50%, the available food waste for feed decreased accordingly. It was assumed that 75% of the food waste in each region was collected and used as pig feed which is a doubling of levels in countries currently leading in using food waste as animal feed (zu Ermgassen et al., 2016). Currently, feeding food waste to livestock is prohibited in some regions *e.g.* in the EU (EU, 2011) due to the risk of contamination and infection. However, with proper sanitization and handling, food waste is a valuable feed ingredient to especially pigs (Westendorf, 2000). The food waste was complemented with some cereals using cropland for its production and oil cake to ensure high growth rates. As in all other scenarios by-products from the production of plant-based foods for human consumption were used as feed.

S3.4. Emission factors for enteric fermentation

In this study we used factors for the yearly methane production per animal for different animal types calculated using the method by (Lindgren, 1980). The factors were published in a report by (Berglund et al., 2009) and are summarized in Table S8 below. These factors were reduced by 10% to account for mitigation potential from breeding and feeding (see section 2 in main paper for justification). Slaughtering age for pigs was set to six months. For cattle slaughtering ages see Table S3 and S5.

Table S7. Emissions factors methane emissions from animals (Berglund et al 2009), reduced by 10% to account for mitigation potential from breeding and feeding.

	Emissions of methane, kg CH_4 per animal and year
Dairy cow milk yield 11,000 kg EMC/year	122
Dairy cow milk yield 6,000 kg EMC/year	111
Suckler cow	69
Bulls, heifers, steers	49
Pig	1.4

S5. Sensitivity analysis for land use

S5.1 Using grass biomass from pastures for ruminants in the INT, IDP and IDA scenarios

In the INT, IDP and IDA scenarios all forage for ruminants (raised in intensive systems; see Section S3.1) is assumed to be produced on cropland i.e. no biomass from permanent pastures was utilized as animal feed. Here we perform a sensitivity analysis in which it is assumed that permanent pastures is used exclusively to provide forage (through grazing or harvesting silage and hay from grasslands). The same pasture utilization rate as in the EL scenario was assumed (30%) (Section S3.3).

Cropland requirements are then reduced by 29-36% for the INT scenario PD, by 19-24% for the INT scenario HD and 7-13% for the PD and HD diets in the IDP and IDA scenarios (variation depending on waste and yield levels; compare Figure 2 and Figure S3 for the INT, IDP and IDA scenarios). However, total land use increases; for the INT scenario PD (HD in parenthesis) by 38% (21%) for current yields and waste levels, by 36% (21%) for current yields and waste reduced by 50%, by 66% (37%) for yield gaps closed to 50% and current waste level, and by 62% (38%) for yield gaps closed to 50% and waste reduced by 50%.

When all forage is collected from permanent pastures and crop yield gaps are closed to 50% available cropland (2,000 Mha) would suffice for all scenarios on a global scale, except for the IDA scenario for which land requirements was estimated to slightly more (Figure S3c and S3d). However, regionally there are large differences. In Western Europe, South and South East Asia and North America permanent pastures would not suffice to provide forage for the ruminant production needed to cover projected consumption in these regions (Table S8).

