Supplement of Earth Syst. Sci. Data, 11, 823–843, 2019
https://doi.org/10.5194/essd-11-823-2019-supplement

Open Access Earth System Science Data

Supplement of

Generating a rule-based global gridded tillage dataset

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S1 Terms and definitions used

Arable cropland is the land under temporary agricultural crops (multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category (FAO, 2014).

Conservation Agriculture (CA) as reported by the FAO is a farming practice comprising minimum soil disturbance, the maintenance of a permanent vegetative cover of the soil (either by residue mulch layer and standing biomass) and diverse crop rotation (http://www.fao.org/conservation-agriculture/en/, accessed 08/31/2018). The no-tillage farm implements for seeding may range from disc like furrow openers but new developments of air-pressured seeding equipment embark even lesser soil disturbance. The use of no-tillage or minimum tillage practices (direct planting) mitigates some of the pressures on the soil and requires operational costs on farm. At the same time it enables the farmer for multiple cropping per year. Direct planting without proper soil cover may lead to increased herbicide requirements.

Cropland is considered as the sum of arable land cultivated with annual and perennial crops.

Perennial cropland is the land cultivated with long-term crops which do not have to be replanted for several years (such as cocoa and coffee); land under trees and shrubs producing flowers, such as roses and jasmine; and nurseries (except those for forest trees) (FAO, 2014).

Tillage is a means of soil management in order "To provide a favorable environment for crop growth and production, but still conserve soil and water resources" (FAO, 1984). The choice of tillage practice depends on soil, climatic, crop type, and socio-economic factors (Opara-Nadi, 1993). Conventional tillage practices are mostly perceived as the inversion and mixing of the soil layer with a plow after harvest in order to burry residues or for seedbed preparation. During the crop growing season cultivation as mechanical disturbance of the soil surface is practiced to loosen the soil, to manage weeds, to work in fertilizer, or other soil amendments. Tillage has a high altering effect on soil aggregates, and increases the decomposition of soil organic matter through aeration and exposure to microbial oxidation. This effect is approved off in conventional tillage, as with increased turnover times of soil organic matter, nutrients become available for promoting crop growth in case of timely seeding.

Alternative tillage practices as reduced tillage or no-tillage are holding promising potential to improve the water content and aggregate stability of the soil, protect from erosion, and to increase the soil organic matter pools in the soil. Literature findings of comparative site studies show different outcomes on the effect of reduced tillage on soil organic matter stocks exhibiting the fact that the outcome varies in time and space, due to cropping intensity, crop type, climate regime, soil type, and depth (Pittelkow et al., 2015).

Table S2 List of crop types as in SPAM2005 (IFPRI/IIASA, 2017b), with indication of crop type grouping to annual or perennial, and whether considered as suitable for CA in this study.

Crop name long	Crop category	CA suitability
wheat	annual	included
rice	annual	excluded
maize	annual	included
barley	annual	included
rest	annual	included
other oil crops	perennial	excluded
tobacco	annual	included

Crop name long	Crop category	CA suitability
teas	perennial	excluded
cocoa	perennial	excluded
robusta coffee	perennial	excluded
arabica coffee	perennial	excluded
other fibre crops	perennial	excluded
cotton	annual	included
sugarbeet	annual	excluded
sugarrcane	perennial	excluded
oilpalm	perennial	excluded
vegetables	annual	included
temperate fruit	perennial	excluded
tropical fruit	perennial	excluded
plantain	perennial	excluded
banana	perennial	excluded
coconut	perennial	excluded
groundnut	annual	included
other roots	annual	excluded
cassava	annual	excluded
yams	annual	excluded
sweet potato	annual	excluded
potato	annual	excluded
sesameseed	annual	included
rapeseed	annual	included
sunflower	annual	included
soybean	annual	included
other pulses	annual	included
lentil	annual	included
pigeon pea	annual	included
cow pea	annual	included
chick pea	annual	included
beans	annual	included
other cereals	annual	included
sorghum	annual	included
small millet	annual	included
pearl millet	annual	included

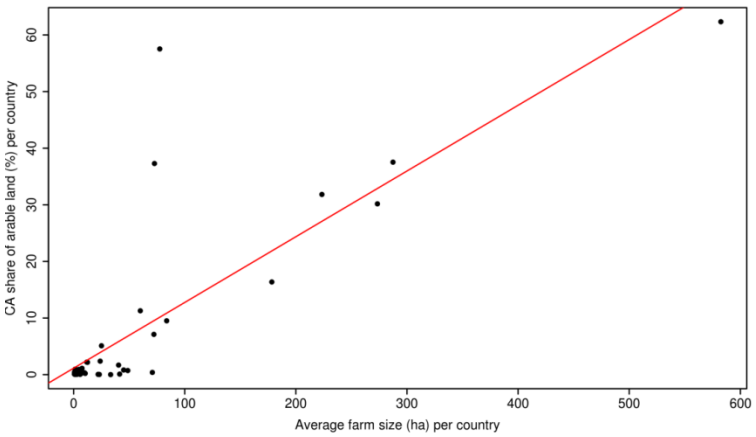

Figure S3 Relation between national average farm size (ha) (Lowder et al., 2014) and share (%) of Conservation Agricultural area on arable land (FAO, 2016). Black dots denote country values and the red line is the fitted regression line with the resulting coefficient of determination of r^2=0.66 ($p < 0.001$, slope of 0.116, n=41 excluding Australia, because of its very large average farm size of 3243 ha $farm^{-1}$ but still with a CA adoption share of 20.4 % on their arable land).

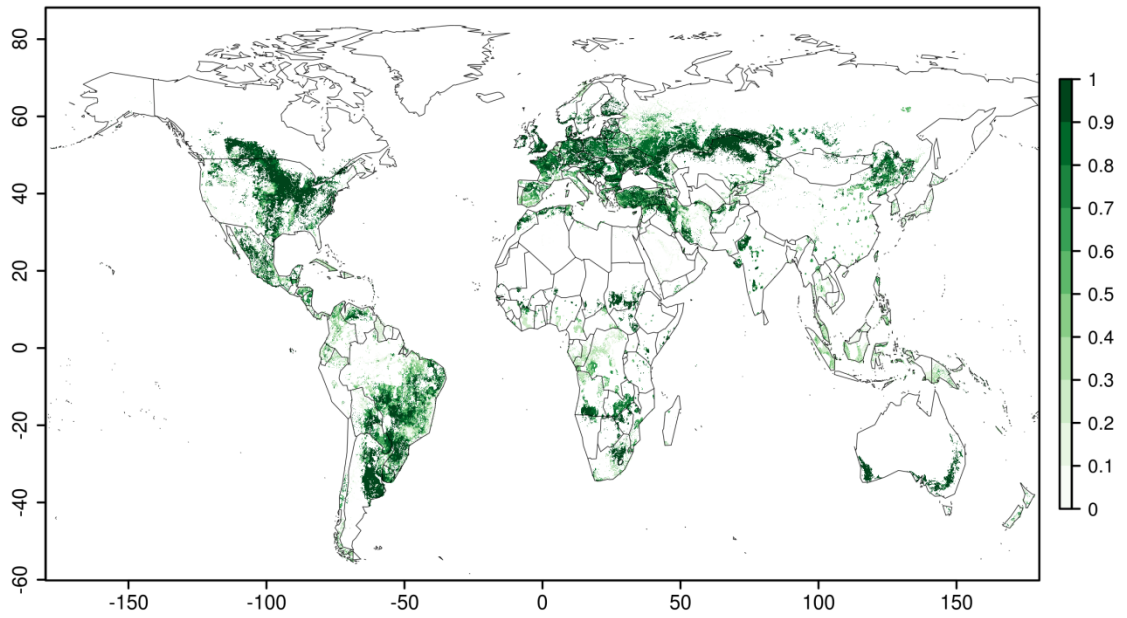

Figure S4.1 Crop mix as ratio, of cropland area of 22 annual rainfed considered CA-suitable crop types to total sum of cropland per grid cell on potential CA area (based on IFPRI/IIASA (2017b)) with values ranging between 0 and 1.

