



***Development of a GTAP 8 Land Use and Land Cover Data Base
for Years 2004 and 2007***

By

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I. Background and Motivation

The land-use augmented version of the GTAP Data Base has been used for a wide variety of applications (Hertel, Rose, & Tol, 2009). The original GTAP-AEZ Data Base incorporated geospatial data on land use into the GTAP 6 Data Base, with a benchmark year of 2001. The methodology for integrating this information into the GTAP-AEZ framework is documented by Lee et al. (2009). This data base has been updated for 2004 using the GTAP 7 Data Base, national-level crop production data from FAOSTAT and updated time-series data on cropland and pasture cover developed by Navin Ramankutty (2011). For version 7, the original geospatial data on crop production circa 2000 from Monfreda et al. (2008) was used since updates for this data are currently unavailable.

This memorandum documents how the land use data has been updated for use in the GTAP 8 Data Base. In keeping with the multi-year release of v.8, the land use data base is updated to two base years: 2004 and 2007. This update heavily relies on the methods outlined by Avetisyan, Baldos and Hertel (2010), but there are some changes in sources and procedures, as will become evident in the comparisons of the v.7-2004 and v.8-2004 data bases.

II. Land Cover Data

The *land cover* data, available by land type, agro ecological zone (AEZ), and country for the years 2004 and 2007 have been constructed using several land cover maps. These include¹:

Cropland and pasture cover: This is based on the Global Cropland and Pasture Data by Navin Ramankutty from McGill University (2011). The spatial data set, which covers the period 1700-2007, is a beta release of the revised historical cropland data set of Ramankutty and Foley (1999). It consists of annual data on the fraction of cropland and pasture cover as a share of total land cover in each grid cell. The resolution of the data is 0.5 degree in latitude by longitude

Built-up land cover: Data on built-up lands at 500m resolution for the period 2001-2002 is also used. This data is part of the Global Maps of Urban Extent from Satellite Data from the Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin-Madison (Schneider, Friedl, & Potere, 2009; 2010). The built-up land cover data is aggregated to 0.5 degree resolution so that it can be incorporated with the data on cropland and pasture cover.

Potential cover for other lands types (i.e. forests, shrub lands, savanna & grasslands and other lands): Land cover for other land types is calculated as a residual. This residual land cover is then allocated to savanna & grasslands, forests, shrub lands and other lands using the Global Maps of Potential Vegetation by Ramankutty and Foley (1999). This map shows the expected vegetation type that would grow in a given grid-cell in the absence of human activities.

¹ A summary of the methods used to in updating the land cover data for version 8 are outlined in Figure A.1 in the Appendix.

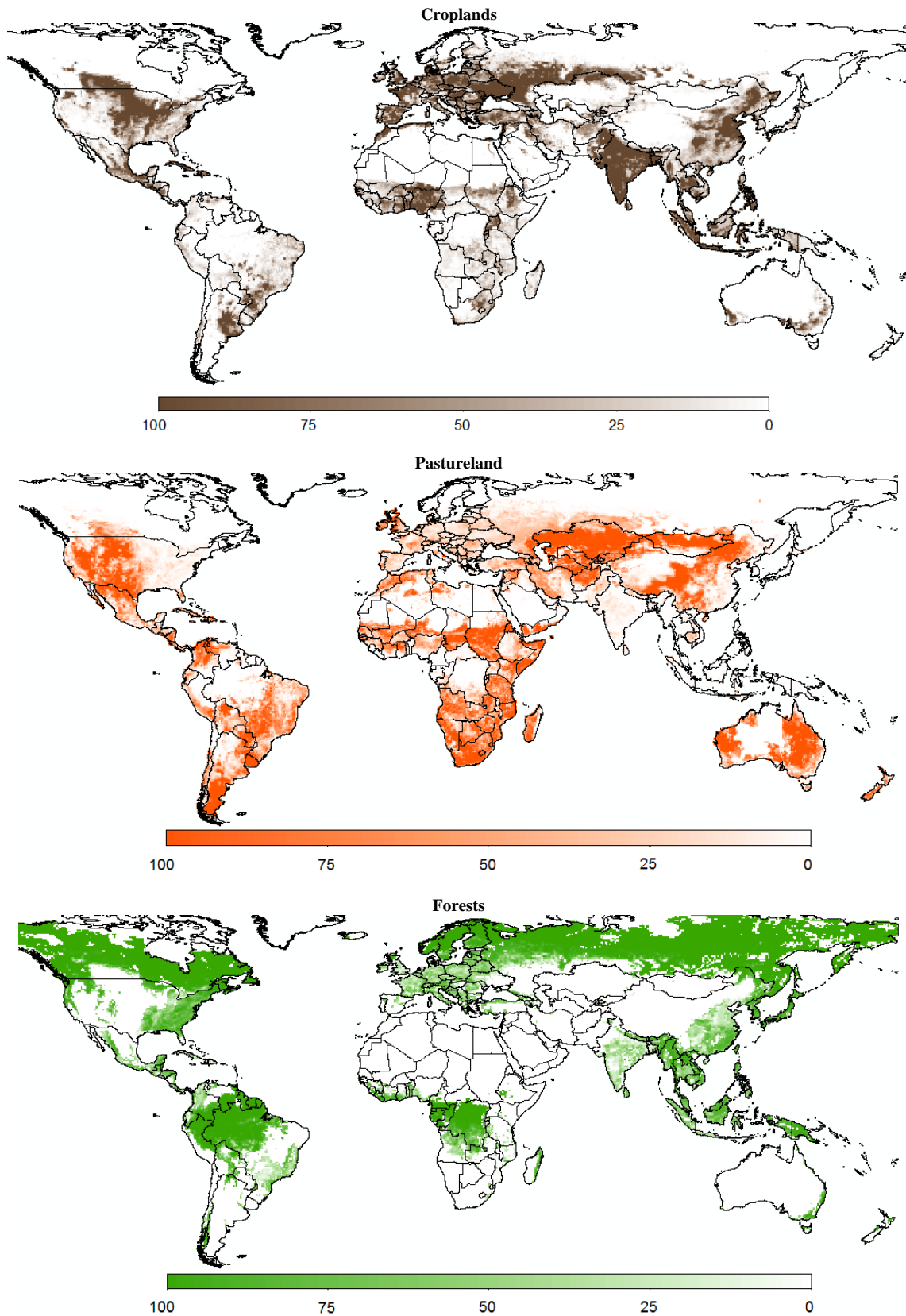
Key changes in the data and procedures in updating the land cover for version 8

As mentioned earlier, the land use data for the GTAP 8 Data Base uses 2004 and 2007 as base years. This means that v.8-2004 and v.7-2004 represent the same base year. However, the land cover data for both these versions are *not exactly* the same. There are two main changes for version 8. First, the latest version of Navin Ramankutty's data on cropland and pasture land cover is used (as of July 2011). Second, there are slight changes in the methodology. Specifically, during the data aggregation process, only the grid cells whose centroids are *within* the country shape file maps are considered in version 7. This implies that observations on the edges of these country maps are excluded. For version 8, all data points are considered by mapping all observations to the *nearest* country. This has an effect on total land cover data for most countries.

Global distribution and changes in cropland and pasture cover

Global maps on cropland, forests and pasture intensities for the year 2007, and the changes in intensities during 2004 to 2007 are provided in Figures 1 and 2, respectively. The upper panel reports the intensity of cropland cover at each pixel. Areas with the highest percentages of cropland cover are observed in Asia, North America, Brazil and Argentina, Europe and in Russia. In Africa, intense cropland cover is identified in the population dense regions around Nigeria, as well as some parts of East Africa. In Asia, grid cells with high cropland intensities are clustered in South Asia, Southeast Asia, and in Northeastern China. Pasture land cover intensities are displayed in the middle panel of Figure 1. The highest concentrations of pasture land in the Western Hemisphere are found in the Western U.S. and in South America (Brazil, Argentina, Colombia and Venezuela). Intense pasture cover in Africa is clustered in Eastern and Southern Africa, as well as the Sahel. In Asia, pasture lands are concentrated in Central Asia, China and Mongolia. Australia also has areas with high intensity of pasture cover. The lower panel of Figure 1 maps shows the forest cover intensities. The highest concentrations of forests in the Western Hemisphere are found in the Eastern U.S., Canada and in South America (Brazil, Peru, Colombia and Venezuela). Dense forest cover in Africa is clustered in Central Africa. A large part of Russia has high percentages of forest cover. In Asia, forests are concentrated in South East Asia, East Asia and China.

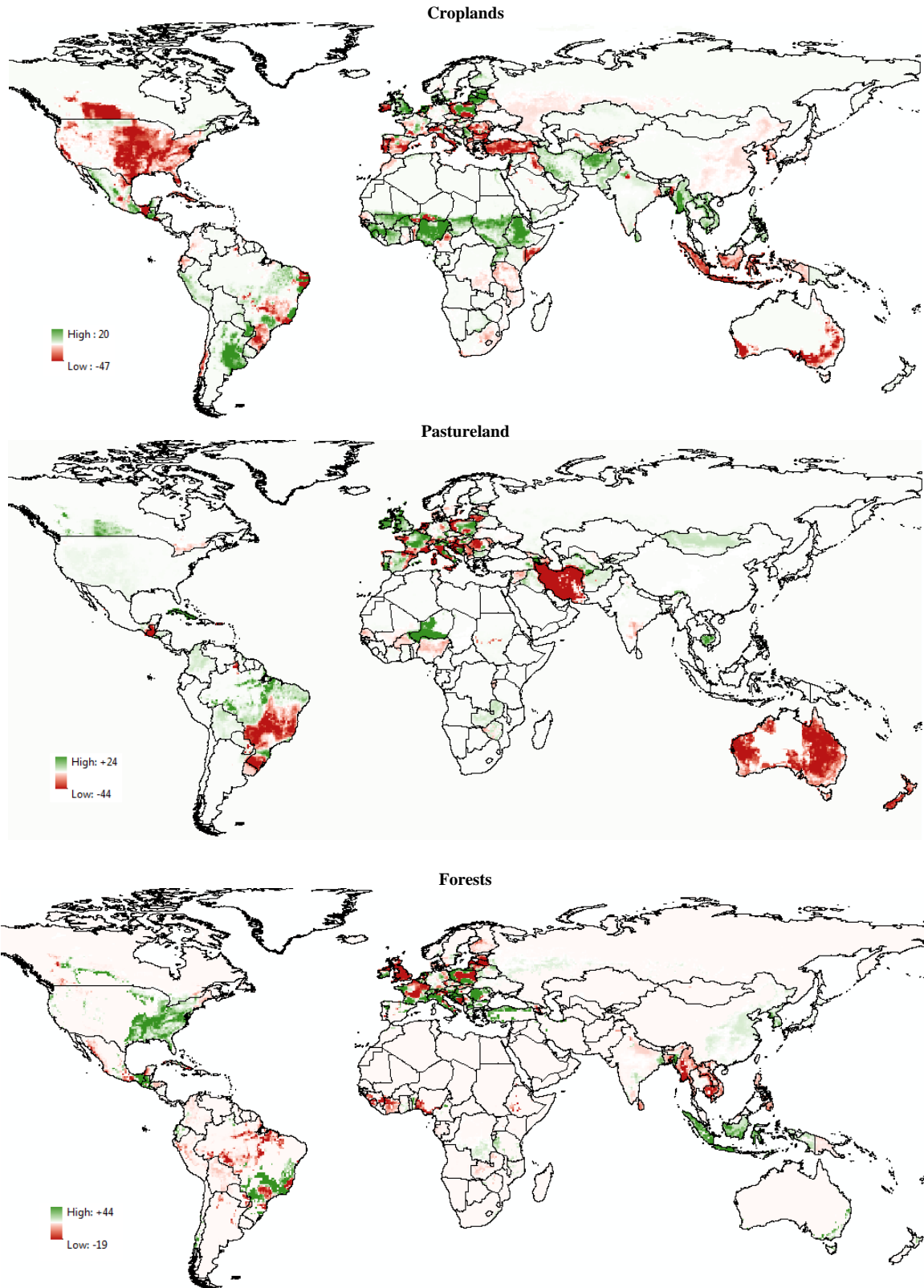
Figure1. Global distribution of croplands, pasturelands and forests for year 2007 (% cover by grid cell)



