



Supplement of

HIStory of LAND transformation by humans in South America (HISLAND-SA): annual and 1 km gridded data for soybean, maize, wheat, and rice (1950–2020)

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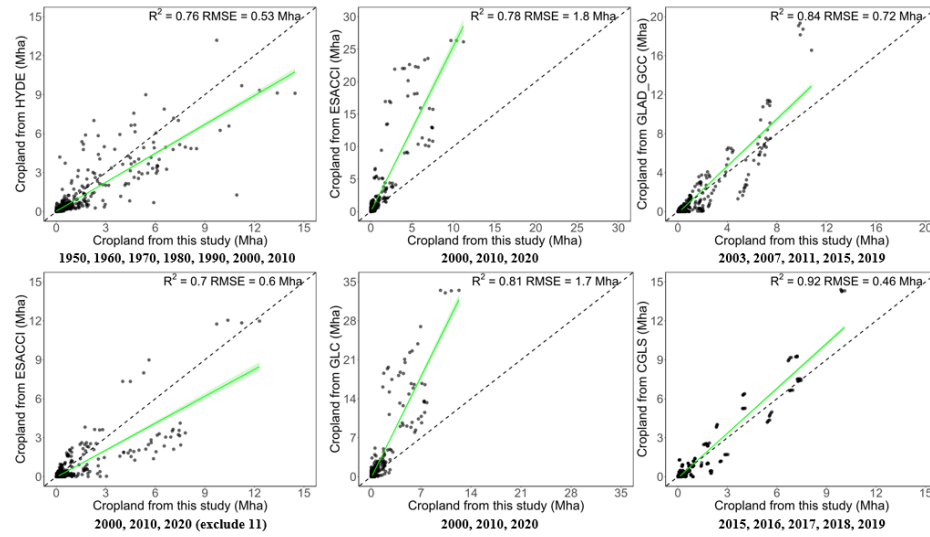


Figure S1. Comparisons between reconstructed cropland area and other datasets at the provincial level.

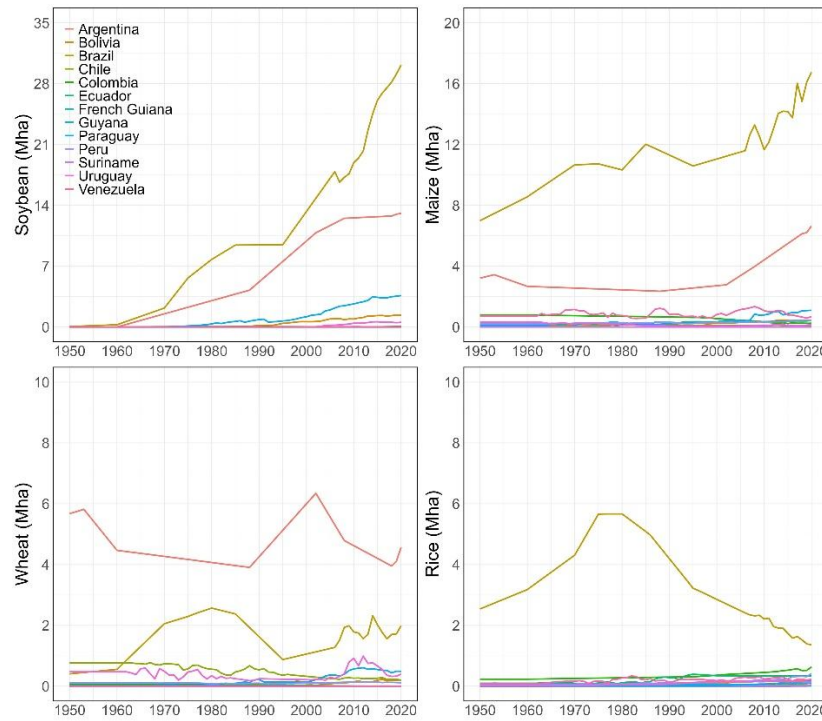


Figure S2. Temporal changes in crop-specific areas in South America at the country level during 1950-2020.