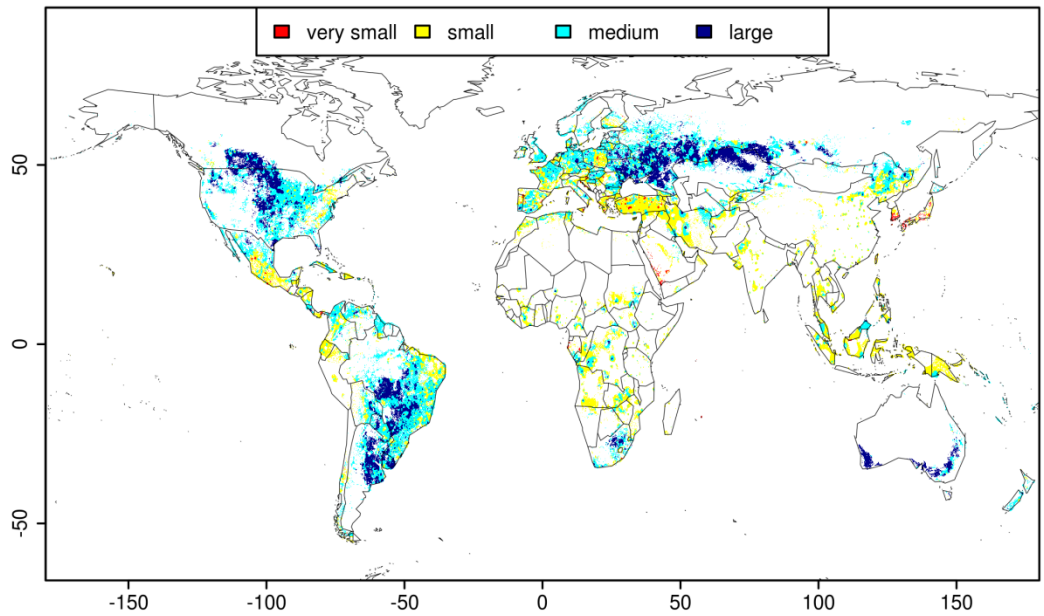

Figure S4.2 Field size on potential CA area (classes: very small (<0.5 ha), small (0.5-2 ha), medium (2-100 ha), large (>100 ha) as in (Herrero et al., 2017)) based on Fritz et al. (2015); with own modifications).

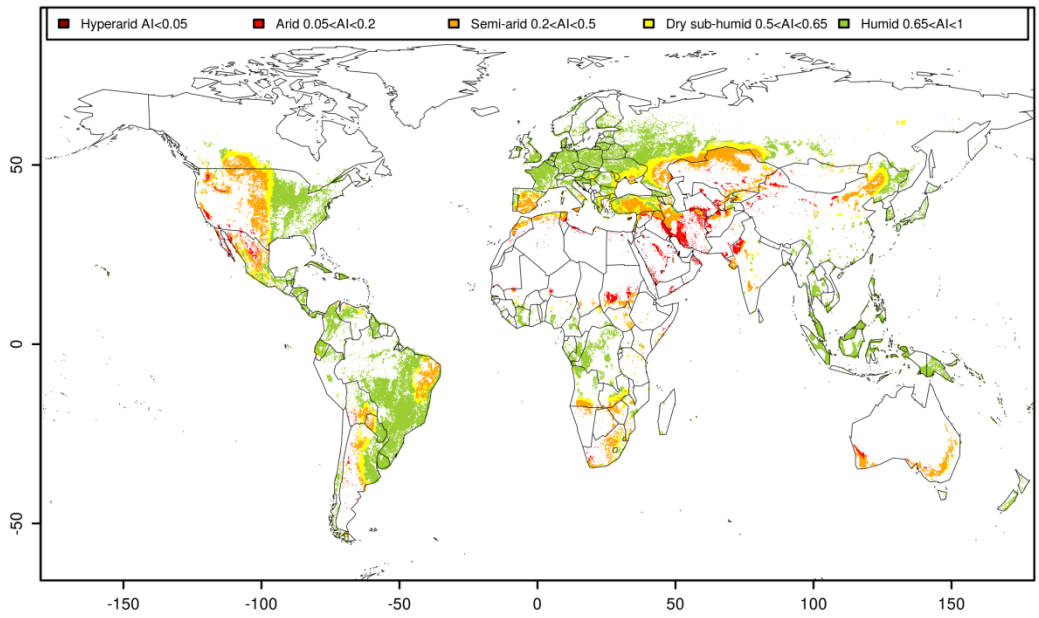

Figure S4.3 Aridity index as ratio of average yearly precipitation divided by average yearly potential evapotranspiration on potential CA area (based on data by FAO (2015), with own modifications).

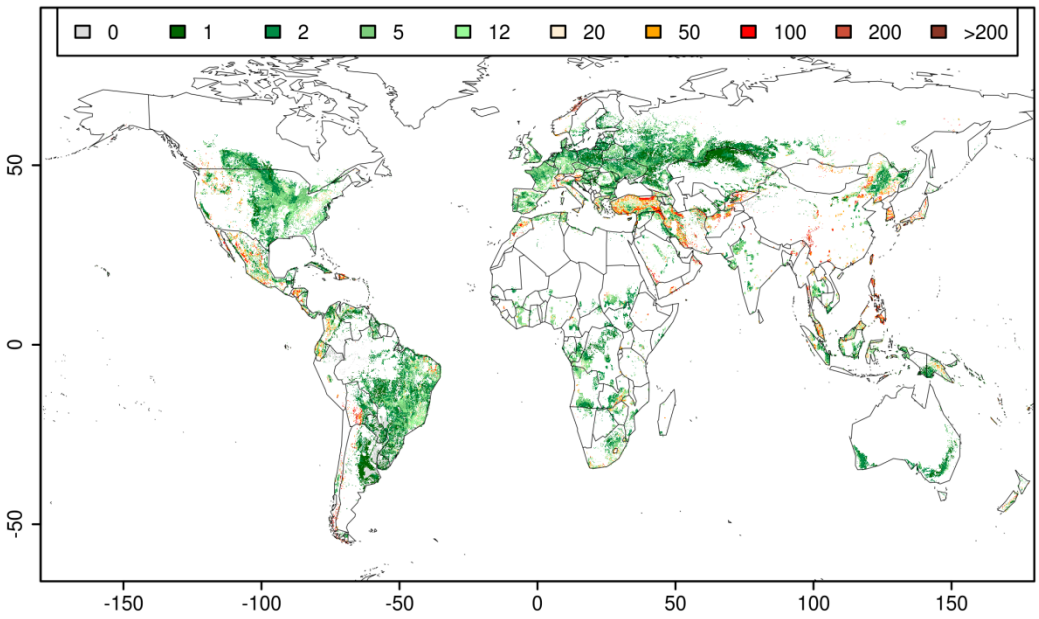

Figure S4.4 Water erosion in t ha^{-1} $year^{-1}$ on potential CA area (based on GLADIS by Nachtergaele et al. (2011); with own modifications).