The upper, middle and lower panels of Figure 2 report the change in grid-cell cover for cropland, forest and pasture cover, respectively, over the 2004-2007 period. The Eastern U.S. and the Great Plains of Canada show relatively intense reduction in cropland cover. Since harvested area actually rose over this period, this land cover change appears to be largely due to a reclassification of cropland pasture into the pasture cover category (Nickerson, Ebel, Borchers, & Carriazo, 2011). In South America, increases are observed in Argentina and Paraguay while in Brazil cropland cover changes are mixed, with some decreases along the coast, and more increases in the interior. Other regions which experienced intense decline in cropland cover are parts of Western Europe, Indonesia and Australia. Cropland cover increased in across the middle of the African continent, while declining somewhat in Southeastern Africa. The intensities of pasture cover change are clustered in selected regions (Figure 2, middle panel). For example, much of Brazil, Iran and Australia shows pasture cover reduction while in Niger pasture cover is increasing. In Western Europe, both increases and decreases in pasture cover are observed. In Brazil, pasture cover decreased in the Southeast, while increasing in the Northeast and Amazon regions.

Forest cover increased in the Eastern U.S.. Again, Brazil shows some interesting patterns of change, with forest cover rising in the Southeast and falling in the Amazon region (Figure 2, lower panel). Similar to pasture cover, intense increases and decreases in forest cover are observed in Western Europe. In South East Asia, Myanmar, Laos, Cambodia and Viet Nam experienced forest reduction during this period while in Indonesia intense forest cover increase is observed. However, caution must be exercised when examining the changes in forest cover because the cover for other land types is imputed from the residual land cover (see Figure A.1 in the Appendix).

Figure 2. Difference in croplands, pasturelands and forests cover between 2004 to 2007 (% cover by grid cell)



Total areas summed across AEZs and countries for different land cover types and different land use data base versions are listed in Table 1. It is important to note that the grand total land area in versions 7 and 8 are less than in version 6 due to the differences in grid-cell resolution of the land cover data used. Land cover data in version 6 is based on a 5 minute resolution which is more detailed compared to the 0.5 degree resolution used in the later versions. As mentioned earlier, land cover in v.7 and v. 8-2004 are also different due to the slight changes in the data and methodology.

Table 1. Total area for selected land cover types

Land Cover Types (in 1000 hectares)	Versions			
	V.6	V.7	V.8: 2004	V.8: 2007
Forest (accessible only)	1,656,377	1,678,148	1,678,370	1,683,200
Savanna & Grassland	1,383,181	1,424,756	1,425,090	1,434,345
Shrubland	906,928	930,578	930,590	949,139
Cropland	1,528,109	1,544,485	1,544,468	1,536,127
Pastureland	2,841,724	2,745,751	2,745,713	2,715,907
Built-upland	77,346	61,691	61,690	61,694
Other land	2,109,597	2,111,197	2,112,459	2,115,170
Total	10,503,262	10,496,605	10,498,380	10,495,582

Comparing v.8-2004 and v.8-2007, land cover types which experienced area increases in 2007 are forests, savanna & grassland, shrubland, and other lands. Global cropland and pasture land coverage lower in 2007 than in 2004.

The changes in global land cover, by AEZ, between v.7, v.8-2004 and v.8-2007 relative to version 6, are illustrated in Figures 3 to 5. Comparing versions 8:2004 and 8:2007 we see that for cropland cover, area increases are observed in the tropics: AEZ's 1 to 6, while for other AEZs cropland cover is slightly lower (Figure 3). For pasture cover, large reductions are seen in the temperate AEZs: 7, 8 and 11 (Figure 4) while increases in forest cover are observed for these same AEZs (Figure 5).

The land cover changes within selected countries are shown in Figures 6 to 8. Overall, cropland cover rose sharply in Brazil and Indonesia (Figure 6). Large reductions are observed in Canada and the U.S. Figure 7 shows that pasture land cover shrunk in Brazil, France and India while it expanded slightly in Canada. For forest cover (Figure 8), the strongest area expansion is observed in China, France and South Africa.

In these figures, it is interesting to note that the data points for v.7-2004 and v.8-2004 typically overlap, indicating that the changes in the data and methodology in v.8 do not alter the land cover data significantly. Details of the cropland, forest, and pasture land cover by AEZs and for selected countries are shown in Tables A.1 and A.2 in the Appendix while Table A.3 shows the land cover across all AEZ between versions 6, 7 and 8.

Figure 3. Cropland cover by AEZs: data in v.7 and v.8 relative to v.6

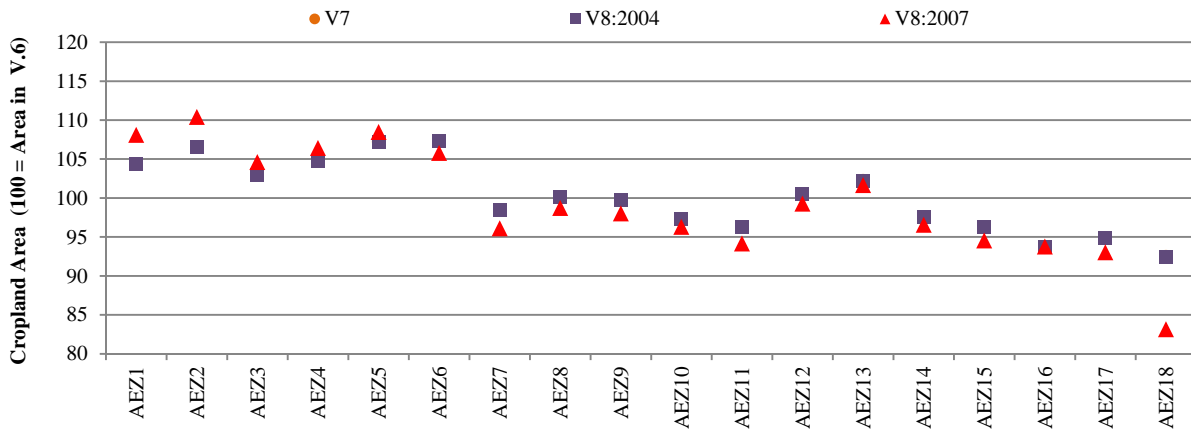


Figure 4. Pastureland cover by AEZs: data in v.7 and v.8 relative to v.6

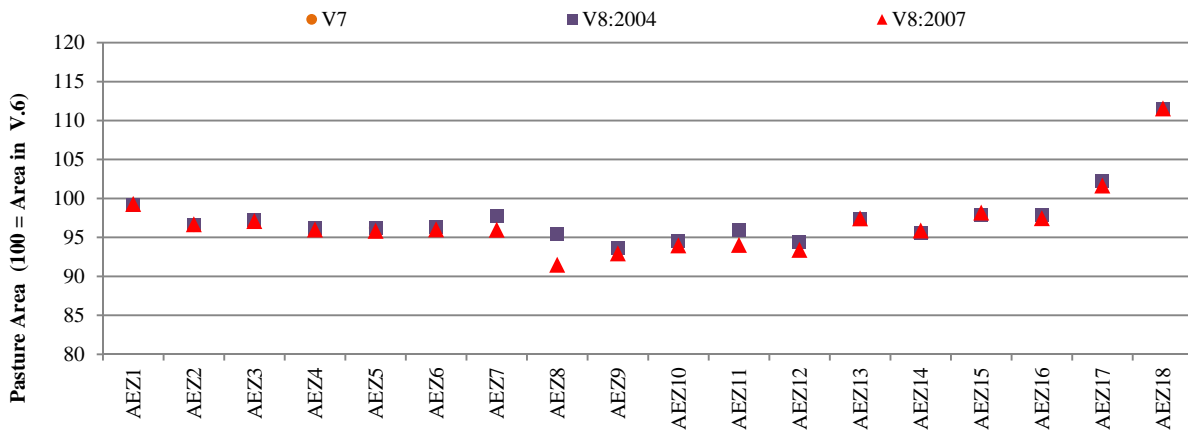


Figure 5. Forestland cover by AEZs: data in v.7 and v.8 relative to v.6

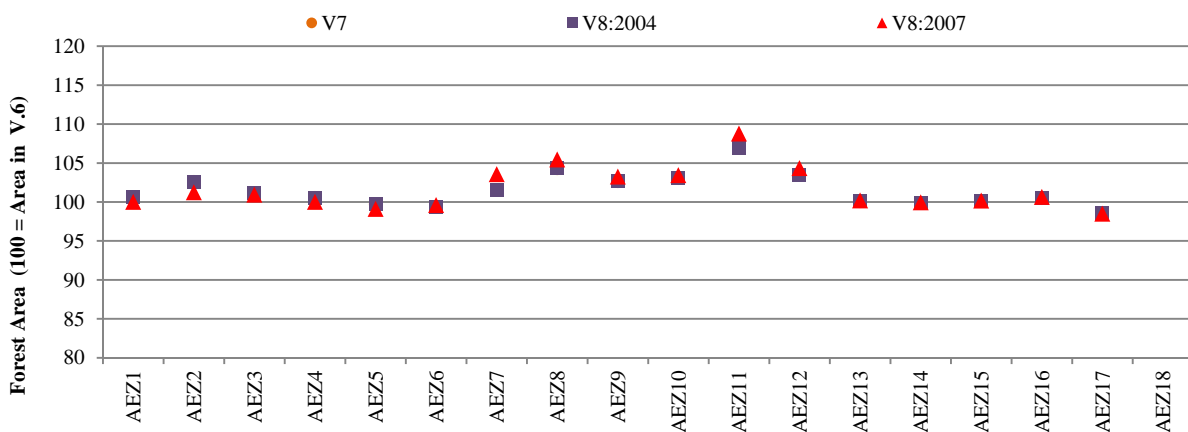


Figure 6. Cropland cover for selected countries: data in v.7 and v.8 relative to v.6