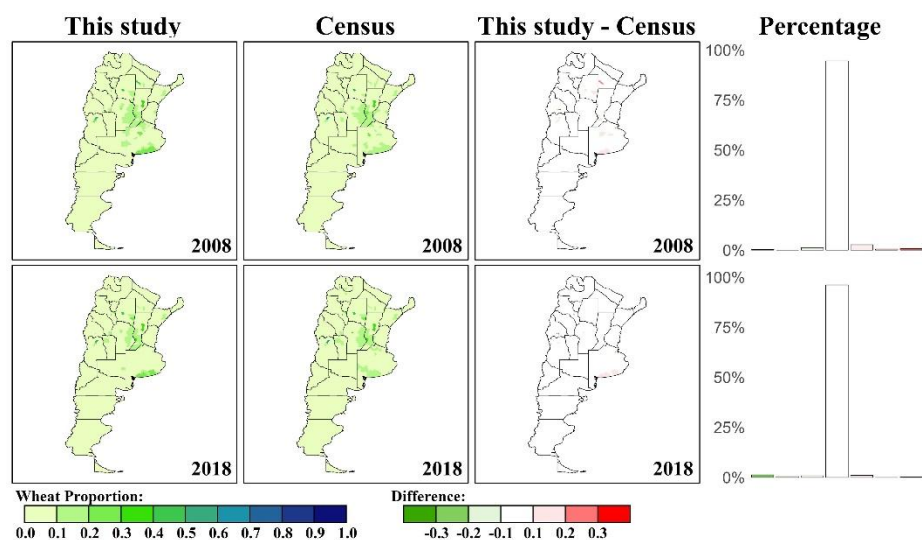


Figure S3. Spatial comparison of the wheat proportion (i.e., rice area/municipal area) between this study and census data at the municipal level in Argentina (2008 and 2018). Proportions were calculated by aggregating gridded crop-type data (allocated from provincial level statistics) and dividing by municipal area. These were compared with official municipal statistics processed in the same way. Left column: wheat proportion from this study; Middle column: wheat proportion from census data; Right column: the difference in wheat proportion between this study and census data.

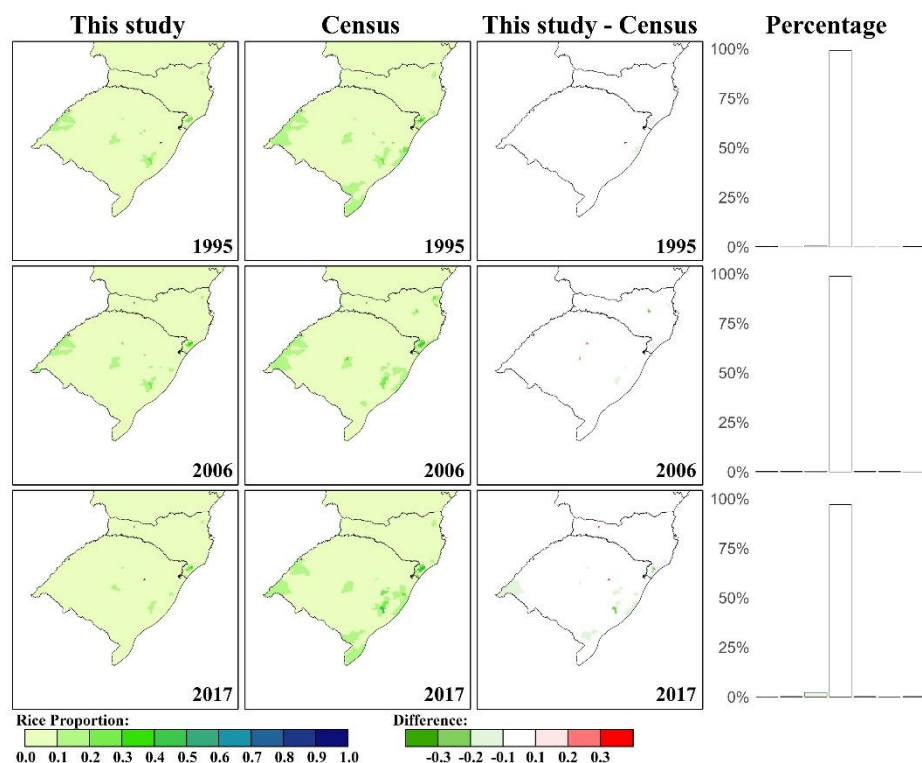


Figure S4. Spatial comparison of the rice proportion (i.e., rice area/municipal area) between this study and census data at the municipal level in Rio Grande do Sul in Brazil (1995, 2006, and 2017). Proportions were calculated by aggregating gridded crop-type data (allocated from provincial level statistics) and dividing by municipal area. These were compared with official municipal statistics processed in the same way. Left column: rice proportion from this

study; Middle column: rice proportion from census data; Right column: the difference in rice proportion between this study and census data.