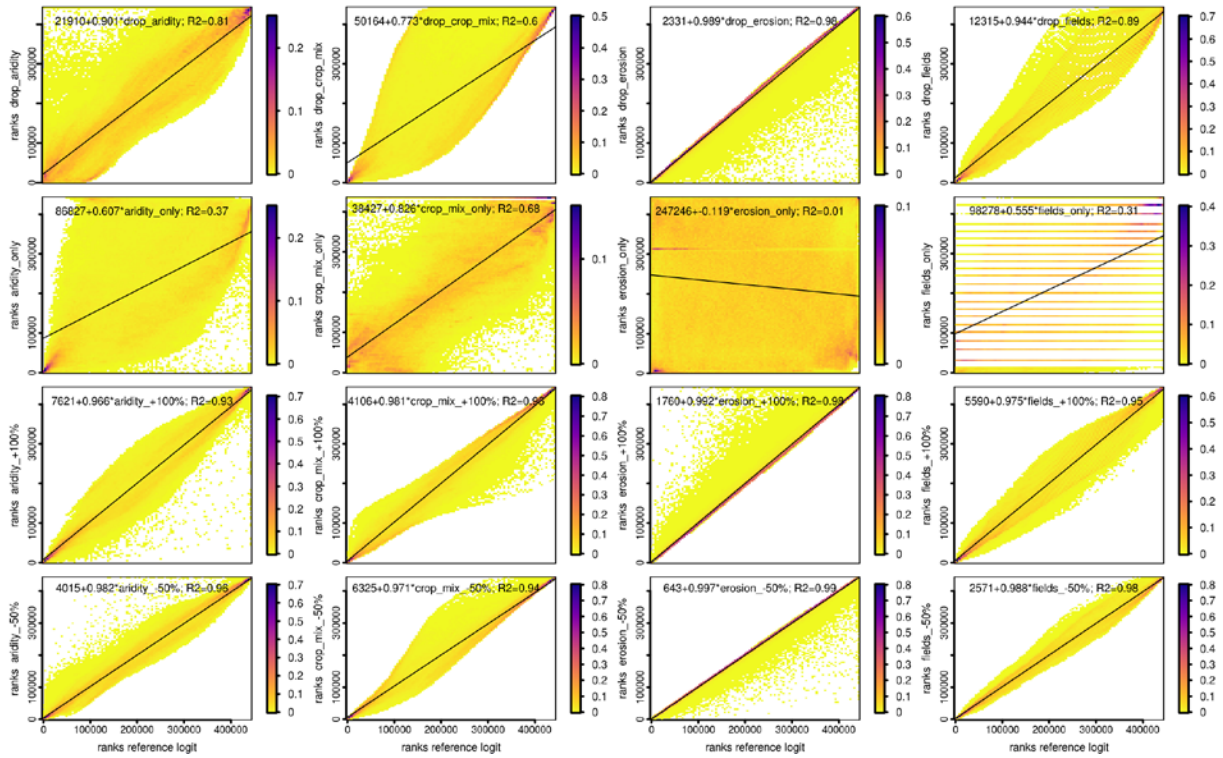

Figure S5 Density scatterplot per sensitivity combinations of our logit model with the four input variables (from left-right: aridity, crop mix, erosion, fields) per grid cell, when (first row) dropping one variable, (second row) taking one variable only, (third row) adding 100 % to slope, and (forth row) taking 50 % off of the original slope of a variable (note for settings in lines three and four, that the other three variable parameters remain unchanged respectively). The plots show that within the scope of our sensitivity analysis ranks of the alternative logit settings mostly show changed order close to the regression line (black line, $p < 0.001$ for all combinations). The darker color pattern within the density plots shows that more grid cells in the lower and upper end of the rank numbers have more different ranks than in the center.

Table S6 Spearman rank correlation coefficient (r) of the reference logit model to each of sensitivity combination of variables and slopes in the logit model for each of the 54 CA area reporting countries. We aggregated values to country scale applying the accompanying grid cell allocation key by IFPRI/IIASA (2017a).

Country	Variable	Correlation (r) reference to drop one variable	Correlation (r) reference to one variable only	Correlation (r) reference to modified slope of one variable by plus 100 %	Correlation (r) reference to modified slope of one variable by minus 50 %
Argentina	field size	0.927	0.653	0.979	0.986
	erosion	0.990	0.085	0.991	0.996
	aridity	0.896	0.370	0.972	0.981
	crop mix	0.609	0.735	0.986	0.980
Australia	field size	0.912	0.744	0.982	0.987
	erosion	0.999	-0.064	0.998	1.000
	aridity	0.879	0.826	0.985	0.984
	crop mix	0.958	0.781	0.995	0.996
Azerbaijan	field size	0.919	0.246	0.971	0.985
	erosion	0.993	0.415	0.995	0.998
	aridity	0.961	-0.323	0.953	0.988
	crop mix	0.102	0.883	0.982	0.951

Country	Variable	Correlation (r) reference to drop one variable	Correlation (r) reference to one variable only	Correlation (r) reference to modified slope of one variable by plus 100 %	Correlation (r) reference to modified slope of one variable by minus 50 %
Belgium	field size	0.883	0.801	0.980	0.981
	erosion	0.998	0.394	0.998	0.999
	aridity	0.957	-0.245	0.930	0.985
	crop mix	0.613	0.868	0.973	0.961
Bolivia (Plurinational State of)	field size	0.905	0.509	0.972	0.982
	erosion	0.956	0.063	0.958	0.986
	aridity	0.962	0.740	0.981	0.992
	crop mix	0.839	0.866	0.982	0.975
Brazil	field size	0.947	0.351	0.960	0.987
	erosion	0.998	0.018	0.999	1.000
	aridity	0.878	0.395	0.940	0.971
	crop mix	0.614	0.870	0.978	0.961
Canada	field size	0.921	0.703	0.983	0.987
	erosion	0.994	-0.148	0.993	0.997
	aridity	0.849	0.627	0.976	0.984
	crop mix	0.772	0.595	0.985	0.981
Chile	field size	0.989	0.045	0.988	0.997
	erosion	0.896	0.076	0.957	0.979
	aridity	0.267	0.774	0.951	0.921
	crop mix	0.884	0.243	0.952	0.972
China	field size	0.931	0.472	0.972	0.986
	erosion	0.963	0.123	0.971	0.990
	aridity	0.937	0.034	0.957	0.984
	crop mix	0.414	0.860	0.974	0.947
Colombia	field size	0.977	0.285	0.981	0.994
	erosion	0.994	0.012	0.995	0.999
	aridity	0.655	0.835	0.969	0.956
	crop mix	0.881	0.629	0.963	0.977
Democratic People's Republic of Korea	field size	0.990	0.312	0.997	0.996
	erosion	0.672	0.853	0.984	0.957
	aridity	0.930	0.023	0.915	0.985
	crop mix	0.869	0.583	0.962	0.980
Finland	field size	0.488	0.778	0.968	0.939
	erosion	0.999	-0.155	0.999	1.000
	aridity	0.907	0.464	0.952	0.978
	crop mix	0.872	0.186	0.958	0.988
France	field size	0.872	0.696	0.973	0.979
	erosion	0.996	-0.243	0.996	0.998
	aridity	0.904	0.136	0.950	0.980
	crop mix	0.558	0.675	0.964	0.952
Germany	field size	0.890	0.770	0.973	0.978
	erosion	0.998	-0.169	0.996	0.999
	aridity	0.889	0.692	0.969	0.981
	crop mix	0.870	0.534	0.971	0.978
Ghana	field size	0.970	0.078	0.985	0.994
	erosion	0.995	-0.140	0.996	0.998
	aridity	0.978	0.722	0.987	0.993
	crop mix	0.649	0.968	0.993	0.989
Greece	field size	0.974	0.409	0.987	0.995
	erosion	0.991	-0.022	0.994	0.998
	aridity	0.952	0.272	0.981	0.991
	crop mix	0.485	0.909	0.989	0.982
Hungary	field size	0.466	0.884	0.975	0.936
	erosion	0.999	0.402	1.000	1.000
	aridity	0.947	-0.009	0.945	0.986
	crop mix	0.901	0.456	0.956	0.980
India	field size	0.980	0.349	0.990	0.996
	erosion	0.934	0.003	0.986	0.987
	aridity	0.906	0.610	0.979	0.987
	crop mix	0.772	0.897	0.988	0.988
Iraq	field size	0.931	0.125	0.962	0.985