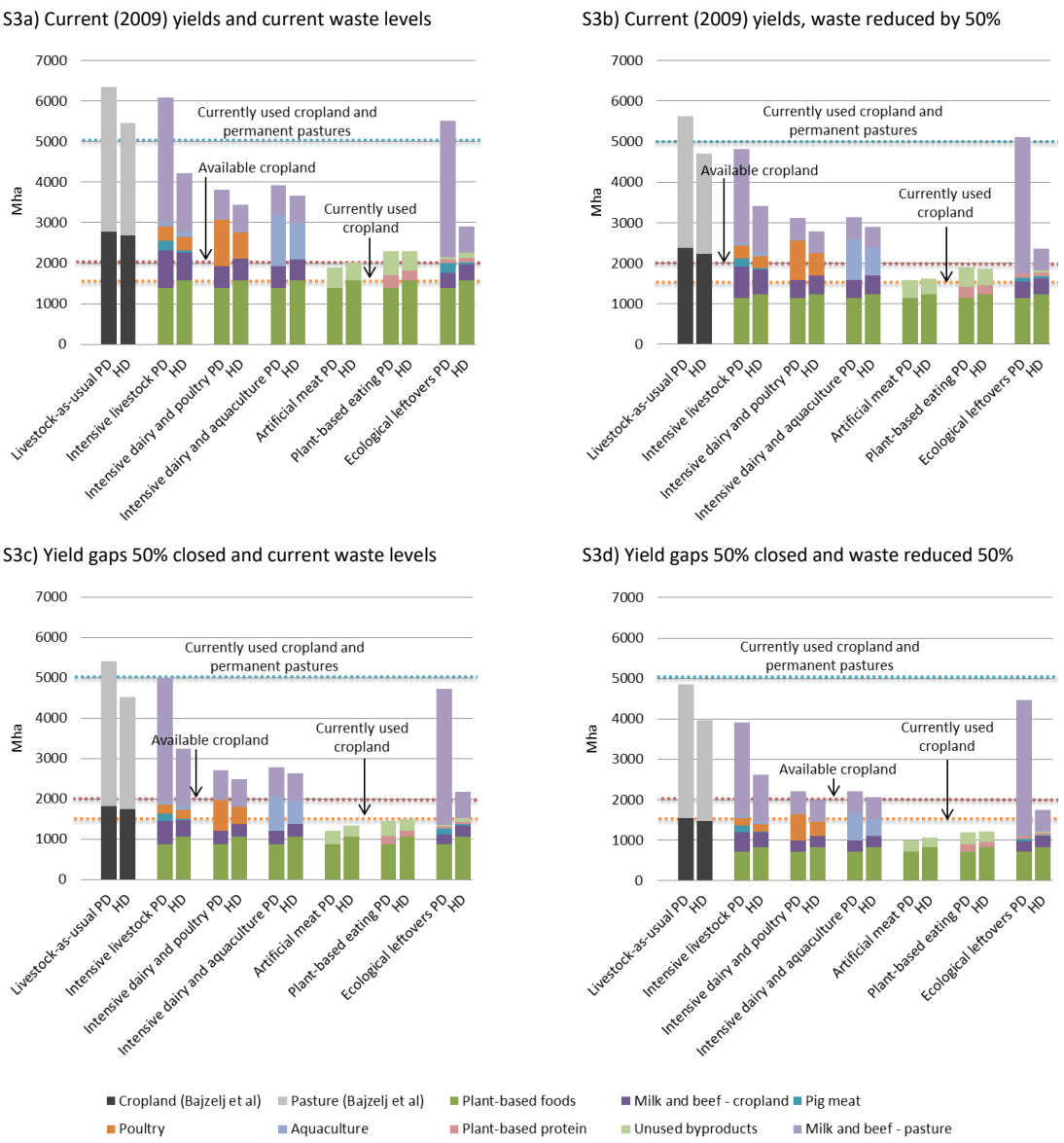

Figure S3. *Land use for the production of food for the global population in 2050 for Projected Diets (PD) and Healthy Diets (HD) for the different livestock production scenarios and under different assumptions for yield gaps closures and waste reductions* ***and when forage for ruminants is exclusively grazed or harvested from permanent pastures***. *The categories 'Milk and beef - cropland', 'Pig meat', 'Poultry' and 'Aquaculture' includes feed for these species grown on cropland, including by-products from plant-based foods (allocated based on mass).* ***The category 'Milk and beef – pasture' is the amount of permanent pastures needed for forage for ruminants.*** *'Unused by-products' are by-products from plant-based foods not utilized as feed (could be used for bioenergy production or refined to human edible products). See text in section 3.1 in the main paper for an explanation of 'available cropland'.*

Table S8. Regional data for land requirements for forage for ruminant production in the INT, IDP and IDA scenarios for the Projected Diet (PD) and with yield gaps closed by 50% and waste reduced by 50%. First two columns shows the cropland and pasture yields (tonnes/ha) in the different regions. The next three columns show the amount of forage needed for dairy production in the INT, IDP and IDA scenarios (same amount of dairy and meat from dairy in these three scenarios) and the land requirement when forage is provided from cropland and pastures respectively. The three consecutive columns show the amount of forage needed for suckler production in the INT scenarios (no meat from suckler production in the IDP and IDA scenarios) and the land requirement when forage is provided from cropland and pastures respectively. The last three columns show total cropland and pasture land needed for the INT scenarios and the ratio of available permanent pastures that would be needed in each region if all forage for ruminant production would come from permanent pastures.