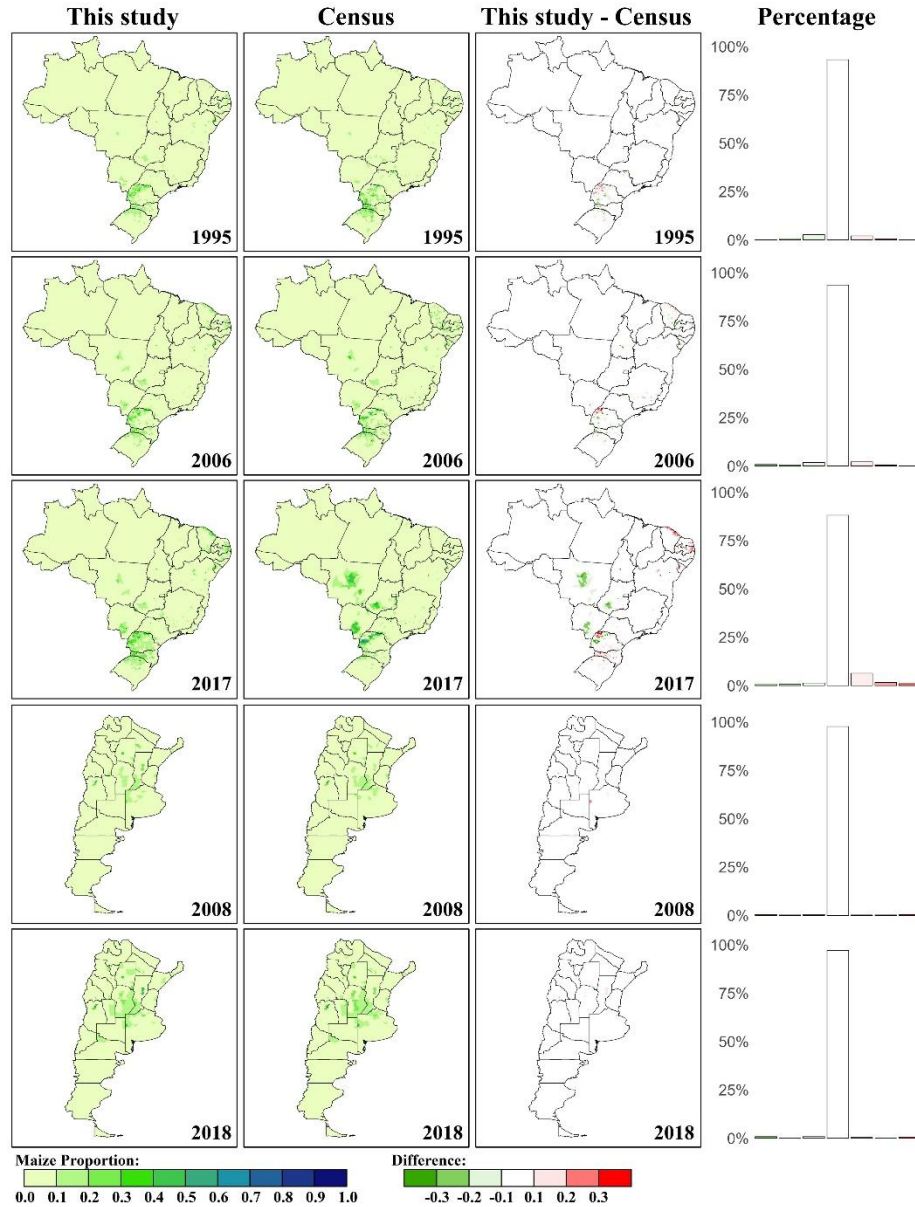


Figure S5. Spatial comparison of the maize proportion (i.e., maize area/municipal area) between this study and census data at the municipal level in Argentina (2008 and 2018) and Brazil (1995, 2006, and 2017). Proportions were calculated by aggregating gridded crop-type data (allocated from provincial level statistics) and dividing by municipal area. These were compared with official municipal statistics processed in the same way. Left column: maize proportion from this study; Middle column: maize proportion from census data; Right column: the difference in maize proportion between this study and census data.