Country	Variable	Correlation (r) reference to drop one variable	Correlation (r) reference to one variable only	Correlation (r) reference to modified slope of one variable by plus 100 %	Correlation (r) reference to modified slope of one variable by minus 50 %
	erosion	0.883	0.533	0.957	0.969
	aridity	0.956	-0.381	0.960	0.988
	crop mix	0.223	0.838	0.971	0.955
Ireland	field size	0.916	0.279	0.935	0.976
	erosion	0.998	-0.182	0.998	0.999
	aridity	0.280	0.895	0.972	0.929
	crop mix	0.989	0.016	0.992	0.998
Italy	field size	0.889	0.506	0.967	0.980
	erosion	0.966	0.244	0.969	0.988
	aridity	0.758	0.399	0.894	0.927
	crop mix	0.722	0.614	0.926	0.948
Kazakhstan	field size	0.716	0.815	0.980	0.967
	erosion	0.995	-0.298	0.994	0.999
	aridity	0.944	0.129	0.965	0.987
	crop mix	0.842	0.638	0.990	0.992
Kenya	field size	0.920	0.086	0.937	0.978
	erosion	0.961	0.328	0.991	0.994
	aridity	0.902	0.671	0.974	0.984
	crop mix	0.739	0.824	0.982	0.974
Kyrgyzstan	field size	0.967	0.002	0.975	0.993
	erosion	0.807	0.758	0.975	0.972
	aridity	0.982	-0.340	0.980	0.995
	crop mix	0.565	0.807	0.968	0.959
Lebanon	field size	0.857	0.336	0.956	0.975
	erosion	0.978	0.338	0.989	0.993
	aridity	0.991	-0.124	0.992	0.998
	crop mix	0.419	0.813	0.971	0.960
Lesotho	field size	0.888	-0.039	0.814	0.968
	erosion	0.891	0.289	0.959	0.974
	aridity	0.470	0.479	0.949	0.837
	crop mix	0.767	0.334	0.942	0.957
Madagascar	field size	0.960	0.253	0.982	0.992
	erosion	0.994	-0.008	0.983	0.998
	aridity	0.937	0.299	0.986	0.989
	crop mix	0.393	0.883	0.983	0.972
Malawi	field size	0.804	0.737	0.950	0.976
	erosion	0.957	-0.173	0.978	0.990
	aridity	0.962	0.663	0.972	0.991
	crop mix	0.837	0.743	0.981	0.954
Mexico	field size	0.940	0.492	0.971	0.988
	erosion	0.988	0.280	0.990	0.997
	aridity	0.935	0.445	0.971	0.987
	crop mix	0.626	0.788	0.968	0.946
Morocco	field size	0.931	0.292	0.970	0.984
	erosion	0.871	0.417	0.955	0.976
	aridity	0.962	-0.241	0.970	0.990
	crop mix	0.348	0.797	0.965	0.948
Mozambique	field size	0.907	0.104	0.934	0.976
	erosion	0.984	0.446	0.993	0.997
	aridity	0.919	0.247	0.944	0.980
	crop mix	0.472	0.860	0.970	0.941
Namibia	field size	0.931	-0.134	0.903	0.991
	erosion	0.996	-0.017	0.998	0.999
	aridity	0.989	0.034	0.992	0.997
	crop mix	-0.077	0.913	0.992	0.897
Netherlands	field size	0.862	0.346	0.955	0.971
	erosion	1.000	0.059	1.000	1.000
	aridity	0.984	0.011	0.987	0.996
	crop mix	0.467	0.900	0.981	0.973
New Zealand	field size	0.966	0.222	0.975	0.992
	erosion	0.952	0.147	0.974	0.985
	aridity	0.617	0.561	0.912	0.927
	crop mix	0.641	0.537	0.924	0.924

Country	Variable	Correlation (r) reference to drop one variable	Correlation (r) reference to one variable only	Correlation (r) reference to modified slope of one variable by plus 100 %	Correlation (r) reference to modified slope of one variable by minus 50 %
Paraguay	field size	0.896	0.616	0.978	0.983
	erosion	1.000	0.172	1.000	1.000
	aridity	0.752	0.467	0.894	0.951
	crop mix	0.633	0.465	0.923	0.918
Portugal	field size	0.958	0.875	0.989	0.992
	erosion	0.999	-0.265	0.999	1.000
	aridity	0.974	0.897	0.995	0.996
	crop mix	0.956	0.896	0.992	0.993
Republic of Moldova	field size	0.871	0.468	0.958	0.976
	erosion	0.998	0.144	0.998	0.999
	aridity	0.993	-0.089	0.993	0.998
	crop mix	0.483	0.868	0.976	0.958
Russian Federation	field size	0.949	0.595	0.984	0.990
	erosion	0.999	-0.303	0.999	1.000
	aridity	0.962	0.737	0.987	0.994
	crop mix	0.794	0.887	0.990	0.985
Slovakia	field size	0.676	0.822	0.967	0.950
	erosion	0.998	-0.226	0.998	0.999
	aridity	0.764	0.523	0.934	0.960
	crop mix	0.923	-0.182	0.961	0.980
South Africa	field size	0.947	0.693	0.984	0.991
	erosion	0.998	-0.565	0.997	0.999
	aridity	0.978	0.219	0.987	0.995
	crop mix	0.647	0.910	0.988	0.981
Spain	field size	0.920	0.525	0.960	0.982
	erosion	0.997	-0.075	0.997	0.999
	aridity	0.954	-0.028	0.967	0.989
	crop mix	0.408	0.836	0.966	0.930
Switzerland	field size	0.959	0.330	0.980	0.991
	erosion	0.770	0.162	0.908	0.915
	aridity	0.798	0.154	0.831	0.915
	crop mix	0.515	0.757	0.957	0.946
Syrian Arab Republic	field size	0.977	0.452	0.984	0.995
	erosion	0.997	0.021	0.997	0.999
	aridity	0.990	0.530	0.993	0.998
	crop mix	0.649	0.958	0.993	0.981
Tunisia	field size	0.960	0.027	0.965	0.990
	erosion	0.994	0.135	0.994	0.998
	aridity	0.967	0.197	0.969	0.992
	crop mix	0.222	0.956	0.989	0.964
Turkey	field size	0.896	0.348	0.958	0.978
	erosion	0.943	0.153	0.959	0.987
	aridity	0.929	0.308	0.961	0.983
	crop mix	0.576	0.798	0.970	0.953
Ukraine	field size	0.881	0.587	0.975	0.983
	erosion	0.999	0.107	0.999	1.000
	aridity	0.925	0.514	0.975	0.986
	crop mix	0.705	0.710	0.980	0.976
United Kingdom	field size	0.903	0.620	0.958	0.978
	erosion	0.996	-0.253	0.996	0.999
	aridity	0.521	0.873	0.970	0.935
	crop mix	0.976	0.051	0.978	0.993
United Republic of Tanzania	field size	0.966	0.204	0.974	0.992
	erosion	0.990	0.119	0.991	0.997
	aridity	0.969	0.476	0.984	0.993
	crop mix	0.565	0.942	0.988	0.974
United States of America	field size	0.942	0.592	0.981	0.990
	erosion	0.995	-0.073	0.997	0.999
	aridity	0.890	0.475	0.962	0.981
	crop mix	0.599	0.552	0.965	0.947
Uruguay	field size	0.824	0.142	0.950	0.956
	erosion	1.000	-0.291	1.000	1.000

Country	Variable	Correlation (r) reference to drop one variable	Correlation (r) reference to one variable only	Correlation (r) reference to modified slope of one variable by plus 100 %	Correlation (r) reference to modified slope of one variable by minus 50 %
	aridity	0.976	0.223	0.973	0.993
	crop mix	0.255	0.850	0.978	0.968
Uzbekistan	field size	0.762	0.483	0.939	0.966
	erosion	0.978	0.047	0.991	0.997
	aridity	0.933	0.119	0.952	0.984
	crop mix	0.519	0.606	0.963	0.910
Venezuela (Bolivarian Republic of)	field size	0.954	0.420	0.975	0.990
	erosion	0.995	-0.183	0.997	0.998
	aridity	0.928	0.325	0.971	0.987
	crop mix	0.479	0.859	0.977	0.957
Zambia	field size	0.825	0.396	0.931	0.962
	erosion	0.950	0.388	0.981	0.990
	aridity	0.918	0.377	0.957	0.981
	crop mix	0.696	0.721	0.961	0.962
Zimbabwe	field size	0.725	0.649	0.986	0.978
	erosion	0.958	0.085	0.969	0.988
	aridity	0.953	0.387	0.980	0.990
	crop mix	0.752	0.556	0.993	0.996

The logit model sensitivity results show differing patterns for each of the countries, where cell ranks change due to differing slopes and variable combinations in the logit model equation. For the setting of dropping a variable, most correlation to the reference logit model is lowest for dropping crop-mix (see Namibia, Azerbaijan, Iraq correlation values respectively) and highest mostly for dropping erosion. For the sensitivity setting of taking one variable only into the logit model, more than half of the correlation coefficients to the reference logit model are lower than r^2=0.5. For 32 out of 216 total country-variable combinations, we even find negative correlations mostly occurring when taking erosion only into the logit model. For South Africa we find the overall lowest correlation coefficient when taking erosion only (r^2=-0.565) but relatively high correlation when dropping erosion (r^2=0.998). Changing the slope of the functions results in very low changes of the rank order of grid cells and corresponding CA-suitable area, as can be interpreted from the fact that even the lowest correlations coefficients of slope settings to the reference logit model remain above r^2= 0.812 when manipulating the slopes of the input variable functions by +100 % or -50 %.

Table S7 Conservation Agriculture area for 54 reporting countries (FAO, 2016), as presented in this study and the difference between both values (note, that for New Zealand and North Korea not enough potential CA area could be detected in the SPAM2005 cropland dataset, so instead of 230 km^2 for Korea only 23.9 km^2, and for New Zealand instead of 1620 km^2 only 785.2 km^2 could be downscaled. Deviation between reported and downscaled CA area of the further countries are caused by our downscale algorithm, which tries to minimize deviation from reported national CA area value by in- or excluding potential CA area of a whole grid cell).