	Yields		Milk and meat from dairy production (INT, IDP and IDA scenarios)			Meat from suckler production (only INT scenario)			Total land for forage needed in the INT scenario		
	Forage yield crop-land (t/ha)	Yield past-ures (t/ha)	Forage needed (Mt)	Crop-land area (Mha)	Pasture area (Mha)	Forage needed (t/yr)	Crop-land area (Mha)	Pasture area (Mha)	Crop-land area (Mha)	Pasture area (Mha)	Ratio of available pastures
E Eu	3.0	1.4	46	15	34	66	22	49	38	82	71%
W Eu	8.7	2.1	117	14	57	154	18	74	31	131	211%
C Asia	3.2	1.7	17	5	10	95	30	55	35	65	26%
E Asia	12.1	1.8	79	7	45	565	47	321	53	366	72%
S Asia	4.5	1.7	326	72	189	405	89	235	161	424	543%
SE Asia	6.1	2.1	16	3	8	168	28	81	30	88	519%
W Asia	5.5	1.9	50	9	26	124	23	65	32	91	40%
L Am	8.7	2.2	93	11	43	460	53	212	63	255	45%
N Am	8.2	1.0	102	12	101	225	27	223	40	324	122%
SS Af	2.7	2.1	38	14	18	724	273	346	287	364	49%
N Af	7.8	1.9	37	5	20	121	16	64	20	84	50%
Oc	3.8	1.7	11	3	7	41	11	25	14	31	8%

S5.2 Accounting for multi-cropping

As multi-cropping has been highlighted as an underestimated option to increase yearly yields (Mauser et al., 2015; Ray & Foley, 2013) the land use calculations were repeated under the assumption that double and/or triple cropping is possible to some extent in some regions.

By using the IISA 'Multiple cropping zones for rain-fed crop production' map (IISA, 2000) and overlaying it with a map of 'rain-fed cultivated land' (IISA, 2012) and a third map of the 12 geographical regions used in this study, the approximate amount of cropland possible to crop multiple times was estimated for each region (Table S9). It was assumed that vegetables, cereals, roots, pulses and forage are possible to grow in multi-cropping systems and for these crops yield were increased by 50% for 'limited double cropping' by 100% for 'double cropping', by 150% for 'limited triple cropping' and with 200% for 'triple cropping'.

Table S9. Proportion of cropland that is suitable for multiple cropping in each region.

	Limited double cropping	Double cropping	Limited triple cropping	Triple cropping
E Eu	2%	0%	0%	0%
W Eu	5%	1%	0%	0%
C Asia	0%	0%	0%	0%
E Asia	5%	15%	14%	1%
S Asia	6%	6%	1%	0%
SE Asia	1%	33%	5%	29%
W Asia	0%	0%	0%	0%
L Am	7%	38%	11%	7%
N Am	17%	15%	7%	1%
SS Af	11%	23%	5%	1%
N Af	2%	0%	0%	0%
Oc	2%	3%	0%	2%

Land use results when accounting for multi-cropping according to this approximation are shown in Figure S4. The need for cropland was reduced between 15-19% globally for the different scenarios by accounting for multi-cropping.