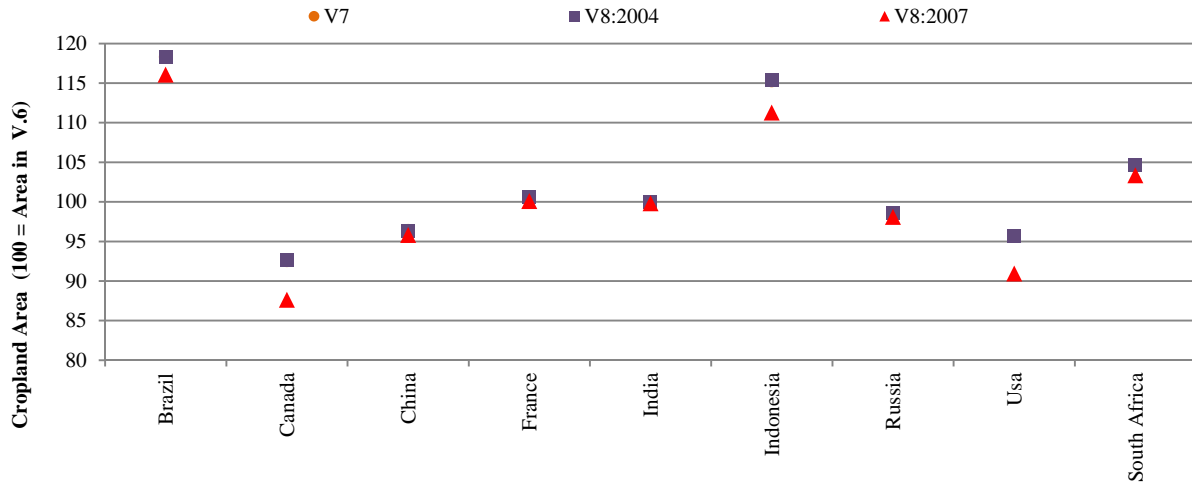


Figure 7. Pasture cover for selected countries: data in v.7 and v.8 relative to v.6

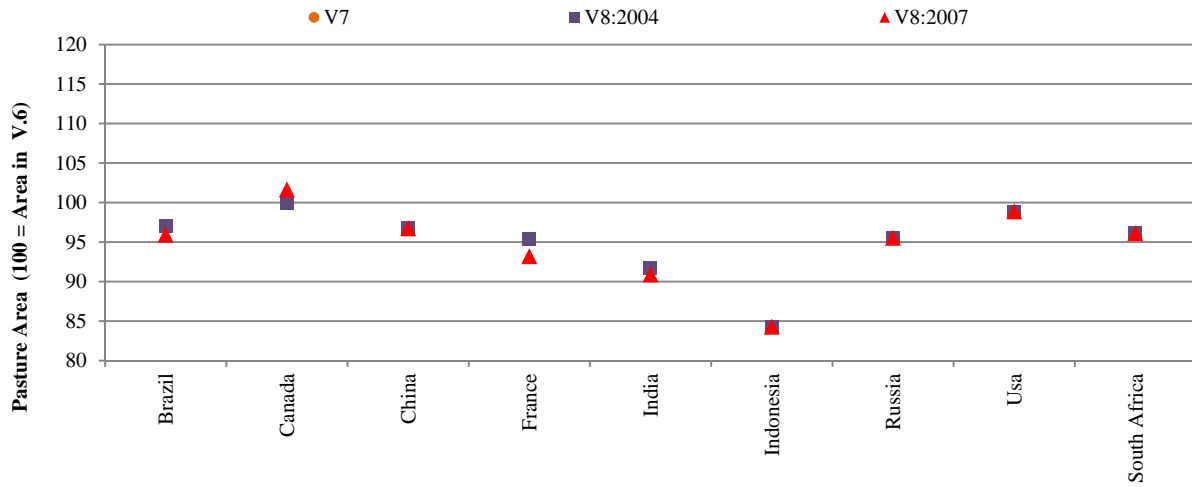
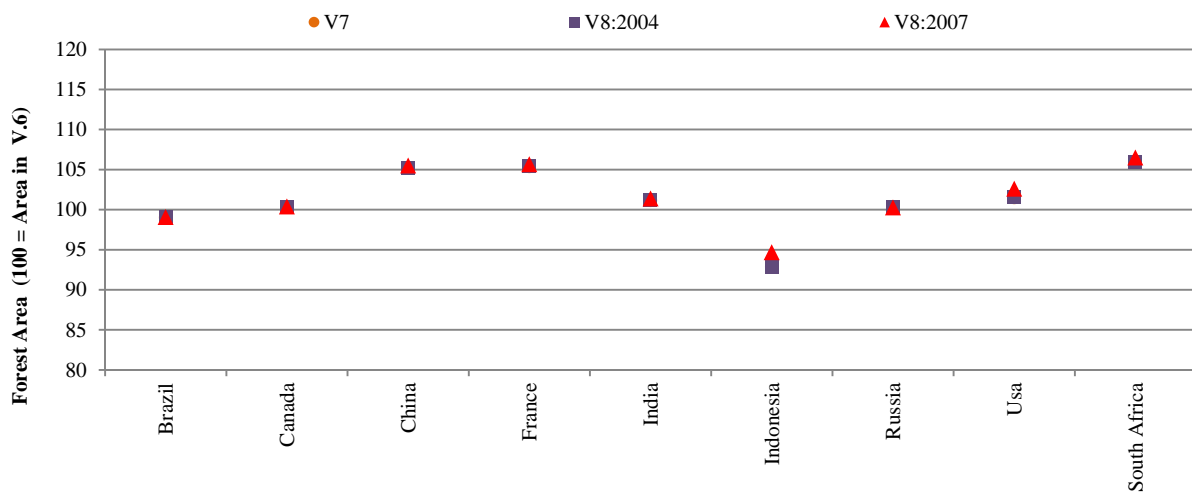


Figure 8. Forest cover for selected countries: data in v.7 and v.8 relative to v.6



III. Crop Production data

The GTAP 8 Land Use Data Base is also updated using *crop output, prices and harvested area* data from FAOSTAT (<http://faostat.fao.org/>). The latest 2004 and 2007 data available by country and by 159 crop categories is used. However, these data are only available at the national level. To get the distribution in production and harvested area across AEZs, the geospatial crop production data from Monfreda et al. (2008) is used.

The original Monfreda et al. dataset covers 175 crops. To fix the discrepancy between this data base and the FAOSTAT crop production data (159 crops), we assume that the production and harvested area data for certain crops, primarily crops used fodder, are the same in both versions 6 and 8 (see Table A.4 in the Appendix).

Comparison of global production and harvested areas for selected GTAP crop sectors in 2007 and 2004 are shown in Table 2. Almost all crop sectors experienced increase in production levels during this period. Notable increases in production are seen for paddy rice (8.1%), oilseeds (9.6%) and sugar cane, sugar beets (17.6%). Large expansions in harvested areas are observed for paddy rice (2.9%), cereal grains (4.5%), vegetables, fruits and nuts (3.7%) and for sugar cane & sugar beets (8.9%). During this period, harvested area for Plant-based fibers dropped significantly (-4.5%), likely as a consequence of continuing substitution of synthetics for cotton in apparel.

Table 2. Global production and harvested area for selected sectors: 2004-2007

Crops	Harvested Area (in 1000 ha.)			Production (in 1000 MT)		
	2007	2004	% chg.	2007	2004	% chg.
Paddy Rice	154,915	150,493	2.94	657,023	607,882	8.08
Wheat	216,646	216,868	(0.10)	612,438	632,528	(3.18)
Cereal Grains	324,065	310,084	4.51	1,083,202	1,036,828	4.47
Vegetables, Fruits, Nuts	236,860	228,346	3.73	2,241,871	2,134,671	5.02
Oilseeds	212,562	209,887	1.27	611,921	558,160	9.63
Sugar cane, sugar beet	27,892	25,625	8.85	1,856,072	1,578,905	17.55
Plant-based fibers	36,379	38,084	(4.48)	77,892	74,835	4.08
Crops, nec	184,706	185,133	(0.23)	2,575,673	2,574,487	0.05

Table 3 shows the aggregated production and harvested areas for selected GTAP crop sectors by AEZ, for the years 2004 and 2007. Harvested areas across AEZs generally increased with large expansion in harvested areas in AEZ1 (11.7%) and AEZ2 (10.8%). With regard to production, strong increases are observed for the tropical AEZs 2 to 6 (14.9%, 25.5%, 15.1%, 13.8%, and 14.4%, respectively) and for the boreal AEZ 13(12.5%).

Table 3. Global production and harvested area by AEZ: 2004-2007

Regions	Harvested Area (in 1000 ha.)			Production (in 1000 MT)		
	2007	2004	% chg.	2007	2004	% chg.
AEZ1	20,852	18,673	11.7	148,229	136,785	8.4
AEZ2	51,806	46,770	10.8	109,608	95,361	14.9
AEZ3	116,149	111,105	4.5	504,762	402,091	25.5
AEZ4	117,702	112,320	4.8	589,811	512,480	15.1
AEZ5	123,605	118,902	4.0	818,299	719,346	13.8
AEZ6	96,656	93,553	3.3	1,071,633	936,371	14.4
AEZ7	72,004	70,867	1.6	502,449	491,655	2.2
AEZ8	153,672	151,930	1.1	877,222	850,472	3.1
AEZ9	158,464	157,156	0.8	1,005,238	971,658	3.5
AEZ10	203,907	204,891	(0.5)	1,813,649	1,850,791	(2.0)
AEZ11	108,265	108,602	(0.3)	1,078,301	1,090,660	(1.1)
AEZ12	114,138	114,431	(0.3)	968,960	919,787	5.3
AEZ13	21,742	20,834	4.4	56,491	50,203	12.5
AEZ14	10,629	10,624	0.0	40,290	39,564	1.8
AEZ15	22,686	22,124	2.5	116,081	115,733	0.3
AEZ16	1,725	1,715	0.6	14,944	15,215	(1.8)
AEZ17	25	24	4.2	123	125	(1.6)
AEZ18	-	-	-	1	1	-

In general, the global production and harvested areas of crops for selected countries are higher in 2007 (Table 4). In Brazil, cereal grain, oilseed, sugar cane & sugar beet production rose by around 9.2, 8.2 and 135 million metric tonnes (Mt), respectively. In China, wheat and cereal grain production increased by 17.3 Mt and 20.4 Mt, respectively while oilseed production declined by 9.4 Mt. In India and Indonesia, oilseed production increased by 10.9 Mt and 20.7 Mt, respectively. Sugar cane & sugar beet production in India also increased strongly (122 Mt). In the U.S., cereal grain production increased by 30.5 Mt while oilseed production declined by 12.1 Mt – likely the result of the boom in corn ethanol production over this period, with corn area substituting for soybeans. Notable changes in the harvested areas are observed in Brazil, China, India, Indonesia and in the U.S. Harvested area for sugar cane & sugar beet in Brazil rose by around 1.4 million hectares (Mha). In China, harvested area for wheat and cereal grains expanded by 2.1 and 3.8 Mha, respectively while harvested area for oilseeds declined by around 3.8 Mha. In India, wheat, oilseed and sugar cane & sugar beet harvested area increased by 1.4, 2.1 and 1.2 Mha, respectively. In Indonesia, harvested area increased significantly for oilseeds (1.3 Mha). Harvested area for U.S. cereal grains expanded by around 5.0 Mha while oilseed harvested area declined by 3.9 Mha. Details of harvested area for GTAP crop sectors by AEZ for all versions are listed in Table A.5 in the Appendix.