Country	Year of considered national reported CA value	National reported CA (km^2)	CA downscaled (km^2)	Difference CA downscaled to reported CA (km^2)
Argentina	2007	227080	227069.6	-10.4
Australia	2005	90000	90006.1	6.1
Azerbaijan	2013	13	12.3	-0.7
Belgium	2013	2.68	13.9	11.3
Bolivia (Plurinational State of)	2007	7060	7042.2	-17.8
Brazil	2006	255020	255024.5	4.5

Country	Year of considered national reported CA value	National reported CA (km^2)	CA downscaled (km^2)	Difference CA downscaled to reported CA (km^2)
Canada	2006	134790	134797.6	7.6
Chile	2005	1200	1196.1	-3.9
China	2005	1000	1016.8	16.8
Colombia	2005	1020	1021.2	1.2
Democratic People's Republic of Korea	2011	230	23.9	-206.1
Finland	2011	1600	1602.1	2.1
France	2005	1500	1510.2	10.2
Germany	2013	2000	2005.5	5.5
Ghana	2008	300	302.7	2.7
Greece	2013	240	231.9	-8.1
Hungary	2005	80	73.1	-6.9
India	2013	15000	15000.8	0.8
Iraq	2012	150	149.8	-0.2
Ireland	2005	1	18.4	17.4
Italy	2005	800	794.0	-6.0
Kazakhstan	2007	6000	5997.8	-2.2
Kenya	2004	150	165.2	15.2
Kyrgyzstan	2013	7	6.8	-0.2
Lebanon	2011	12	10.4	-1.6
Lesotho	2005	1.3	12.7	11.4
Madagascar	2011	60	60.1	0.1
Malawi	2011	160	129.9	-30.1
Mexico	2007	228	228.2	0.2
Morocco	2008	40	39.4	-0.6
Mozambique	2006	90	89.1	-0.9
Namibia	2011	3.4	5.2	1.8
Netherlands	2011	5	0.4	-4.6
New Zealand	2008	1620	785.2	-834.8
Paraguay	2007	20940	20941.5	1.5
Portugal	2006	250	245.3	-4.7
Republic of Moldova	2011	400	382.0	-18.0
Russian Federation	2011	45000	45011.3	11.3
Slovakia	2006	100	92.5	-7.5
South Africa	2005	3000	3005.0	5.0
Spain	2005	3000	3008.1	8.1
Switzerland	2005	90	86.9	-3.1
Syrian Arab Republic	2012	300	304.4	4.4
Tunisia	2007	60	61.7	1.7
Turkey	2013	450	446.7	-3.3
Ukraine	2011	6000	6015.5	15.5
United Kingdom	2005	240	234.0	-6.0
United Republic of Tanzania	2011	250	260.6	10.6
United States of America	2007	265000	264992.6	-7.4
Uruguay	2007	5539	5538.8	-0.2
Uzbekistan	2013	24.5	36.2	11.7
Venezuela (Bolivarian Republic of)	2005	3000	2999.8	-0.2
Zambia	2002	400	398.6	-1.4
Zimbabwe	2011	1393	1394.9	1.9
World		**1102899.9**	**1101899.2**	**-1000.7**

Table S8 Area weighted means of aridity, field size, crop mix, and water erosion over tillage system areas generated in this study.

Area type	Aridity index (P/PET)	Field size (10-40)	Crop mix (0-1)	Water erosion ($t\ ha^{-1}\ year^{-1}$)
Potential CA	0.734	31	0.87	10.8
CA	0.675	36	0.96	5.2
Traditional annual tillage	0.823	15	0.00	35.2
Traditional rotational tillage	1.106	15	0.00	46.7

Area type	Aridity index (P/PET)	Field size (10-40)	Crop mix (0-1)	Water erosion (t ha^{-1} $year^{-1}$)
Rotational tillage	1.007	26	0.34	24.6
Reduced tillage	0.607	16	0.03	33.8
Conventional annual tillage	0.755	29	0.72	13.0
Scenario CA	0.733	31	0.87	10.8
Total cropland	**0.806**	**23**	**0.41**	**23.1**

In the Table S8 we show area weighted means of our four logit model input variables aridity, field size, crop mix, and water erosion aggregated over each of tillage system areas mapped in this study. For aridity reduced tillage is the only area with dry sub-humid conditions, i.e. with an average aridity below the threshold of 0.65, all others are humid with values above 0.65. Traditional rotational and rotational tillage are on average more humid than the annually tilled areas. Potential CA area is more humid than downscaled CA area. Regarding field size we find, that downscaled CA area has the largest field size contrary to both traditional tillage system areas showing the smallest ones. Crop mix is calculated for cells with at least one of the 22 CA-suitable annual crop type areas in grid cells reporting large fields in low income or all field sizes in high income countries, so that none was derived for traditional tillage system areas. The highest crop mix ratio is found for the actually downscaled CA area. Regarding water erosion we find very low erosion levels under CA area which is either because we actually did hit the right cells where this practice is already protecting the soil or the general low impact of the variable in the logit equation. For downscaled, potential, and scenario CA area we calculated lower erosion levels than the T-value (12 t ha^{-1} $year^{-1}$ as erosion loss tolerance level) defined by USDA (Montgomery, 2007). Even for conventional annual tillage area the average erosion level of 13 t ha^{-1} $year^{-1}$ is only 1 t higher than the T-value. We find largest average water erosion levels for both types of traditionally tilled areas (in cells reporting small fields as dominant and in low income countries), which either might result from the climatic conditions in the tropics and sub-tropics with intensive rainfall events, increased slopes because of mountainous landscapes, deforestation, or nutrient mining resulting in degradation of the soil asset. As well does reduced tillage area have a quite high average water erosion rate, as it is mainly distributed within a narrow band of the tropical climate zone, this may also be because of climate conditions, where elevated weathering of soils results in shallow soil depths. Generally the averaged values of the four datasets across the potential and scenario CA data are similar or identical because of just few different amounts of grid cells considered.

Table S9 Sums of tillage systems areas per country (n=191) on physical cropland aggregated with grid cell allocation key for countries (IFPRI/IIASA, 2017a).

Country name	Cropland (km^2) (IFPRI/ IIASA, 2017b)	Conven-tional annual tillage (km^2)	CA (km^2)	Reduced tillage (km^2)	Rota-tional tillage (km^2)	Tradi-tional rotational (km^2)	Tradi-tional annual tillage (km^2)	Scenario CA (km^2)
Afghanistan	28932	12139	0	0	337	1039	15417	6086
Åland Islands	14	12	0	0	2	0	0	8
Albania	2918	26	0	0	5	770	2116	24
Algeria	39101	29981	0	0	6591	607	1922	26559
Andorra	13	6	0	0	7	0	0	3
Angola	29135	10473	0	0	614	731	17317	6285
Anguilla	10	3	0	0	7	0	0	2
Antigua & Barbuda	24	12	0	0	12	0	0	11
Argentina	248058	11329	227070	0	9659	0	0	231220
Armenia	2938	1343	0	0	306	172	1117	761
Australia	226123	129800	90006	0	6317	0	0	213540
Austria	10430	9435	0	0	995	0	0	8530