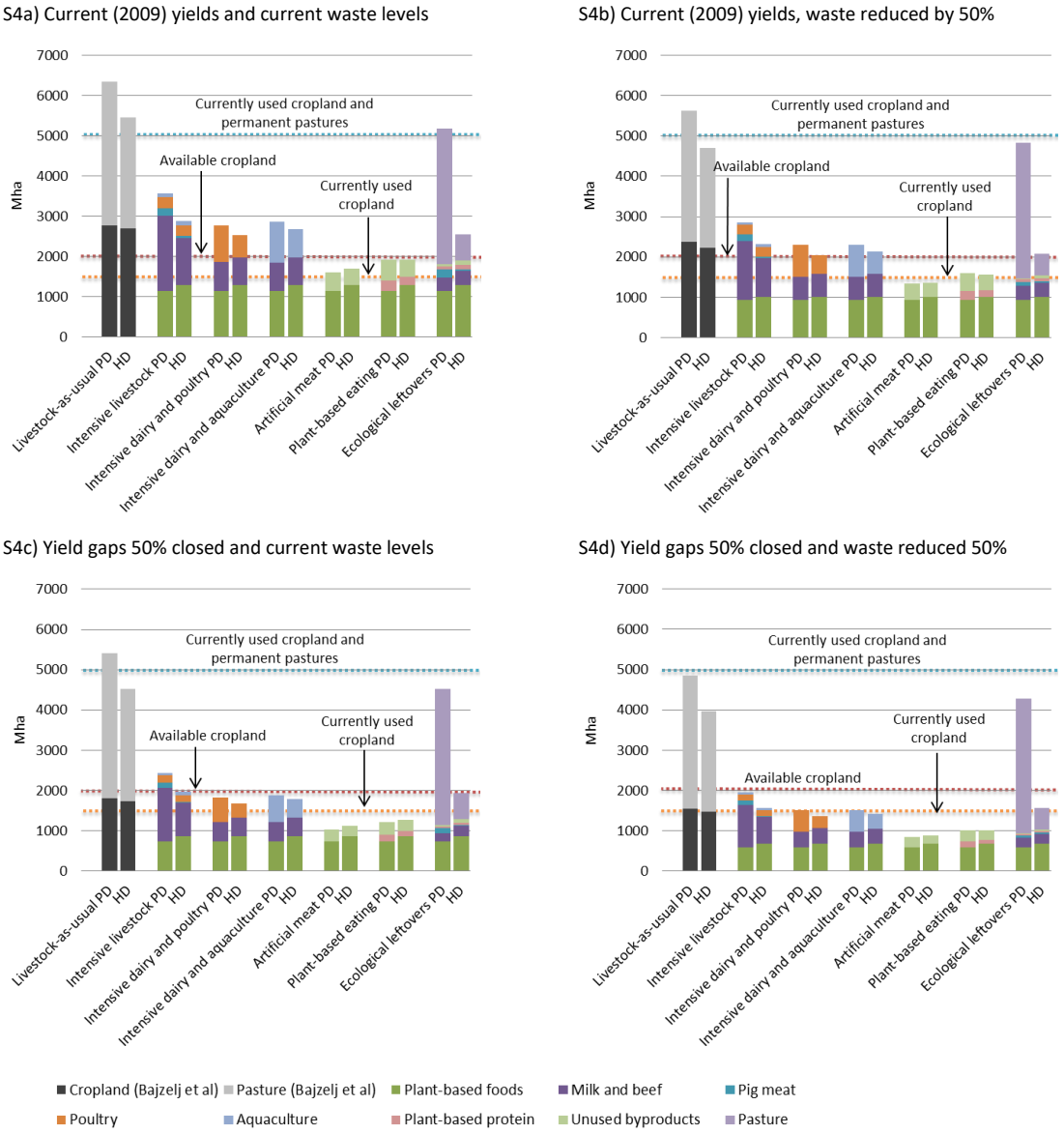

Figure S4. *Land use for the production of food for the global population in 2050 for Projected Diets (PD) and Healthy Diets (HD) for the different livestock production scenarios and under different assumptions for yield gaps closures and waste reductions* ***when multi-cropping is accounted for in all scenarios except the Livestock-as-usual scenario****. The categories 'Milk and beef', 'Pig meat', 'Poultry' and 'Aquaculture' includes feed for these species grown on cropland, including by-products from plant-based foods (allocated based on mass). 'Unused by-products' are by-products from plant-based foods not utilized as feed (could be used for bioenergy production or refined to human edible products). See text in section 3.1 in the main paper for an explanation of 'available cropland'.*

S6. Foods in diets

Table S10, S12, S14…S32 shows the daily amounts of animal foods consumed in different regions in the Projected Diets (PD) and Healthy Diets (HD) for the different scenarios as well as amounts of additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Dairy and Aquaculture, Plant Based Eating and Ecological Leftovers scenarios, in comparison with consumption in 2009 (Bajželj et al., 2014). Table S11, S13, S15…S33 shows amount of plant-based foods which are the same for all scenarios in one region.