Table 4. Global production and harvested area for selected sectors and countries: 2004-2007

Crops	Version 8: 2004				Version 8: 2007				Difference: 2007 - 2004			
	Wheat	Cereal Grains	Oilseeds	Sugar cane, sugar beet	Wheat	Cereal Grains	Oilseeds	Sugar cane, sugar beet	Wheat	Cereal Grains	Oilseeds	Sugar cane, sugar beet
Harvested area (in 1000 ha.)												
Brazil	2,807	13,834	22,234	5,632	1,853	14,672	21,306	7,081	-954	838	-928	1,449
Canada	9,389	6,745	6,898	14	8,636	7,570	8,288	14	-753	825	1,390	0
China	21,626	29,371	24,016	1,583	23,721	33,158	20,192	1,813	2,095	3,787	-3,824	230
France	5,237	4,050	1,898	385	5,239	3,754	2,266	393	2	-296	368	8
India	26,595	29,304	27,534	3,938	27,995	28,929	29,648	5,150	1,400	-375	2,114	1,212
Indonesia	-	3,357	7,299	420	-	3,630	8,560	480	-	273	1,261	60
Russia	22,920	17,449	5,572	790	23,501	16,652	6,321	988	581	-797	749	198
USA	20,222	35,211	31,837	908	20,639	40,168	27,971	861	417	4,957	-3,866	-47
South Africa	830	3,489	745	325	632	2,771	546	323	-198	-718	-199	-2
Production (in 1000 MTs)												
Brazil	5,819	44,807	53,674	415,206	4,114	54,031	61,846	549,707	-1,705	9,224	8,172	134,501
Canada	24,796	25,903	11,573	744	20,054	28,008	13,179	762	-4,742	2,105	1,606	18
China	91,952	140,689	48,302	96,902	109,298	161,117	38,879	122,663	17,346	20,428	-9,423	25,761
France	39,693	30,545	5,673	30,788	32,764	26,323	6,143	33,230	-6,929	-4,222	470	2,442
India	72,156	32,992	31,420	233,862	75,807	40,109	42,273	355,520	3,651	7,117	10,853	121,658
Indonesia	-	11,225	78,903	26,955	-	13,288	99,602	25,505	-	2,063	20,699	-1,450
Russia	45,413	30,348	5,690	21,848	49,368	30,135	7,032	28,836	3,955	-213	1,342	6,988
USA	58,697	319,789	88,974	59,034	55,820	350,306	76,886	59,663	-2,877	30,517	-12,088	629
South Africa	1,687	10,334	993	19,095	1,905	7,598	573	19,724	218	-2,736	-420	629

IV. Changes in the AEZ Land Rental Data Base

The land rents generated for versions 8 and 7 and relative to version 6 are compared in Figures 9 to 18. Figure 9 illustrates the changes in the shares of global firms' purchases of demanded commodities at agents' prices (EVFA) for selected GTAP regions (i.e. the share of any one region in global agricultural and forestry land rents). In this figure, notable increases in *global* share for 2007 is observed in China and Russia while it declined for the U.S. Note that the shares between v.8-2004 and v.7-2004 are not the same due to the differences in the GTAP Data Base used in constructing these land rent data versions. Figures 10 to 12 report on the global shares of firms' purchases of endowments at market prices (VFM), value of endowments at supplied at agent's prices (EVOA) and the value of commodity at supplied at market prices (VOM). Again we see in these figures, increases in the global shares in China and Russia while it declines for the U.S.

Figure 13 shows the global land rent share by GTAP sector. Rental shares for vegetables, fruits and nuts, and cereal grains increased in 2007 relative to 2004 while it declined for plant-based fibers, crops, nec., and forestry sectors.

The shares of global land rents across global AEZs are illustrated in Figure 14. Not surprisingly, vegetables and fruit – the most profitable crops – also show the highest land rents – followed by forestry. Increases in land rental shares can be observed in AEZs 3 to 6 between 2004 and 2007. Recall that in these AEZs, large increases in crop outputs are observed for this period. This reflects changes in the mix of national production in global output. Subnational changes are not captured here, since we are using the same geospatial map on the distribution of crop production for all these versions (Monfreda, et al., 2008). Rental shares for AEZs 10 and 11 declined due the observed decline in crop production for these AEZs. In general, the distribution across AEZs is generally similar for version 6 to 8.

For version 8, the land rent computations and assumptions closely follow those used in version 7, with a few modifications aimed at preserving tax rates by factor/sector. Given this, there is strong agreement in the distribution of land rents by AEZs across all versions for individual crop categories but not for aggregated crop categories. For example, wheat is not aggregated by crop category. Globally, the land rent shares are different across AEZs for wheat due to aggregation across countries (Figure 15). However, the land shares by AEZ at country level, for example in the U.S., are identical across all versions by construction (Figure 16). In the case of cereal grain which is aggregated from several crop commodities, changes are observed in both global and country level (Figures 17 and 18 respectively). Details of land rents for GTAP crop sectors by AEZ for all versions are listed in Table A.6 in the Appendix.

In the future, we hope to benefit from an update of the Monfreda et al. (2008) data base on harvested area and yields at the subnational level. Such an update is a goal of the recently initiated GEOSHARE project (www.geoshareproject.org), based at Purdue University.

Figure 9. Shares of global EVFA by region (in percent)

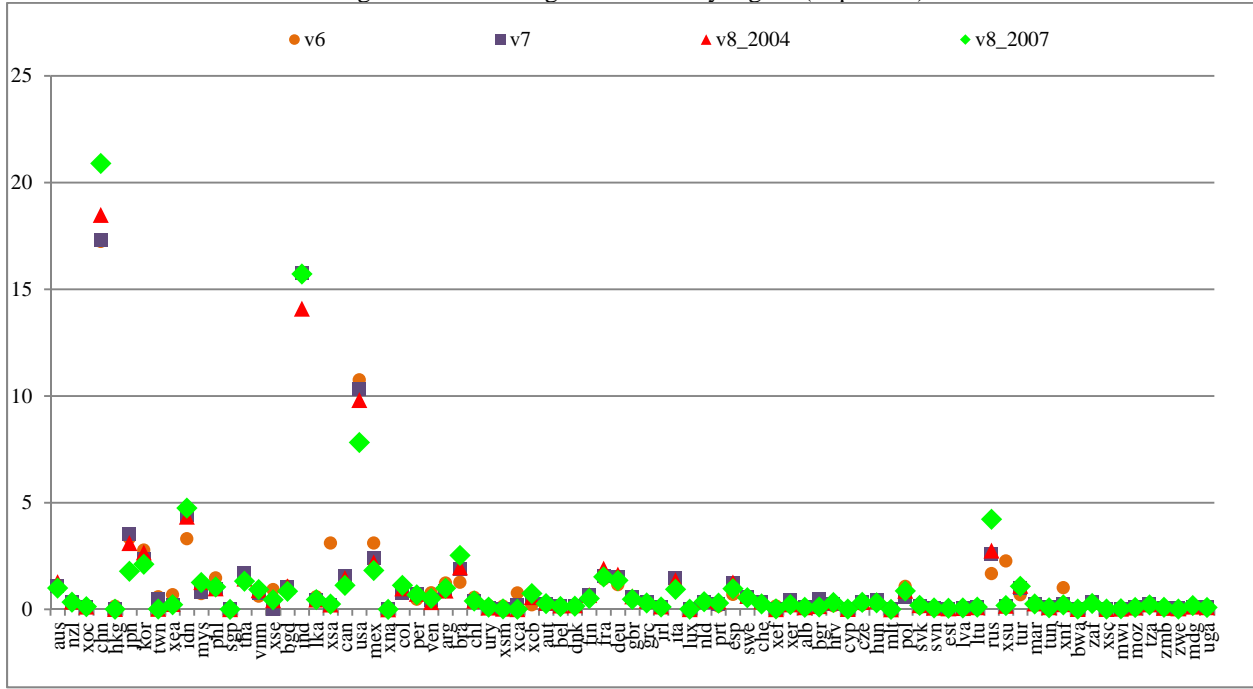


Figure 10. Shares of global VFM by region (in percent)

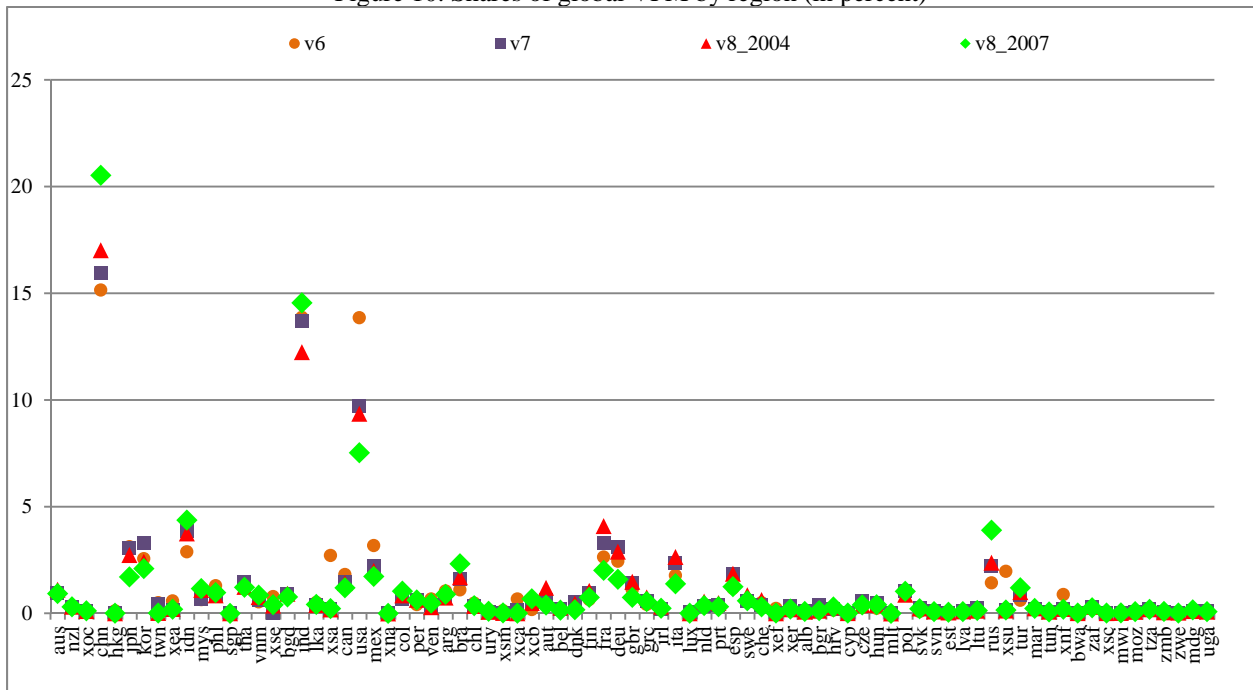


Figure 11. Shares of global EVOA by region (in percent)