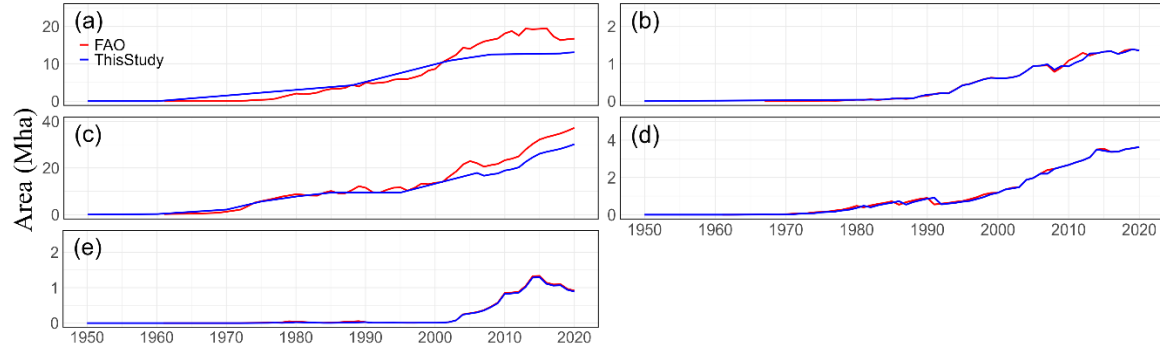


Figure S6. Comparison of soybean areas with FAO data in South America at the country level. (a) Argentina, (b) Bolivia, (c) Brazil, (d) Paraguay, (e) Uruguay.

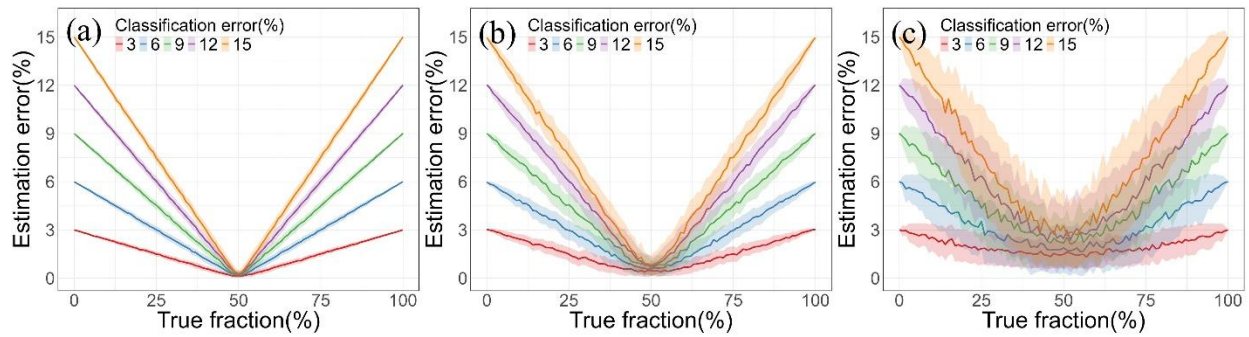


Figure S7. Monte Carlo simulation of aggregation-induced estimation error under varying classification error rates and spatial resolutions. (a), (b), and (c) represent the spatial resolution of 10 m, 30 m, and 100 m, respectively. The x-axis represents the true fraction (%) of the target class in a 1 km grid, while the y-axis shows the absolute estimation error (%) after aggregating the modified high-resolution raster. Each line corresponds to different simulated classification error rates (i.e., 3%, 6%, 9%, 12%, and 15%). Shaded areas represent the standard deviation across 100 Monte Carlo iterations.