Country name	Cropland (km^2) (IFPRI/ IIASA, 2017b)	Conven-tional annual tillage (km^2)	CA (km^2)	Reduced tillage (km^2)	Rota-tional tillage (km^2)	Tradi-tional rotational (km^2)	Tradi-tional annual tillage (km^2)	Scenario CA (km^2)
Azerbaijan	13112	10279	12	0	1084	221	1516	1744
Bahrain	22	5	0	0	17	0	0	0
Bangladesh	90550	6347	0	0	1025	8986	74191	1514
Barbados	53	11	0	0	41	0	0	10
Belarus	33239	30893	0	0	2305	3	38	25161
Belgium	6189	5670	14	0	505	0	0	3695
Belize	631	241	0	0	390	0	0	216
Benin	16824	522	0	379	34	741	15149	443
Bhutan	1788	0	0	0	0	290	1498	0
Bolivia	25098	11191	7042	0	1607	753	4505	15496
Bosnia & Herzegovina	5706	2504	0	0	534	405	2263	2317
Botswana	1554	1529	0	0	25	0	0	1383
Brazil	616114	223944	255024	0	119508	2030	15607	420609
Brunei	204	119	0	0	85	0	0	47
Bulgaria	26883	23998	0	0	1945	195	745	22911
Burkina Faso	51851	3555	0	1705	55	482	46053	3971
Burundi	12881	0	0	0	0	4566	8315	0
Cambodia	26899	9918	0	0	545	556	15880	1156
Cameroon	43770	3208	0	108	2543	10874	27037	2241
Canada	261638	118646	134798	0	8194	0	0	246921
Cape Verde	465	0	0	0	0	39	427	0
Central African Republic	9058	1557	0	0	281	1307	5914	999
Chad	29280	5273	0	0	92	717	23198	4951
Chile	12851	8133	1196	0	3521	0	0	5496
China	1335729	303891	1017	126	24144	133202	873348	183326
Colombia	40010	16093	1021	0	17738	3871	1287	8848
Congo	2917	1534	0	0	569	220	593	650
Congo, DRC	59365	16171	0	0	2955	5258	34981	7691
Costa Rica	4458	939	0	0	3519	0	0	312
Cote d'Ivory	67051	14954	0	0	16432	20751	14915	8928
Croatia	8518	7591	0	0	928	0	0	7034
Cuba	17550	9097	0	0	8254	94	104	5028
Cyprus	1125	769	0	0	356	0	0	544
Czech Republic	22675	21673	0	0	1001	0	0	20600
Denmark	16996	16940	0	0	57	0	0	14275
Djibouti	76	0	0	0	0	0	76	0
Dominica	107	38	0	0	70	0	0	9
Dominican Republic	8288	3104	0	0	4844	216	123	774
Ecuador	24591	10447	0	0	10894	1592	1658	4976
Egypt	47432	3231	0	0	669	6496	37036	219
El Salvador	6364	528	0	0	321	2036	3479	516
Equatorial Guinea	889	353	0	0	536	0	0	0
Eritrea	6759	510	0	1568	62	358	4260	440
Estonia	3688	3560	0	0	127	0	0	3408
Ethiopia	97701	2430	0	6797	514	10416	77544	2217
Fiji	1492	262	0	0	1230	0	0	47
Finland	12979	11311	1602	0	66	0	0	12257
France	134435	120717	1510	0	12208	0	0	104406
French Guiana	146	124	0	0	21	0	0	7
Gabon	2204	1440	0	0	764	0	0	601
Georgia	5819	4222	0	0	1314	64	218	2174
Germany	93173	89155	2005	0	2012	0	0	82287
Ghana	64610	1440	303	0	643	26024	36201	1061
Greece	28323	18190	232	0	9901	0	0	10321
Grenada	94	42	0	0	53	0	0	35
Guadeloupe	171	31	0	0	140	0	0	24
Guatemala	19721	2497	0	34	3074	3782	10334	1981
Guinea	29333	2288	0	112	327	6719	19887	1357
Guinea-Bissau	3365	14	0	191	1	325	2834	24
Guyana	1990	1246	0	0	744	0	0	125
Haiti	10702	1479	0	0	647	1964	6611	1081
Honduras	10106	3812	0	0	3379	1266	1649	3402
Hungary	40622	38383	73	0	2166	0	0	36471
India	1558662	181111	15001	107461	11018	126696	1117375	161503
Indonesia	270842	56095	0	0	48388	51416	114944	32279
Iran	136040	91162	0	0	13206	2996	28676	48739
Iraq	38137	29609	150	0	1912	309	6157	15546
Ireland	3358	3316	18	0	24	0	0	2984
Israel	3142	2108	0	0	1034	0	0	1019
Italy	53978	34986	794	0	18198	0	0	27214

Country name	Cropland (km^2) (IFPRI/ IIASA, 2017b)	Conven-tional annual tillage (km^2)	CA (km^2)	Reduced tillage (km^2)	Rota-tional tillage (km^2)	Tradi-tional rotational (km^2)	Tradi-tional annual tillage (km^2)	Scenario CA (km^2)
Jamaica	1448	3	0	0	28	1140	276	2
Japan	28083	25134	0	0	2949	0	0	4849
Jordan	1661	194	0	0	112	645	711	70
Kazakhstan	148677	140046	5998	0	2633	0	0	134797
Kenya	44766	9449	165	0	1715	5094	28343	8953
Kiribati	272	18	0	0	253	0	0	7
Kosovo	57	0	0	0	0	8	49	0
Kuwait	70	48	0	0	22	0	0	38
Kyrgyzstan	8548	7300	7	0	736	76	430	1101
Laos	12334	1787	0	0	199	1070	9278	284
Latvia	7126	6912	0	0	214	0	0	6274
Lebanon	2505	1335	10	0	1160	0	0	619
Lesotho	2245	1933	13	0	34	2	263	1875
Liberia	4959	1602	0	0	337	796	2225	878
Libya	7005	4482	0	0	2523	0	0	2443
Liechtenstein	5	5	0	0	0	0	0	5
Lithuania	12256	11872	0	0	384	0	0	10914
Luxembourg	451	414	0	0	36	0	0	407
Macedonia	3609	939	0	0	141	442	2087	739
Madagascar	29263	435	60	0	52	4762	23955	105
Malawi	34520	5763	130	0	283	1193	27150	5159
Malaysia	57839	18173	0	0	39666	0	0	12890
Maldives	61	0	0	0	0	45	16	0
Mali	47428	6322	0	1189	239	1117	38560	5959
Malta	67	54	0	0	13	0	0	36
Martinique	191	37	0	0	153	0	0	31
Mauritania	3792	595	0	0	47	173	2976	445
Mauritius	741	39	0	0	703	0	0	34
Mexico	145349	111783	228	5791	27546	0	0	82423
Moldova, Republic of	17401	14529	382	0	2342	55	93	13888
Mongolia	1631	1525	0	0	4	0	102	1176
Montenegro	113	0	0	0	0	60	53	0
Montserrat	3	2	0	0	1	0	0	2
Morocco	72316	41365	39	0	5084	3156	22671	36777
Mozambique	55194	8366	89	0	887	3515	42336	6840
Myanmar	102876	6769	0	0	409	6237	89460	2706
Namibia	3597	3216	5	0	59	10	307	2910
Nepal	47046	2355	0	0	265	4299	40127	728
Netherlands	6512	6182	0	0	330	0	0	2831
New Caledonia	117	70	0	0	47	0	0	40
New Zealand	2264	904	785	0	575	0	0	785
Nicaragua	9878	5179	0	0	1287	784	2629	4294
Niger	73479	5919	0	0	38	615	66907	5910
Nigeria	410586	27641	0	22805	8253	50935	300952	13537
North Korea	25889	310	24	0	13	2026	23516	24
Norway	3526	3480	0	0	46	0	0	2887
Oman	443	129	0	0	314	0	0	24
Pakistan	201969	10841	0	0	1394	15288	174445	3827
Palestinian Territory, Occupied	85	0	0	0	0	32	53	0
Panama	3313	2101	0	0	1212	0	0	840
Papua New Guinea	9182	2692	0	0	6333	110	46	742
Paraguay	39442	16135	20941	0	1948	17	400	34687
Peru	27867	1566	0	0	1273	6436	18592	605
Philippines	105635	35751	0	0	28926	20350	20608	22169
Poland	103304	99157	0	0	4147	0	0	89970
Portugal	14498	6720	245	0	7533	0	0	3400
Puerto Rico	348	40	0	0	308	0	0	29
Qatar	51	31	0	0	20	0	0	24
Romania	78111	73946	0	0	4165	0	0	66381
Russia	549795	493599	45011	0	11185	0	0	484052
Rwanda	12128	206	0	0	248	2847	8827	199
San Marino	13	11	0	0	2	0	0	10
Sao Tome & Principe	355	0	0	0	0	298	57	0
Saudi Arabia	9822	7342	0	1	2479	0	0	1154
Senegal	23371	1906	0	40	63	529	20832	1608
Serbia	9767	5917	0	0	568	660	2623	5540
Seychelles	34	22	0	0	12	0	0	22
Sierra Leone	13960	950	0	0	32	1208	11770	197
Slovakia	11967	11429	92	0	446	0	0	10789
Slovenia	1412	1177	0	0	235	0	0	1036