S6.1 Eastern Europe

Table S10. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	31[1]	18	16	18	16	18	16					28/28	23/24
Beef suckler		30	5					225[3]	132[3]			14/28	0/0
Pig meat	54	52	9									84/42	8/7
Poultry	52	58	58	250	141								
Egg	35	40	36										
Dairy	525	572	504	572	504	572	504	572[3]	504[3]			572/572	504/504
Capt. seafood	27[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		21	21			193	106						
Add. veg oil						6	4						
Add. pulses										63	46	9/16	14/14
Add. cereals										162	118	23/40	37/36
Protein in total	89	94	84	104	87	103	86	95	82	71	67	84/83	73/74
Total energy, kcal	2667	2736	2500	2736	2500	2736	2500	2736	2500	2736	2500	2736/2736	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S11. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	252	236	484
Fruit, g	111	105	250
Sugar, g	90	87	44
Veg oils, g	37	41	41
Wheat, g	255	253	248
Rice, g	8	8	8
Maize, g	19	19	18
Other grains, g	34	34	33
Roots, g	218	205	201
Pulses, g	5	5	5
Other crops, g	58	58	57

S6.2 Western Europe

Table S12. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	37[1]	23	16	23	16	23	16					22/27	21/24
Beef suckler		36	4					281[3]	136[3]			0/0	0/0
Pig meat	84	83	10									81/40	9/7
Poultry	50	55	55	312	145								
Egg	28	32	32										
Dairy	656	717	504	717	504	717	504	717[3]	504[3]			489/563	473/504
Capt. seafood	38[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		32	32			243	110						
Add. veg oil						7	4						
Add. pulses										79	47	33/37	17/15
Add. cereals										203	120	84/93	42/37
Protein in total	90	99	85	113	88	111	86	102	82	72	67	82/81	73/74
Total energy, kcal	2811	2920	2500	2920	2500	2920	2500	2920	2500	2920	2500	2920/2920	2500/2500

1 Meat from both dairy and suckler production systems
2 Seafood from both capture fisheries and aquaculture
3 Artificial meat and milk

Table S13. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	228	212	484
Fruit, g	191	179	250
Sugar, g	92	90	44
Veg oils, g	59	65	41
Wheat, g	190	189	227
Rice, g	12	12	15
Maize, g	22	22	26
Other grains, g	13	12	15
Roots, g	122	114	138
Pulses, g	8	9	10
Other crops, g	71	72	87

S6.3 Central Asia

Table S14. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	86[1]	19	17	19	17	19	17					33/31	25/25
Beef suckler		121	14					198[3]	63[3]			273/377	0/0
Pig meat	15	20	2									83/43	7/7
Poultry	11	17	17	216	55								
Egg	12	20	20										
Dairy	448	559	504	559	504	559	504	559[3]	504[3]			559/559	504/504
Capt. seafood	9[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/0
Farm. seafood		0	0			167	38						
Add. veg oil						5	2						
Add. pulses										59	36	0/0	4/4
Add. cereals										151	92	0/0	11/10
Protein in total	81	96	81	105	82	104	81	97	80	76	70	126/135	77/78
Total energy, kcal	2355	2585	2500	2585	2500	2585	2500	2585	2500	2585	2500	2954/3026	2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S15. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	342	358	484
Fruit, g	105	109	250
Sugar, g	44	46	44
Veg oils, g	27	31	31
Wheat, g	367	362	383
Rice, g	16	16	16
Maize, g	13	13	14
Other grains, g	14	13	14
Roots, g	131	138	145
Pulses, g	2	2	2
Other crops, g	21	22	23