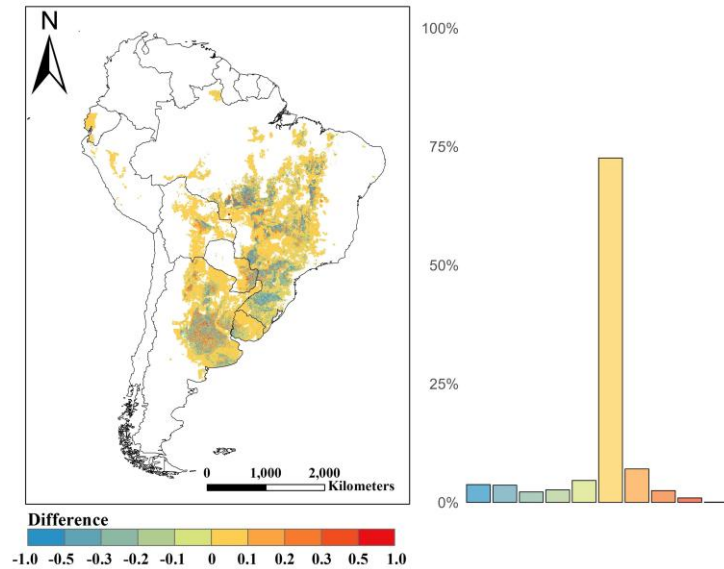


Figure S8. Mean soybean density difference (GLAD-this study) at 1-km resolution across South America (2001-2020): spatial pattern (left) and pixel-wise frequency (right).

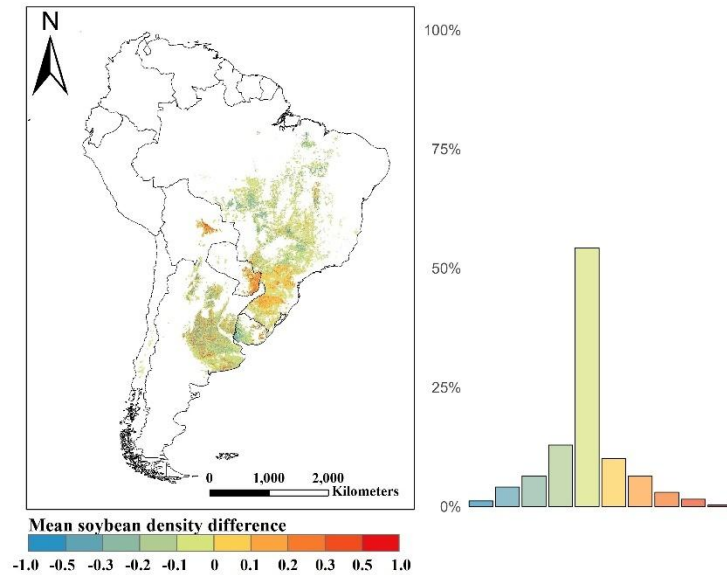


Figure S9. Spatial distribution (left) and frequency (right) of mean soybean density difference between GLAD and this study at the 1-km resolution from 2001 to 2020 for South America.

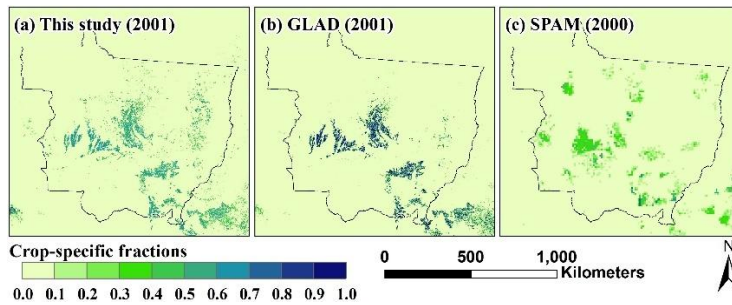


Figure S10. Spatial comparison of soybean fraction maps in Mato Grosso: (a) this study (2001), (b) GLAD (2001), and (c) SPAM (2000).

Table S1. The number of provinces in each country of South America.

Country	GADM Provinces	Units in this study	Available census data
Argentina	24	23	5
Bolivia	9	9	40
Brazil	27	27	8
Chile	16	16	2
Colombia	33	32	7
French Guiana	2	1	/
Ecuador	24	24	3
Guyana	10	10	11
Paraguay	18	17	21
Peru	26	24	1
Suriname	10	10	2
Uruguay	19	19	2
Venezuela	25	25	1

Total	243	237	103
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Table S2. Definitions of different cropland datasets.