Country name	Cropland (km^2) (IFPRI/ IIASA, 2017b)	Conven-tional annual tillage (km^2)	CA (km^2)	Reduced tillage (km^2)	Rota-tional tillage (km^2)	Tradi-tional rotational (km^2)	Tradi-tional annual tillage (km^2)	Scenario CA (km^2)
Solomon Is.	836	170	0	0	666	0	0	40
Somalia	8385	4897	0	0	177	172	3139	4324
South Africa	55841	46397	3005	0	6439	0	0	44374
South Korea	14821	12666	0	0	2155	0	0	3488
Spain	132010	86117	3008	0	42884	0	0	69584
Sri Lanka	18798	586	0	0	424	6987	10802	376
St. Kitts & Nevis	18	3	0	0	14	0	0	2
St. Lucia	87	18	0	0	69	0	0	8
St. Vincent & the Grenadines	92	32	0	0	60	0	0	15
Sudan	125120	64140	0	6058	1711	1915	51296	64178
Suriname	545	472	0	0	73	0	0	13
Swaziland	1461	749	0	0	634	7	71	629
Sweden	12255	12175	0	0	81	0	0	11322
Switzerland	2322	2025	87	0	210	0	0	1694
Syria	44650	30387	304	0	5999	1342	6618	21820
Taiwan	4900	3121	0	0	1779	0	0	1943
Tajikistan	8687	5960	0	0	840	194	1692	1899
Tanzania	113154	11195	261	0	1440	16384	83874	8283
Thailand	168057	74221	0	0	17846	11239	64751	16952
The Gambia	2698	389	0	0	5	34	2271	357
Timor-Leste	1465	678	0	0	351	77	359	312
Togo	14656	243	0	25	48	1318	13022	199
Trinidad & Tobago	483	78	0	0	405	0	0	49
Tunisia	37116	17365	62	0	13872	4291	1527	14057
Turkey	204423	183746	447	0	20231	0	0	158681
Turkmenistan	17389	16593	0	0	642	18	136	1160
Uganda	43409	2431	0	0	2443	11068	27467	1884
Ukraine	220606	207247	6015	0	4706	54	2584	187922
United Arab Emirates	1936	115	0	0	1821	0	0	0
United Kingdom	41700	40761	234	0	705	0	0	37849
United States	955389	669911	264993	0	20485	0	0	792663
Uruguay	10232	4253	5539	0	440	0	0	7455
Uzbekistan	37354	32660	36	0	3041	63	1553	5439
Vanuatu	1026	99	0	0	928	0	0	45
Venezuela	20337	10920	3000	10	6407	0	0	9723
Vietnam	85611	24076	0	0	3634	11279	46622	1962
Yemen	10452	190	0	0	65	1162	9036	108
Zambia	13899	6510	399	0	335	182	6472	5531
Zimbabwe	30367	9371	1395	0	331	868	18403	10178

Figure S10 Area difference (km^2) map of the calculated sum of our mapped traditional annual and traditional rotational tillage system area and the sum of cropland under low input and subsistence farming (IFPRI/IIASA, 2017b). Reddish colors indicate less cropland in our traditional tillage dataset, mostly found in high income countries – larger discrepancy depicted in the South of Brazil. Blue colors show more area in our traditional tillage dataset in large parts of India, and South-East Asia.

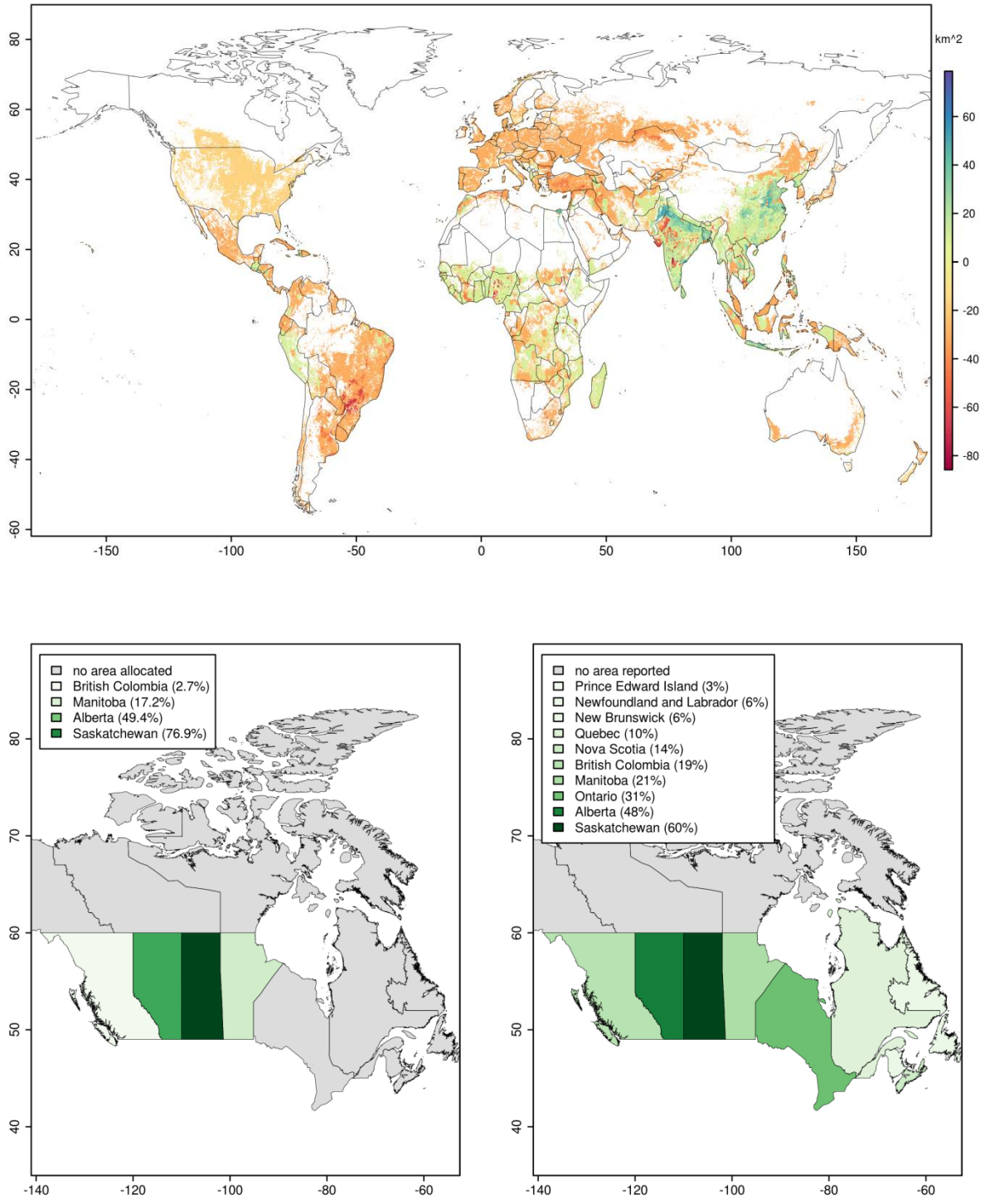

Figure S11.1.1 We aggregated mapped Conservation Agricultural area to state or provincial scale using the GADM-1 data (Global Administrative Areas, 2015). The map (left) shows the downscaled CA area share (%) on cropland (IFPRI/IIASA, 2017b) per Canadian province and territory. The other map (right) shows reported provincial no-tillage shares (%) on cropland by Statistics Canada (2007) for year 2006.

Table S11.1.2 Aggregated cropland, downscaled CA area, CA share on cropland as well as reported reference (Statistics Canada, 2007) cropland, no-tillage area values, and no-tillage shares on cropland for Canadian provinces and territories.