S6.4 Eastern Asia

Table S16. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	26[1]	6	6	6	6	6	6					8/8	8/8
Beef suckler		40	4					436[3]	142[3]			33/45	0/0
Pig meat	114	175	17									89/46	19/19
Poultry	37	58	58	520	164								
Egg	45	71	36										
Dairy	99	161	161	161	161	161	161	161[3]	161[3]			161/161	161/161
Capt. seafood	38[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		32	32			410	125						
Add. veg oil						12	4						
Add. pulses										72	29	39/46	16/15
Add. cereals										185	75	99/118	40/39
Protein in total	83	103	74	131	78	131	77	112	72	74	59	84/82	62/62
Total energy, kcal	2485	2884	2500	2884	2500	2884	2500	2884	2500	2884	2500	2884/2884	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S17. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	578	539	539
Fruit, g	126	118	250
Sugar, g	20	27	27
Veg oils, g	34	51	41
Wheat, g	152	147	160
Rice, g	166	160	174
Maize, g	19	18	20
Other grains, g	4	4	4
Roots, g	144	135	147
Pulses, g	4	4	4
Other crops, g	49	51	55

S6.5 Southern Asia

Table S18. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	8 [1]	15	15	15	15	15	15					8/12	8/11
Beef suckler		19	17					80 [3]	77 [3]			0/0	0/0
Pig meat	1	2	2									62/32	19/16
Poultry	7	26	26	78	72								
Egg	6	22	22										
Dairy	267	425	425	425	425	425	425	425 [3]	425 [3]			150/235	150/214
Capt. seafood	8[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		2	2			56	52						
Add. veg oil						3	2						
Add. pulses										34	34	12/13	21/17
Add. cereals										88	87	31/33	53/44
Protein in total	62	76	73	78	75	77	73	75	72	65	62	70/70	65/66
Total energy, kcal	2248	2800	2500	2800	2500	2800	2500	2800	2500	2800	2500	2800/2800	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S19. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	149	224	484
Fruit, g	116	170	250
Sugar, g	52	75	44
Veg oils, g	28	51	41
Wheat, g	177	179	155
Rice, g	183	185	160
Maize, g	18	18	16
Other grains, g	28	29	25
Roots, g	66	97	84
Pulses, g	30	27	24
Other crops, g	24	27	24

S6.6 South-Eastern Asia

Table S20. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	18 [1]	2	2	2	2	2	2					3/3	3/3
Beef suckler		27	8					197 [3]	118 [3]			3/7	0/0
Pig meat	38	58	17									58/30	22/22
Poultry	26	40	40	235	140								
Egg	14	22	22										
Dairy	40	65	65	65	65	65	65	65 [3]	65 [3]			65/65	65/65
Capt. seafood	41 [2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		35	35			182	106						
Add. veg oil						6	4						
Add. pulses										32	21	15/21	12/12
Add. cereals										83	53	39/53	31/31
Protein in total	64	73	64	82	67	81	66	73	62	56	51	61/60	53/54
Total energy, kcal	2534	2775	2500	2775	2500	2775	2500	2775	2500	2775	2500	2775/2775	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S21. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	145	138	484
Fruit, g	183	170	250
Sugar, g	43	59	44
Veg oils, g	31	46	41
Wheat, g	48	46	42
Rice, g	326	315	283
Maize, g	50	48	43
Other grains, g	2	2	1
Roots, g	113	105	95
Pulses, g	9	8	7
Other crops, g	47	49	43

S6.7 Western Asia

Table S22. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	31 [1]	14	14	14	14	14	14					20/21	20/21
Beef suckler		37	17					154 [3]	128 [3]			57/80	0/0
Pig meat	5	6	3									90/46	11/11
Poultry	51	81	81	169	138								
Egg	17	28	28										
Dairy	331	411	411	411	411	411	411	411 [3]	411 [3]			411/411	411/411
Capt. seafood	9 [2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		3	3			128	104						
Add. veg oil						5	4						
Add. pulses										44	41	0/0	13/13
Add. cereals										114	104	0/0	34/34
Protein in total	83	95	86	99	88	98	87	93	83	77	69	95/92	75/75
Total energy, kcal	2798	3015	2500	3015	2500	3015	2500	3015	2500	3015	2500	3104/3039	2500/2500