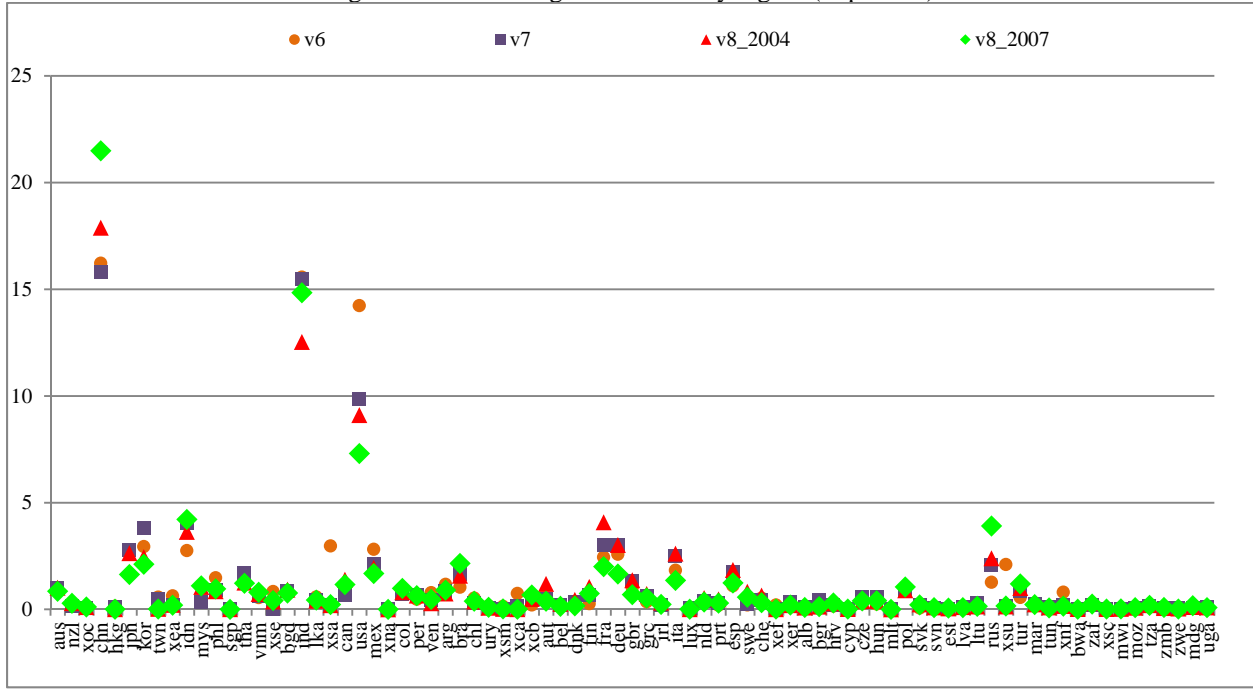


Figure 12. Shares of global VOM by region (in percent)

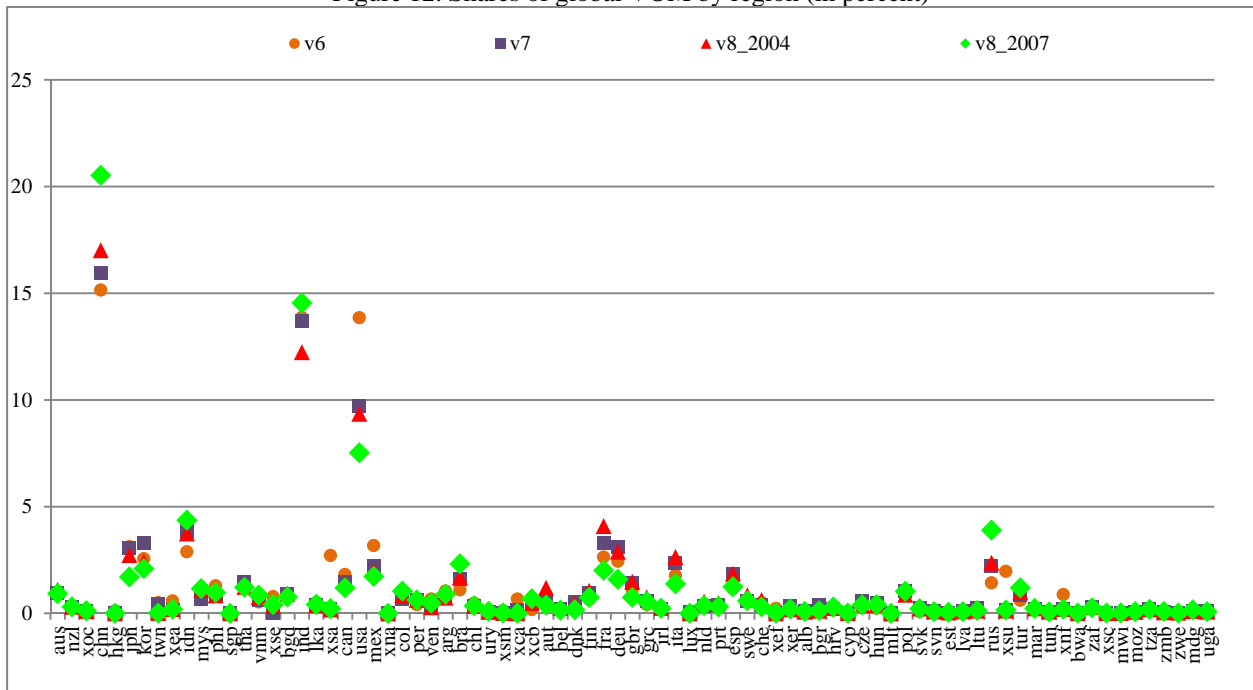


Figure 13. Shares of global land rent by sector (in percent)

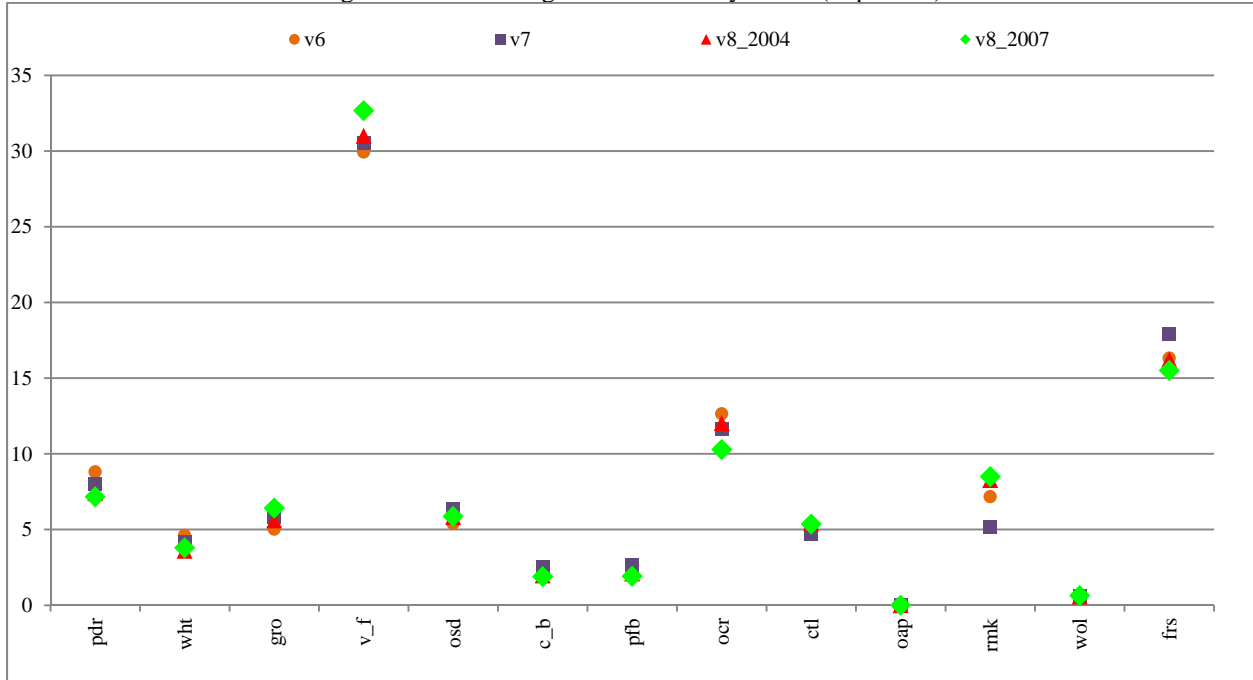


Figure 14. Shares of global land rent by agro-ecological zones (in percent)

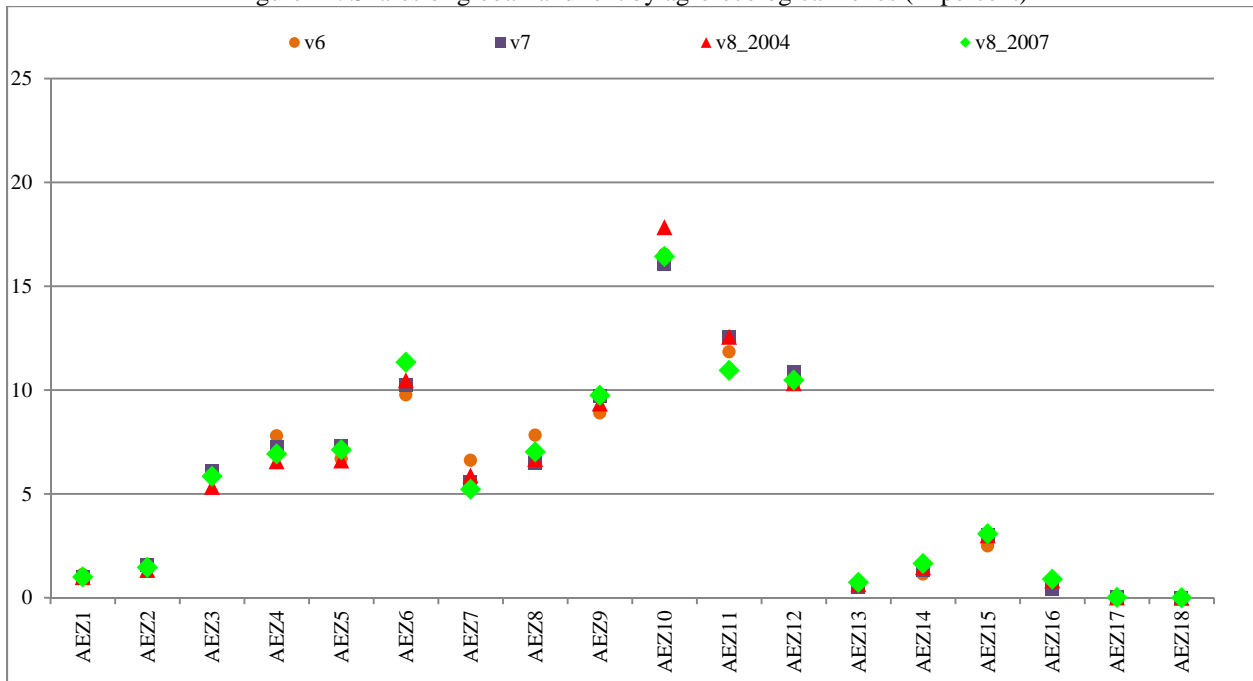


Figure 15. Shares of global wheat land rent by agro-ecological zones (in percent)