Datasets	Definition
HYDE	After 1960 identical to FAO's category: Arable land and permanent crops.
ESA CCI	(1) 10: Cropland, rainfed (2) 20: Cropland, irrigated or post-flooding (3) 30: Mosaic cropland (> 50%) / natural vegetation (tree, shrub, herbaceous cover) (< 50%)
GLAD GCC	(1) Annual and perennial herbaceous crops for human consumption, forage (including hay), and biofuel. (2) Perennial woody crops, permanent pastures, and shifting cultivation are excluded from the definition.
GLC FCS30D	(1) 10: Rainfed cropland (2) 11: Herbaceous cover cropland (3) 12: Tree or shrub (Orchard) cropland (4) 20: Irrigated cropland
CGLS-LC100	Cultivated and managed vegetation/agriculture: Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single, and multiple cropping systems). Note that perennial woody crops will be classified as the appropriated forest or shrub land cover type.

Table S3. Detailed information of inventory datasets used in this study.

Country	Data type	Resolution	Period	Item	Source
Argentina	Crop type	National	1947, 1952, 1970, 1980, 1990, 1995, 2000, 2011	10 crops	Censo Nacional Agropecuario 1952: https://www.patagonia3mil.com.ar/wp-content/uploads/libros/publicaciones-Decires.pdf .
			1960	crops	Censo Nacional Agropecuario 1960: https://biblioteca.indec.gob.ar/cgi-bin/wxis.exe/iah/scripts/?IsisScript=iah.xis&lang=es&base=minde&nextAction=lnk&exprSearch=CERDOS&indexSearch=DD#:~:text=Autor%20Institucional%3A%20Argentina.%20Direcci%C3%B3n%20Nacional%20de%20Estad%C3%ADstica%20y,Fe%2C%20Santiago%20del%20Esteros%2C%20Tucum%C3%A1n%2C%20Tierra%20del%20Fuego.
			1969 - 2022	crops	Agricultural Estimates: FAO based https://datosestimaciones.magyp.gob.ar/reportes.php?reporte=Estimaciones
			1961-2021	crops	FAO: https://www.fao.org/faostat/zh/#data/QCL
		State	1960	crops	Censo Nacional Agropecuario 1960: https://biblioteca.indec.gob.ar/cgi-bin/wxis.exe/iah/scripts/?IsisScript=iah.xis&lang=es&base=minde&nextAction=lnk&exprSearch=CERDOS&indexSearch=DD#:~:text=Autor%20Institucional%3A%20Argentina.%20Direcci%C3%B3n%20Nacional%20de%20Estad%C3%ADstica%20y,Fe%2C%20Santiago%20del%20Esteros%2C%20Tucum%C3%A1n%2C%20Tierra%20del%20Fuego.
			1969 - 2022	crops	Agricultural Estimates: FAO based https://datosestimaciones.magyp.gob.ar/reportes.php?reporte=Estimaciones
			1988	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
			2002	crops	Censo Nacional Agropecuario 2002: https://sitioanterior.indec.gob.ar/cna_index.asp
			2008	crops	Censo Nacional Agropecuario 2008: https://microdata.fao.org/index.php/catalog/1610/related-materials
			2018	crops	Censo Nacional Agropecuario 2018: https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87
		Municipal	1960	crops	Censo Nacional Agropecuario 1960: https://biblioteca.indec.gob.ar/cgi-