1 Meat from both dairy and suckler production systems
2 Seafood from both capture fisheries and aquaculture
3 Artificial meat and milk

Table S23. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	283	295	484
Fruit, g	214	225	250
Sugar, g	83	87	44
Veg oils, g	49	57	41
Wheat, g	349	345	289
Rice, g	39	38	32
Maize, g	34	33	28
Other grains, g	21	21	18
Roots, g	86	90	75
Pulses, g	21	19	16
Other crops, g	38	40	34
Total energy, kcal	2798	3015	2500

S6.8 Latin America

Table S24. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	64 [1]	13	13	13	13	13	13					21/19	19/19
Beef suckler		79	13					260 [3]	152 [3]			82/114	0/0
Pig meat	29	35	6									65/34	13/14
Poultry	76	103	103	298	168								
Egg	23	32	32										
Dairy	294	363	363	363	363	363	363	363 [3]	363 [3]			363/363	363/363
Capt. seafood	13 [2]	7	7	7	7	7	7	7	7	7	7	7/8	7/8
Farm. seafood		6	6			232	128						
Add. veg oil						7	5						
Add. pulses										57	42	9/11	17/16
Add. cereals										147	106	23/29	43/42
Protein in total	83	96	89	105	92	104	90	95	86	70	70	85/86	75/75
Total energy, kcal	2573	2656	2500	2656	2500	2656	2500	2656	2500	2656	2500	2656/2656	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S25. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	118	122	484
Fruit, g	206	208	250
Sugar, g	103	101	44
Veg oils, g	39	28	28
Wheat, g	108	113	123
Rice, g	64	67	72
Maize, g	124	130	141`
Other grains, g	5	5	6
Roots, g	142	144	156
Pulses, g	31	29	31
Other crops, g	39	38	41

S6.9 North America

Table S26. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	57 [1]	22	17	22	17	22	17					31/32	25/25
Beef suckler		55	10					303 [3]	183 [3]			10/22	0/0
Pig meat	48	45	5									88/44	7/7
Poultry	118	133	119	339	200								
Egg	32	37	36										
Dairy	578	631	504	631	504	631	504	631 [3]	504 [3]			631/631	504/504
Capt. seafood	26 [2]	5	5	5	5	5	5	5	5	5	5	5/7	5/7
Farm. seafood		21	21			267	155						
Add. veg oil						8	5						
Add. pulses										78	54	20/27	22/21
Add. cereals										199	137	50/69	55/55
Protein in total	100	107	92	117	95	116	94	104	87	74	68	87/86	75/75
Total energy, kcal	3002	3131	2500	3131	2500	3131	2500	3131	2500	3131	2500	3131/3131	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S27. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	228	212	484
Fruit, g	187	177	250
Sugar, g	92	89	44
Veg oils, g	76	83	41
Wheat, g	151	150	158
Rice, g	17	17	18
Maize, g	84	83	88
Other grains, g	9	9	9
Roots, g	78	73	77
Pulses, g	13	13	14
Other crops, g	75	75	79

S6.10 Sub-Saharan Africa

Table S28. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	20 [1]	2	3	2	3	2	3					5/5	5/5
Beef suckler		29	20					75 [3]	60 [3]			47/66	0/0
Pig meat	8	12	8									70/37	21/21
Poultry	10	16	16	88	69								
Egg	4	7	7										
Dairy	77	92	92	92	92	92	92	92 [3]	92 [3]			92/92	92/92
Capt. seafood	13 [2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		7	7			64	49						
Add. veg oil						3	2						
Add. pulses										14	14	0/0	4/4
Add. cereals										36	35	0/0	10/9
Protein in total	72	75	68	78	70	77	69	75	68	68	62	83/80	64/64
Total energy, kcal	2314	2792	2500	2792	2500	2792	2500	2792	2500	2792	2500	2922/2872	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S29. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	83	83	484
Fruit, g	158	160	250
Sugar, g	32	43	43
Veg oils, g	32	45	41
Wheat, g	65	80	64
Rice, g	59	72	58
Maize, g	131	159	128
Other grains, g	117	143	115
Roots, g	470	474	382
Pulses, g	31	39	32
Other crops, g	39	40	32