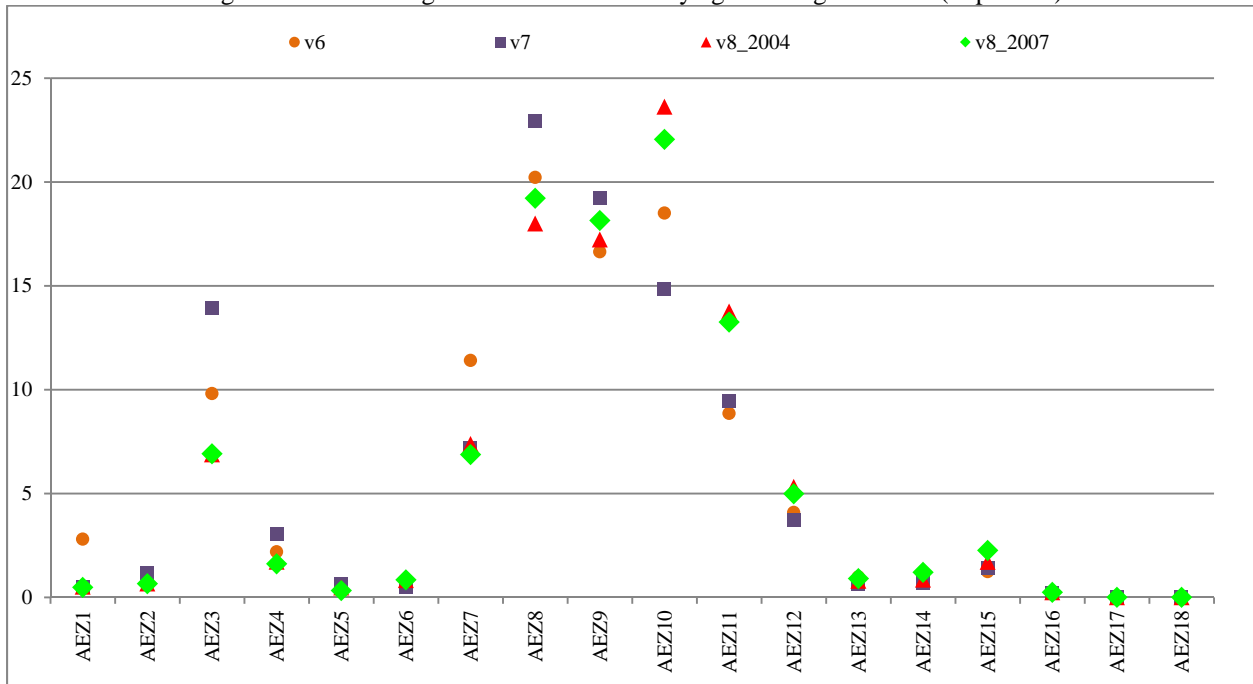


Figure 16. Shares of U.S. wheat land rent by agro-ecological zones (in percent)

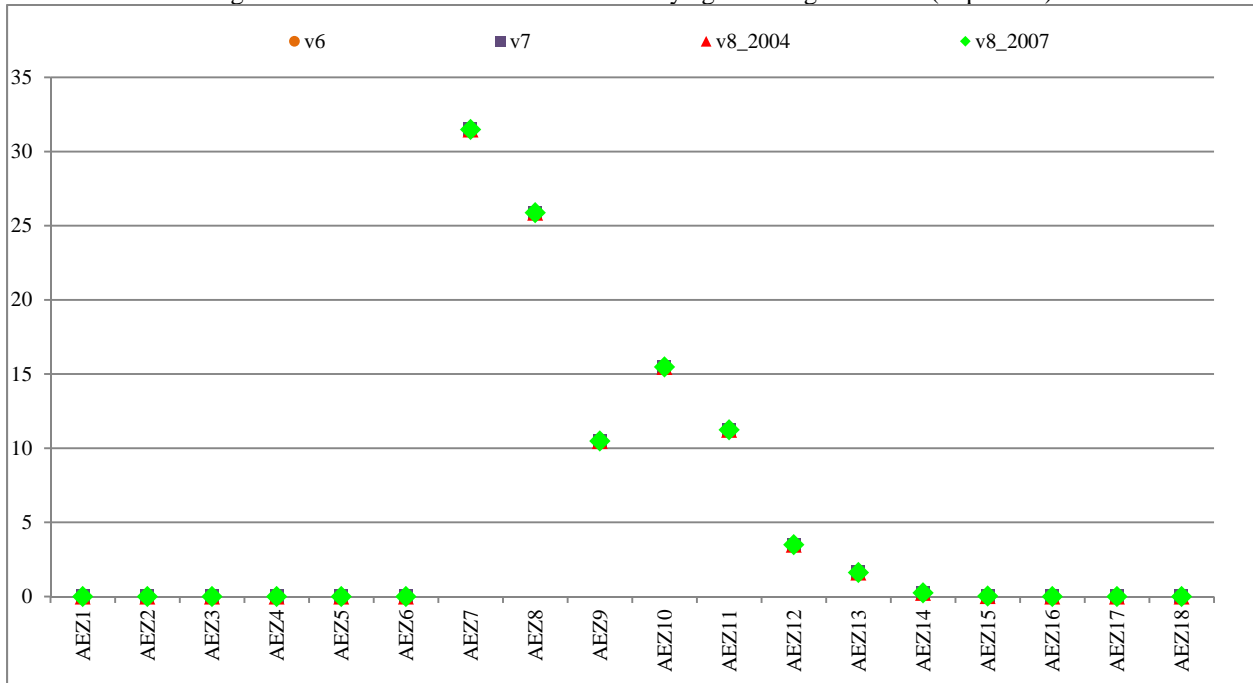


Figure 17. Shares of global cereal grain land rent by agro-ecological zones

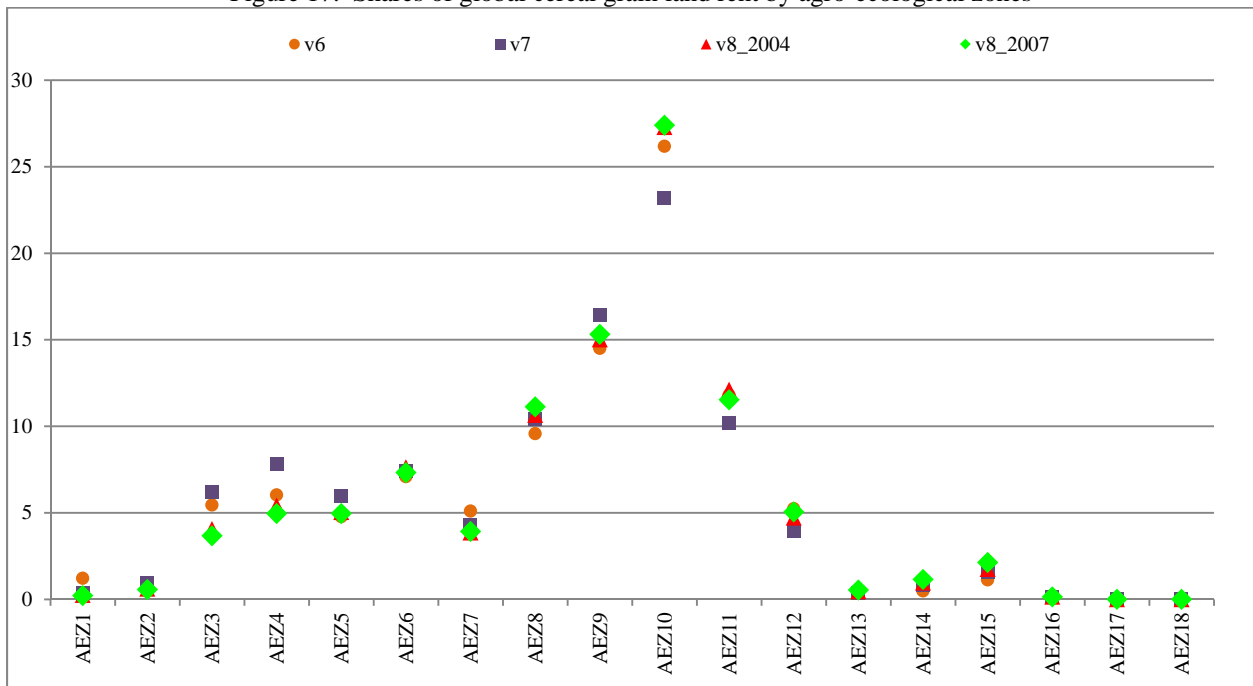
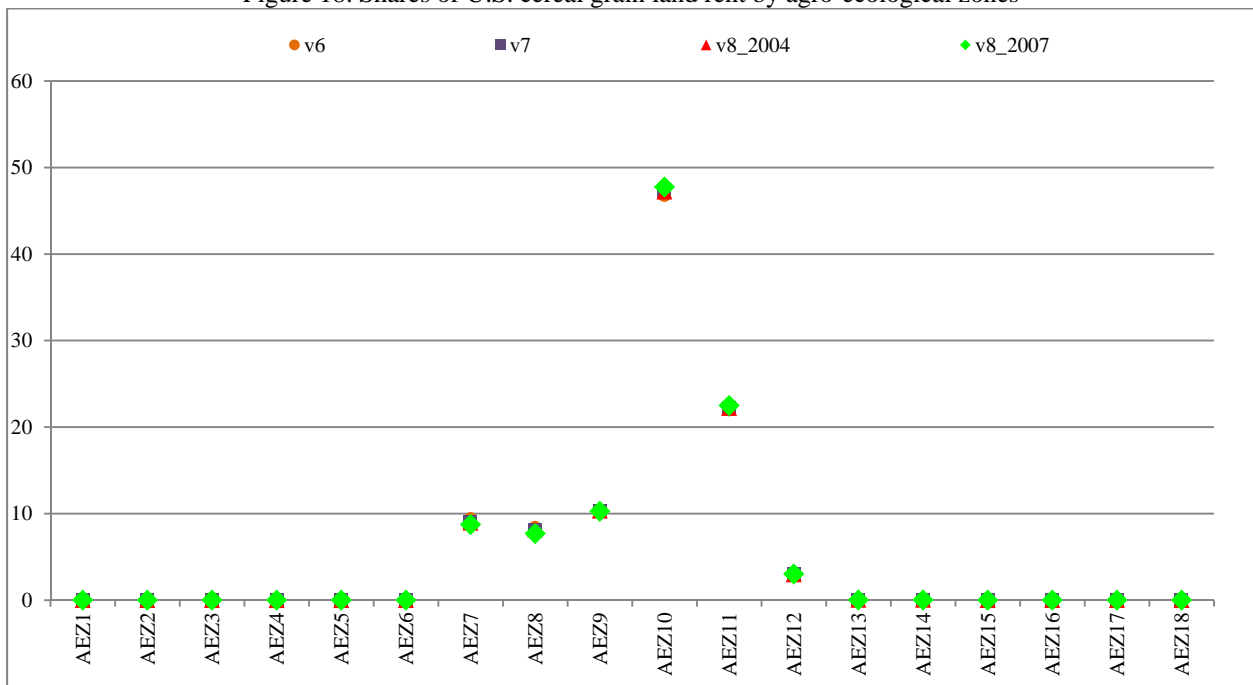