					bin/wxis.exe/iah/scripts/?IsisScript=iah.xis&lang=es&base=minde&nextAction=lnk&exprSearch=CERDOS&indexSearch=DD#:~:text=Autor%20Institucional%3A%20Argentina.%20Direcci%C3%B3n%20Nacional%20de%20Estad%C3%ADstica%20y,Fe%2C%20Santiago%20del%20Esteros%2C%20Tucum%C3%A1n%2C%20Tierra%20del%20Fuego.
			1969 - 2022	crops	Agricultural Estimates: https://datosestimaciones.magyp.gob.ar/reportes.php?reporte=Estimaciones
			2008	crops	Censo Nacional Agropecuario 2008: https://microdata.fao.org/index.php/catalog/1610/related-materials
			2018	crops	Censo Nacional Agropecuario 2018: https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87
	Land use	National	1961-2021	Cropland, pasture, forest	FAO: https://www.fao.org/faostat/zh/#data/RL
		State	1960	Cropland, pasture, forest	Censo Nacional Agropecuario 1960: https://biblioteca.indec.gob.ar/cgi-bin/wxis.exe/iah/scripts/?IsisScript=iah.xis&lang=es&base=minde&nextAction=lnk&exprSearch=CERDOS&indexSearch=DD#:~:text=Autor%20Institucional%3A%20Argentina.%20Direcci%C3%B3n%20Nacional%20de%20Estad%C3%ADstica%20y,Fe%2C%20Santiago%20del%20Esteros%2C%20Tucum%C3%A1n%2C%20Tierra%20del%20Fuego.
			2002	Cropland, pasture, forest	Censo Nacional Agropecuario 2002: https://sitioanterior.indec.gob.ar/cna_index.asp
			2008	Cropland, pasture, forest	Censo Nacional Agropecuario 2008: https://microdata.fao.org/index.php/catalog/1610/related-materials
			2018	Cropland, pasture, forest	Censo Nacional Agropecuario 2018: https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87
		Municipal	1960	Cropland, pasture, forest	Censo Nacional Agropecuario 1960: https://biblioteca.indec.gob.ar/cgi-bin/wxis.exe/iah/scripts/?IsisScript=iah.xis&lang=es&base=minde&nextAction=lnk&exprSearch=CERDOS&indexSearch=DD#:~:text=Autor%20Institucional%3A%20Argentina.%20Direcci%C3%B3n%20Nacional%20de%20Estad%C3%ADstica%20y,Fe%2C%20Santiago%20del%20Esteros%2C%20Tucum%C3%A1n%2C%20Tierra%20del%20Fuego.

			2008	Cropland, pasture, forest	Censo Nacional Agropecuario 2008: https://microdata.fao.org/index.php/catalog/1610/related-materials
			2018	Cropland, pasture, forest	Censo Nacional Agropecuario 2018: https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87
Bolivia	Crop type	State	1950	crops	Censo Nacional Agropecuario 1950: https://es.scribd.com/doc/152215679/I-Censo-Agropecuario1950?doc_id=152215679&download=true&order=611811074#
			1984-2022	crops	Instituto Nacional de Estadística: https://www.ine.gob.bo/index.php/estadisticas-economicas/agropecuaria/agricultura-cuadros-estadisticos/#
			1995	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
		Municipal	1950	crops	Censo Nacional Agropecuario 1950: https://es.scribd.com/doc/152215679/I-Censo-Agropecuario1950?doc_id=152215679&download=true&order=611811074#
		National			
	Land use	State	1950	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1950: https://es.scribd.com/doc/152215679/I-Censo-Agropecuario1950?doc_id=152215679&download=true&order=611811074#
			1984	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1984: https://www.scribd.com/doc/152218425/II-Censo-Agropecuario-1984
			2013	cropland	Censo Nacional Agropecuario 2013: https://www.scribd.com/document/652777940/Censo-Agropecuario-Bolivia-Final
		Municipal	1950	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1950: https://es.scribd.com/doc/152215679/I-Censo-Agropecuario1950?doc_id=152215679&download=true&order=611811074#
		State	2017 - 2020	crops	Companhia Nacional de abastecimento do Brazil (Conab)
Brazil	Crop type	National	1940 - 1970	crops	https://sidra.ibge.gov.br/pesquisa/censo-agropecuaria/censo-agropecuaria-1995-1996
		State	1970 - 2017	crops	https://sidra.ibge.gov.br/pesquisa/censo-agropecuaria/censo-agropecuaria-1995-1996