Province or Territory	Aggregated SPAM2005 cropland (km^2)	Downscaled CA (km2)	Downscaled CA share on cropland (%)	Reference cropland (km^2)	Reference no-tillage share (%)
Alberta	64179	31708	49	75782	48
British Columbia	1072	29	3	1985	19
Manitoba	32382	5563	17	38906	21
New Brunswick	614	0	0	657	6
Newfoundland and Labrador	12	0	0	24	6
Northwest Territories	0	0	0	0	0
Nova Scotia	280	0	0	267	14
Nunavut	0	0	0	0	0
Ontario	23876	0	0	26995	31
Prince Edward Island	969	0	0	1100	3
Quebec	9695	0	0	11291	10
Saskatchewan	124708	95933	77	133482	60
Yukon	0	0	0	0	0
Canada	**257786**	**133233**	**52**	**290488**	**46**

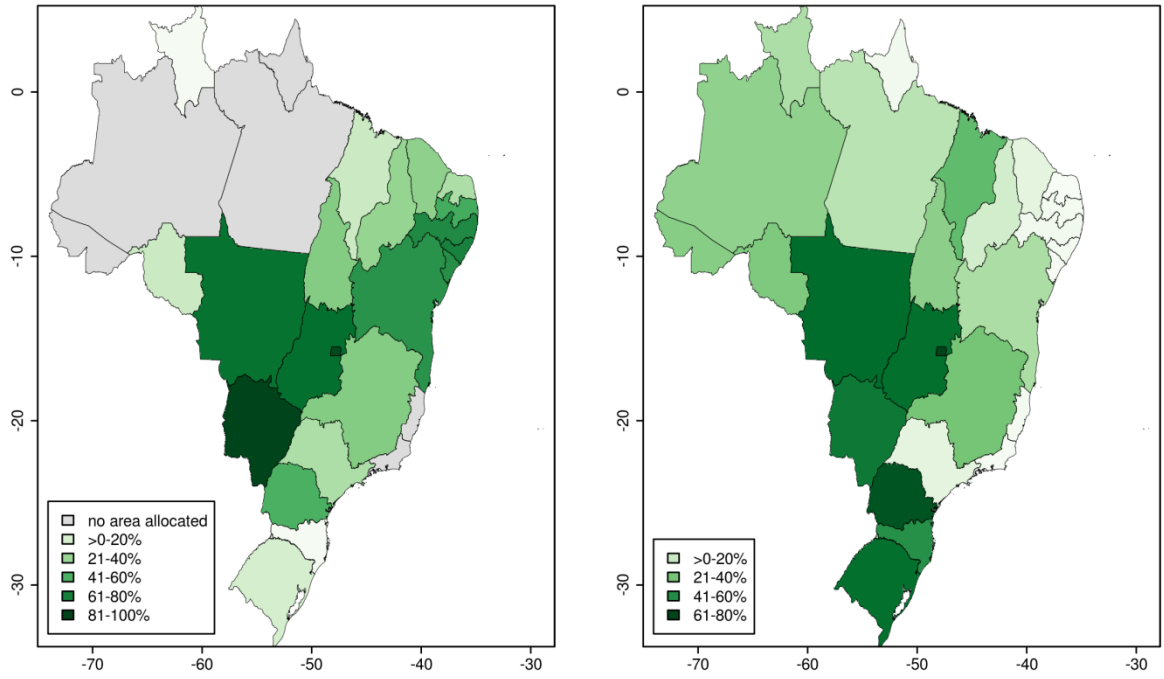

Figure S11.2.1 Aggregating tillage area for Brazilian states the map (left) shows the downscaled CA area share (%) on annuals cropland (IFPRI/IIASA, 2017b) and the other map (right) based on no-tillage share (%) on annuals cropland reported in the 2006 Agricultural Census by the Brazilian Institute of Geography and Statistics (IBGE) (Fuentes Llanillo et al., 2013) for the years 2007-08.

Table S11.2.2 Aggregated cropland, downscaled CA area, and CA share on cropland as well as reported reference (Fuentes Llanillo et al., 2013) annuals cropland, no-tillage area values, and no-tillage shares on annuals' cropland for Brazilian states.

State	Aggregated SPAM2005 annuals cropland (km2)	Downscaled CA (km2)	Downscaled CA share on annuals cropland (%)	Reference annuals cropland (km2)	Reference no-tillage share (%)
Acre	1118	0.0	0	59	35
Alagoas	2123	1576.2	74	161	3
Amapa	118	0.0	0	2	4
Amazonas	1417	0.0	0	99	33
Bahia	25685	17165.5	67	6363	27
Ceara	13716	5519.3	40	643	11
Distrito Federal	1312	1205.2	92	672	77
Espirito Santo	1041	0.0	0	32	3
Goias	41114	32952.8	80	19161	67
Maranhao	16807	3729.2	22	2982	42
Mato Grosso Do Sul	30223	28236.8	93	12531	68
Mato Grosso	79714	63493.8	80	32872	64
Minas Gerais	27490	11731.1	43	9280	39
Para	10212	0.4	0	477	23
Paraiba	4121	2404.1	58	89	3
Parana	90011	50639.4	56	37071	74
Pernambuco	6362	4524.0	71	333	4
Piaui	9940	3778.4	38	1091	16
Rio De Janeiro	437	0.0	0	35	2
Rio Grande Do Norte	1084	341.0	31	27	1
Rio Grande Do Sul	76516	14273.6	19	40853	66
Rondonia	3993	877.4	22	419	37
Roraima	545	11.7	2	77	27
Santa Catarina	15709	355.8	2	7579	57
Sao Paulo	24634	7744.2	31	4718	11
Sergipe	2329	1604.4	69	18	2
Tocantins	6727	2856.6	42	1073	33
Brazil	**494497**	**255020.8**	**52**	**178718**	**49**

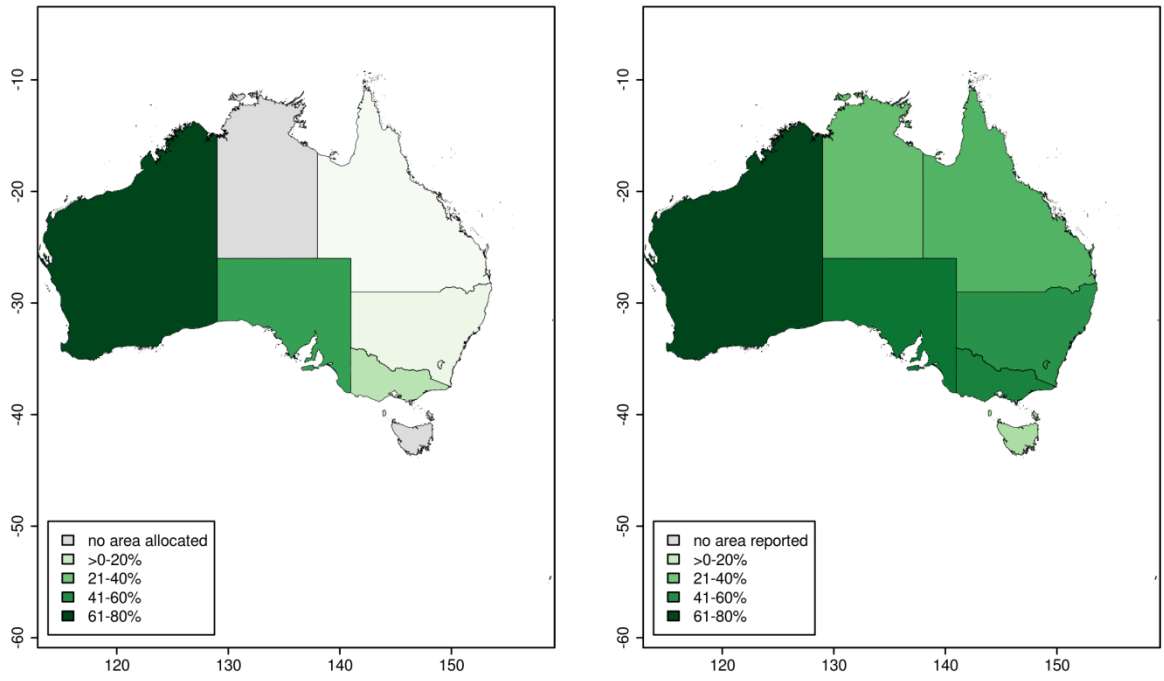

Figure S11.3.1 For the Australian states and territories the map (left) shows the downscaled CA area share (%) on cropland (IFPRI/IIASA, 2017b) and map (right) reported no-tillage share on land prepared for crops and

pastures as collected in the 2007–08 Agricultural Resource Management Survey (ARMS) conducted and published by the Australian Bureau of Statistics (2009) for the year 2006.

Table S11.3.2 Aggregated cropland, downscaled CA area, and share as well as reported reference (Australian Bureau of Statistics, 2009) cropland, no-tillage area values, and no-tillage shares (%) on cropland per Australian state and territory.

State or Territory	Aggregated SPAM2005 cropland (km^2)	Downscaled CA (km^2)	Downscaled CA share (%)	Reference cropland and pasture (km^2)	Reference no-tillage (km^2)	Reference no-tillage share (%)
New South Wales & Australian Capital Territory	4357	64196	7	77889	44608	57
Northern Territory	0	35	0	187	80	43
Queensland	285	15755	2	26978	12576	47
South Australia	20059	38064	53	43462	28902	67
Tasmania	0	419	0	947	265	28
Victoria	7776	33616	23	40198	25233	63
Western Australia	57425	73819	78	79691	63137	79
Australia	**89903**	**225904**	**40**	**269352**	**174803**	**65**

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