Figure 18. Shares of U.S. cereal grain land rent by agro-ecological zones



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Appendix: Supplementary Tables and Figure

Table A.1. Land cover by AEZs for v.7 and v.8

AEZ	Land cover in each AEZ (in 1000 hectares)								
	Version 7			Version 8: 2004			Version 8: 2007		
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
AEZ1	686	26,105	203,931	686	26,106	203,924	682	27,050	204,283
AEZ2	2,270	55,352	115,776	2,271	55,347	115,769	2,240	57,377	115,976
AEZ3	13,776	117,889	134,088	13,777	117,892	134,086	13,742	119,848	133,894
AEZ4	66,570	119,138	185,035	66,564	119,137	185,026	66,214	121,109	184,771
AEZ5	156,336	116,984	190,791	156,335	116,980	190,804	155,432	118,343	190,052
AEZ6	344,247	130,428	98,136	344,251	130,426	98,130	344,955	128,582	97,864
AEZ7	6,962	105,616	779,958	6,962	105,619	779,935	7,101	103,085	766,284
AEZ8	24,770	183,869	285,984	24,772	183,868	285,980	25,045	181,370	274,227
AEZ9	93,955	175,327	118,117	93,962	175,318	118,124	94,546	172,315	117,263
AEZ10	228,545	231,204	118,086	228,539	231,202	118,082	229,517	228,895	117,463
AEZ11	128,432	108,637	73,657	128,422	108,633	73,650	130,740	106,245	72,180
AEZ12	142,026	93,768	114,741	142,032	93,771	114,748	143,170	92,637	113,574
AEZ13	13,160	28,379	149,325	13,173	28,379	149,321	13,177	28,220	149,498
AEZ14	200,223	16,787	97,357	200,388	16,786	97,358	200,344	16,619	97,660
AEZ15	241,274	32,593	62,628	241,305	32,594	62,634	241,340	32,021	62,858
AEZ16	13,274	2,376	17,113	13,277	2,376	17,113	13,300	2,379	17,035
AEZ17	1,655	32	869	1,654	32	869	1,654	31	864
AEZ18	-	1	159	-	1	159	-	1	159

Table A.2. Land cover in selected countries for v.7 and v.8

Country	Land cover to total land in selected countries (in 1000 hectares)								
	Version 7			Version 8: 2004			Version 8: 2007		
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
Brazil	156,064	60,724	175,536	156,070	60,716	175,535	156,145	59,578	173,665
Canada	100,396	39,574	20,352	100,424	39,575	20,354	100,516	37,463	20,693
China	143,878	140,573	277,017	143,868	140,560	277,020	144,261	139,798	277,023
France	16,955	19,507	9,983	16,958	19,504	9,983	17,003	19,408	9,755
India	17,867	171,419	10,816	17,868	171,421	10,817	17,915	171,259	10,724
Indonesia	31,415	63,067	2,075	31,411	63,073	2,075	32,034	60,859	2,075
Russia	267,207	124,542	78,623	267,318	124,545	78,622	267,362	123,952	78,637
USA	228,777	175,807	228,825	228,809	175,804	228,823	231,284	167,088	229,111
South Africa	1,756	15,367	74,304	1,755	15,366	74,303	1,764	15,178	74,302

Table A.3. Comparison of land cover across AEZs between v6, v7, v8:2004 and v8:2007 (in million hectares)

Cover Types	AEZ1	AEZ2	AEZ3	AEZ4	AEZ5	AEZ6	AEZ7	AEZ8	AEZ9	AEZ10	AEZ11	AEZ12	AEZ13	AEZ14	AEZ15	AEZ16	AEZ17	AEZ18	Total
V.6																			
Forest	0.7	2.2	13.6	66.2	156.8	346.3	6.9	23.7	91.5	221.8	120.2	137.2	13.2	200.4	240.9	13.2	1.7	0.0	1656.4
SavnGrasslnd	36.7	76.1	167.5	191.1	166.0	57.6	171.7	114.1	84.7	54.1	34.8	52.4	41.5	65.2	56.1	11.9	1.7	0.0	1383.2
Shrubland	147.5	48.1	43.4	26.3	8.5	2.9	458.6	62.2	43.6	28.6	12.9	2.5	15.1	3.0	1.4	2.3	0.0	0.0	906.9
Cropland	25.0	52.0	114.6	113.8	109.1	121.6	107.3	183.7	175.8	237.7	112.9	93.3	27.8	17.2	33.9	2.5	0.0	0.0	1528.1
Pastureland	205.8	120.0	137.9	192.4	198.3	101.9	798.3	299.8	126.2	125.0	76.8	121.6	153.4	101.9	64.0	17.5	0.9	0.1	2841.7
Builtupland	1.8	0.7	1.9	2.2	2.2	2.8	5.2	7.5	7.7	16.3	16.5	10.5	0.3	0.3	1.5	0.0	0.0	0.0	77.3
Otherland	519.7	2.9	0.4	0.0	0.0	0.0	808.3	15.4	3.5	1.3	0.2	0.2	348.0	379.7	27.8	2.2	0.0	0.0	2109.6
Total	937.1	302.0	479.2	592.1	640.9	633.1	2356.2	706.4	533.1	684.8	374.2	417.8	599.2	767.5	425.7	49.7	4.2	0.1	10503.3
V7																			
Forest	0.7	2.3	13.8	66.6	156.3	344.2	7.0	24.8	94.0	228.5	128.4	142.0	13.2	200.2	241.3	13.3	1.7	0.0	1678.2
SavnGrasslnd	37.2	76.7	167.6	192.7	166.6	58.1	180.7	123.5	88.3	57.5	36.7	54.2	44.0	69.3	57.6	12.3	1.7	0.0	1424.8
Shrubland	148.4	48.3	43.2	26.2	8.5	3.0	468.9	66.6	46.1	31.3	14.2	2.7	16.1	3.1	1.5	2.3	0.0	0.0	930.6
Cropland	26.1	55.4	117.9	119.1	117.0	130.4	105.6	183.9	175.3	231.2	108.6	93.8	28.4	16.8	32.6	2.4	0.0	0.0	1544.5
Pastureland	203.9	115.8	134.1	185.0	190.8	98.1	780.0	286.0	118.1	118.1	73.7	114.7	149.3	97.4	62.6	17.1	0.9	0.2	2745.8
Builtupland	1.1	0.5	1.8	2.0	3.0	3.9	4.4	5.7	5.9	14.0	10.0	7.4	0.3	0.5	1.1	0.1	0.0	0.0	61.7
Otherland	519.6	2.9	0.4	0.0	0.0	0.0	809.6	15.8	3.7	1.3	0.2	0.2	347.9	379.8	27.7	2.2	0.0	0.0	2111.2
Total	937.1	301.9	478.8	591.7	642.2	637.8	2356.2	706.1	531.3	682.0	371.9	415.1	599.1	767.0	424.4	49.6	4.2	0.2	10496.6
V8:2004																			
Forest	0.7	2.3	13.8	66.6	156.3	344.3	7.0	24.8	94.0	228.5	128.4	142.0	13.2	200.4	241.3	13.3	1.7	0.0	1678.4
SavnGrasslnd	37.2	77.1	167.6	192.7	166.6	58.1	180.7	123.5	88.3	57.6	36.7	54.2	44.0	69.3	57.6	12.3	1.7	0.0	1425.1
Shrubland	148.4	48.3	43.2	26.2	8.5	3.0	469.0	66.6	46.1	31.3	14.2	2.7	16.1	3.1	1.5	2.3	0.0	0.0	930.6
Cropland	26.1	55.3	117.9	119.1	117.0	130.4	105.6	183.9	175.3	231.2	108.6	93.8	28.4	16.8	32.6	2.4	0.0	0.0	1544.5
Pastureland	203.9	115.8	134.1	185.0	190.8	98.1	779.9	286.0	118.1	118.1	73.7	114.7	149.3	97.4	62.6	17.1	0.9	0.2	2745.7
Builtupland	1.1	0.5	1.8	2.0	3.0	3.9	4.4	5.7	5.9	14.0	10.0	7.4	0.3	0.5	1.1	0.1	0.0	0.0	61.7
Otherland	519.7	2.9	0.4	0.0	0.0	0.0	809.6	15.8	3.7	1.3	0.2	0.2	348.4	380.0	27.9	2.5	0.0	0.0	2112.5
Total	937.1	302.2	478.8	591.6	642.2	637.8	2356.2	706.1	531.3	682.0	371.8	415.1	599.6	767.4	424.6	50.0	4.2	0.2	10498.4
V8:2007																			
Forest	0.7	2.2	13.7	66.2	155.4	345.0	7.1	25.0	94.5	229.5	130.7	143.2	13.2	200.3	241.3	13.3	1.7	0.0	1683.2
SavnGrasslnd	35.8	74.6	165.8	191.3	166.8	58.2	184.5	131.0	89.9	59.0	37.4	54.9	44.0	69.3	57.8	12.3	1.7	0.0	1434.3
Shrubland	148.7	48.6	43.3	26.3	8.8	3.0	478.4	72.9	47.5	31.5	14.5	2.7	16.0	3.1	1.5	2.3	0.0	0.0	949.1
Cropland	27.1	57.4	119.8	121.1	118.3	128.6	103.1	181.4	172.3	228.9	106.2	92.6	28.2	16.6	32.0	2.4	0.0	0.0	1536.1
Pastureland	204.3	116.0	133.9	184.8	190.1	97.9	766.3	274.2	117.3	117.5	72.2	113.6	149.5	97.7	62.9	17.0	0.9	0.2	2715.9
Builtupland	1.1	0.5	1.8	2.0	3.0	3.9	4.4	5.7	5.9	14.0	10.0	7.4	0.3	0.5	1.1	0.1	0.0	0.0	61.7
Otherland	519.5	2.9	0.4	0.0	0.0	0.0	812.4	15.9	3.6	1.3	0.2	0.2	348.4	379.9	27.9	2.5	0.0	0.0	2115.2
Total	937.1	302.2	478.8	591.7	642.4	636.5	2356.1	706.1	531.1	681.7	371.3	414.6	599.6	767.5	424.5	50.0	4.2	0.2	10495.6