S6.11 North Africa

Table S30. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	35 [1]	13	13	13	13	13	13					22/18	18/18
Beef suckler		43	22					102[3]	81 [3]			43/68	0/0
Pig meat	0											92/46	12/12
Poultry	22	35	35	108	83								
Egg	9	14	14										
Dairy	294	364	364	364	364	364	364	364[3]	364 [3]			364/364	364/364
Capt. seafood	12[2]	6	6	6	6	6	6	6	6	6	6	6/8	6/8
Farm. seafood		6	6			80	60						
Add. veg oil						3	3						
Add. pulses										34	31	0/0	7/6
Add. cereals										88	80	0/0	17/16
Protein in total	83	91	83	93	84	92	83	89	81	78	73	98/94	77/77
Total energy, kcal	2679	2818	2500	2818	2500	2818	2500	2818	2500	2818	2500	2977/2905	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S31. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	299	314	484
Fruit, g	217	227	250
Sugar, g	76	80	44
Veg oils, g	27	31	31
Wheat, g	325	320	280
Rice, g	39	39	34
Maize, g	87	85	75
Other grains, g	67	66	58
Roots, g	88	94	82
Pulses, g	18	15	13
Other crops, g	25	25	22

S6.12 Oceania

Table S32. Daily amounts of animal foods consumed (after waste) and additional pulses, cereals and vegetable oil to substitute for animal protein and fat in the Plant Based Eating and Ecological Leftovers scenarios and total protein and energy content for the complete Projected Diet (PD) and Healthy Diet (HD) for the different scenarios. Meat in carcass weight, fish in edible weight. Foods consumed 2009 from FAOSTAT (FAO, 2015).

Animal foods (g):	Cons-umed 2009	Intensive Livestock		Intensive Dairy and Poultry		Intensive Dairy and Aquacult.		Artificial Meat		Plant Based Eating		Ecological Leftover (2009 waste levels / 50% reduced waste)	
		PD	HD	PD	HD	PD	HD	PD	HD	PD	HD	PD	HD
Beef dairy	98 [1]	18	17	18	17	18	17					26/27	25/25
Beef suckler		98	11					290[3]	155 [3]			636/853	0/0
Pig meat	37	37	4									88/46	9/9
Poultry	90	102	102	328	166								
Egg	14	17	17										
Dairy	485	531	504	531	504	531	504	531 [3]	504 [3]			531/531	504/504
Capt. seafood	29[2]	5	5	5	5	5	5	5	5	5	5	5/7	5/7
Farm. seafood		24	24			258	128						
Add. veg oil													
Add. pulses										71	49	0/0	17/17
Add. cereals						7	4			181	127	0/0	44/43
Protein in total	87	94	88	103	90	102	88	91	83	62	66	160/187	73/73
Total energy, kcal	2608	2713	2500	2713	2500	2713	2500	2713	2500	2713	2500	3532/3789	2500/2500

1 Meat from both dairy and suckler production systems

2 Seafood from both capture fisheries and aquaculture

3 Artificial meat and milk

Table S33. Daily amounts of plant based foods consumed (after waste) in the Projected Diet (PD) and Healthy Diet (HD). Same amounts in all scenarios. Foods consumed 2009 from FAOSTAT (FAO, 2015).

	Consumed 2009	For all scenarios	
Plant-based foods:		PD	HD
Vegetables, g	216	204	484
Fruit, g	196	183	250
Sugar, g	108	106	44
Veg oils, g	58	64	41
Wheat, g	151	150	208
Rice, g	25	25	35
Maize, g	12	12	16
Other grains, g	4	4	6
Roots, g	92	87	121
Pulses, g	10	11	15
Other crops, g	63	64	89

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