					https://www.ibge.gov.br/en/statistics/economic/agriculture-forestry-and-fishing/21929-2017-2017-censo-agropecuario-en.html
Chile	Crop type	State	1997	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
			2007	crops	Censo Nacional Agropecuario 2007: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
		Municipal	2007	crops	Censo Nacional Agropecuario 2007: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
		State	1997	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1997: https://www.fao.org/world-census-agriculture/wcarounds/wca2000/wca2000-country0/en/
	Land use		2007	Cropland, Pasture, Forest	Censo Nacional Agropecuario 2007: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
			1976, 1997, 2007	Pasture	Structural changes in Chilean agriculture: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
			2021	Cropland, Pasture, Forest	Censo Nacional Agropecuario 2021: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
		Municipal	2007	Cropland, Pasture, Forest	Censo Nacional Agropecuario 2007: https://www.ine.gob.cl/estadisticas/economia/agricultura-agroindustria-y-pesca/censos-agropecuarios
Colombia	Crop type	State	1960	crops	Censo Nacional Agropecuario 1960: https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censos-agropecuarios-de-colombia-1960-1970
			1996, 2000	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
			2011-2019	crops	National agricultural survey (historical time series): https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/encuesta-nacional-agropecuaria-ena
	Land use	State	1960	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1960: https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censos-agropecuarios-de-colombia-1960-1970
			1970	Cropland, Pasture	Censo Nacional Agropecuario 1970: https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censos-agropecuarios-de-colombia-1960-1970
			2011-2019	Cropland,	National agricultural survey (historical time series):

				Pasture, Forest	https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/encuesta-nacional-agropecuar-ena
		Municipal	1960	Cropland, Pasture, Forest	Censo Nacional Agropecuario 1960: https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censos-agropecuarios-de-colombia-1960-1970
Ecuador	Crop type	State	1995	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
			2000	Crops No wheat	Resultados_Nacionales_con_resumenes_Provinciales_2000: https://www.ecuadorencifras.gob.ec/censo-nacional-agropecuario/
			2022	Crops	ESPAC_2022: https://www.ecuadorencifras.gob.ec/estadisticas-agropecuarias-2/
	Land use	State	2000	Cropland, Pasture, Forest	Resultados_Nacionales_con_resumenes_Provinciales_2000: https://www.ecuadorencifras.gob.ec/censo-nacional-agropecuario/
			2022	Cropland, Pasture, Forest	ESPAC_2022: https://www.ecuadorencifras.gob.ec/estadisticas-agropecuarias-2/
Guyana	Crop type	National	1960-2016	Rice	Annual report 2016 and Semple Agricultural Change: https://grdb.gy/category/annual-reports/
		State	1994	Rice	AgroMaps: https://gaez.fao.org/pages/agromaps
			2007-2016	Rice	Annual report: https://grdb.gy/category/annual-reports/
			1991	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
Paraguay	Crop type	State	2000-2021	Crops	INE 2000-2021: https://www.ine.gov.py/publicacion/16/anuario
			2008	Crops	Agricultural census 2008: PRY_SPA_REP.VOL1 https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/
			2022	Crops	Agricultural census 2022: https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/
			2008	Cropland, Pasture, Forest	Agricultural census 2008: PRY_SPA_REP.VOL1 https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/
	Land use	State	2022	Cropland, Pasture, Forest	Agricultural census 2022: https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/

			1929	Crops	Agricultural census 1929: https://www.scribd.com/document/360750048/1972-Honorio-Pinto-El-Primer-Censo-Agropecuario-Del-Peru-1929
Peru	Crop type	State	1993	crops	AgroMaps: https://gaez.fao.org/pages/agromaps
			2012	Cropland, Pasture, Forest	Agricultural census 2012: https://microdata.fao.org/index.php/catalog/1616/related-materials
	Land use	State	1995	Crops	AgroMaps: https://gaez.fao.org/pages/agromaps
Suriname	Crop type	State	2008	Crops	Agricultural census 2008: https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/
			1995	Crops	AgroMaps: https://gaez.fao.org/pages/agromaps
	Land use	State	2008	Cropland, Pasture, Forest	Agricultural census 2008: https://www.fao.org/world-census-agriculture/wcarounds/wca2010/countries2010/en/
Uruguay	Crop type	State	1990, 2000	Crops	AgroMaps: https://gaez.fao.org/pages/agromaps
Venezuela	Crop type	State	1995	Crops	AgroMaps: https://gaez.fao.org/pages/agromaps