Table A.4. Selected crops in version 6 used in version 8

Alfalfa
Beets for fodder
Broad beans, green
Cabbage for fodder
Carrots for fodder
Clover
Forage products, other
Green oilseeds for fodder
Grasses, other
Maize for forage and silage
Mixed grasses and legumes
Rye grass for forage and silage
Sorghum for forage and silage
Swedes for fodder
Turnips for fodder
Vegetables and roots for fodder

Table A.5. Comparison of harvested area across AEZs between v6, v7, v8:2004 and v8:2007 (in million hectares)

Crop Sectors	AEZ1	AEZ2	AEZ3	AEZ4	AEZ5	AEZ6	AEZ7	AEZ8	AEZ9	AEZ10	AEZ11	AEZ12	AEZ13	AEZ14	AEZ15	AEZ16	AEZ17	AEZ18	Total
V.6																			
1 pdr	1.2	1.2	17.8	34.5	32.0	21.8	2.2	3.8	3.4	3.8	9.7	24.7	0.0	0.0	0.2	0.1	0.0	0.0	156.4
2 wht	1.9	1.4	11.1	3.3	1.2	0.6	24.3	43.3	36.6	35.6	19.2	9.8	10.7	3.6	5.3	0.3	0.0	0.0	208.0
3 gro	6.2	17.7	26.1	18.2	15.6	11.8	12.2	34.2	39.5	59.6	22.0	14.3	2.7	2.2	5.3	0.5	0.0	0.0	288.4
4 v_f	4.0	6.3	20.0	21.7	25.2	19.2	7.2	15.8	19.5	21.3	12.6	17.6	0.6	0.5	1.3	0.2	0.0	0.0	192.9
5 osd	1.0	6.8	13.8	10.3	16.1	17.2	3.4	16.5	19.8	29.7	21.5	22.7	0.7	0.7	2.1	0.2	0.0	0.0	182.2
6 c_b	0.3	0.1	2.5	2.6	4.5	5.2	1.0	1.3	2.1	3.2	1.4	1.4	0.0	0.0	0.1	0.0	0.0	0.0	25.9
7 pfb	0.8	3.6	3.4	2.8	2.3	1.0	5.8	2.8	3.1	1.9	2.4	3.4	0.2	0.1	0.0	0.0	0.0	0.0	33.7
8 ocr	1.6	1.7	6.0	6.9	9.7	12.9	11.8	25.9	24.3	43.8	18.2	11.1	3.9	2.5	7.8	0.5	0.0	0.0	188.5
Total	16.9	38.7	100.8	100.4	106.5	89.6	68.0	143.6	148.4	198.9	107.0	104.9	18.8	9.7	22.0	1.7	0.0	0.0	1275.9
V7																			
1 pdr	1.2	1.3	17.2	34.0	31.1	21.4	2.2	3.7	3.2	3.6	8.8	22.4	0.0	0.1	0.2	0.1	0.0	0.0	150.5
2 wht	1.9	1.6	11.3	3.4	1.3	0.9	24.7	46.5	37.9	36.3	18.5	10.3	12.4	4.0	5.5	0.3	0.0	0.0	216.8
3 gro	7.2	22.3	29.9	23.2	18.0	12.1	12.6	35.5	41.7	60.3	22.4	15.0	2.5	2.2	4.9	0.4	0.0	0.0	310.4
4 v_f	4.5	7.6	23.4	26.6	30.7	24.1	9.0	18.8	22.8	23.6	14.5	21.4	0.8	0.7	1.5	0.3	0.0	0.0	230.2
5 osd	1.1	7.5	16.0	12.5	21.3	19.3	3.7	17.8	22.2	32.8	22.6	29.3	0.9	0.8	2.2	0.2	0.0	0.0	210.2
6 c_b	0.4	0.2	2.4	2.7	4.4	5.5	1.0	1.2	2.0	3.0	1.4	1.4	0.0	0.0	0.1	0.0	0.0	0.0	25.6
7 pfb	0.9	4.3	4.9	3.2	2.4	0.7	6.0	3.1	3.5	2.0	2.8	3.9	0.3	0.1	0.0	0.0	0.0	0.0	38.3
8 ocr	1.6	1.7	6.0	6.0	9.6	10.0	11.9	25.9	24.1	42.7	17.8	11.2	3.9	2.5	7.8	0.5	0.0	0.0	183.2
Total	18.8	46.7	111.0	111.7	118.9	93.8	71.2	152.4	157.4	204.4	108.8	114.8	20.9	10.4	22.2	1.7	0.0	0.0	1365.2
V8:2004																			
1 pdr	1.2	1.3	17.2	34.0	31.1	21.4	2.2	3.7	3.2	3.6	8.8	22.4	0.0	0.1	0.2	0.1	0.0	0.0	150.5
2 wht	1.9	1.6	11.3	3.4	1.3	0.9	24.7	46.5	37.9	36.3	18.5	10.3	12.4	4.0	5.5	0.3	0.0	0.0	216.9
3 gro	7.3	22.3	29.9	23.2	18.0	12.1	12.6	35.4	41.6	60.2	22.4	14.9	2.5	2.2	4.9	0.4	0.0	0.0	310.1
4 v_f	4.4	7.6	23.4	26.9	30.8	23.6	8.7	18.6	22.5	23.1	14.2	21.2	0.8	0.7	1.4	0.3	0.0	0.0	228.3
5 osd	1.1	7.6	16.0	12.7	21.3	19.3	3.6	17.6	22.1	32.7	22.4	29.1	0.9	1.0	2.2	0.2	0.0	0.0	209.9
6 c_b	0.4	0.2	2.4	2.7	4.4	5.5	1.0	1.2	2.0	3.0	1.4	1.4	0.0	0.0	0.1	0.0	0.0	0.0	25.6
7 pfb	0.9	4.3	4.9	3.3	2.4	0.8	6.0	3.0	3.5	2.0	2.7	3.8	0.3	0.1	0.0	0.0	0.0	0.0	38.1
8 ocr	1.6	1.7	6.0	6.0	9.6	10.0	11.9	26.0	24.3	43.9	18.1	11.2	3.9	2.5	7.8	0.5	0.0	0.0	185.1
Total	18.7	46.8	111.1	112.3	118.9	93.6	70.9	151.9	157.2	204.9	108.6	114.4	20.8	10.6	22.1	1.7	0.0	0.0	1364.5
V8:2007																			
1 pdr	1.3	1.3	17.9	35.9	32.5	21.6	2.3	3.8	3.3	3.5	8.8	22.4	0.0	0.1	0.2	0.1	0.0	0.0	154.9
2 wht	2.1	1.6	11.9	3.5	1.1	0.6	25.1	47.1	37.3	35.1	18.6	9.7	13.2	4.0	5.5	0.3	0.0	0.0	216.6
3 gro	8.1	25.7	30.9	24.8	19.0	12.7	13.1	35.3	42.1	61.6	23.8	16.6	2.7	2.2	5.1	0.4	0.0	0.0	324.1
4 v_f	5.4	9.1	25.2	28.8	32.9	24.3	9.2	19.0	22.7	22.1	13.9	21.1	0.8	0.7	1.4	0.2	0.0	0.0	236.9
5 osd	1.1	7.4	16.5	12.9	21.2	20.8	3.8	18.2	23.2	33.1	21.2	28.4	0.9	1.0	2.7	0.2	0.0	0.0	212.6
6 c_b	0.4	0.3	3.0	2.8	4.8	6.3	1.0	1.3	2.2	2.9	1.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	27.9
7 pfb	0.8	4.6	4.6	3.1	2.3	0.8	5.6	2.9	3.5	1.8	2.7	3.3	0.3	0.1	0.0	0.0	0.0	0.0	36.4
8 ocr	1.6	1.7	6.1	6.0	9.8	9.5	11.9	26.0	24.2	43.8	18.1	11.3	3.9	2.5	7.8	0.5	0.0	0.0	184.7
Total	20.9	51.8	116.1	117.7	123.6	96.7	72.0	153.7	158.5	203.9	108.3	114.1	21.7	10.6	22.7	1.7	0.0	0.0	1394.0

Table A.6. Comparison of land rents across AEZs between v6, v7, v8:2004 and v8:2007 (VFM:in million U.S.D)

Crop Sectors	AEZ1	AEZ2	AEZ3	AEZ4	AEZ5	AEZ6	AEZ7	AEZ8	AEZ9	AEZ10	AEZ11	AEZ12	AEZ13	AEZ14	AEZ15	AEZ16	AEZ17	AEZ18	Total
V.6																			
1 pdr	200	102	1429	3964	4018	3979	851	943	529	2349	4794	3905	4	15	51	9	0	0	27141
2 wht	419	180	1347	308	100	88	3111	4056	3475	7377	5225	1129	253	139	380	70	0	0	27658
3 gro	209	251	948	1096	854	1156	1371	1973	3835	11286	5905	1601	67	83	547	122	0	0	31302
4 v_f	1171	738	3805	5880	5309	9212	4909	8529	11513	15274	11818	14891	191	219	693	110	2	0	94263
5 osd	127	914	2278	1485	919	748	665	1647	1912	4192	3148	1674	31	42	185	28	0	0	19997
6 c_b	133	67	1701	908	652	1070	394	353	779	814	330	408	19	7	17	3	0	0	7656
7 pfb	192	810	563	442	333	189	1222	601	673	347	651	983	22	9	4	2	0	0	7043
8 ocr	294	579	3041	3432	2659	5148	2548	3611	3446	8777	5819	2429	151	109	423	95	0	0	42562
Total	2744	3641	15111	17514	14844	21590	15072	21714	26163	50417	37690	27020	737	623	2300	440	3	0	257622
V7																			
1 pdr	217	109	1792	4761	4327	4322	290	715	608	2705	5941	4472	11	16	53	10	0	0	30350
2 wht	169	171	1819	412	107	74	1466	3369	2975	3895	2395	698	190	110	285	49	0	0	18184
3 gro	216	356	1259	1549	1366	1408	933	2179	3544	6805	2823	917	95	159	478	65	0	0	24152
4 v_f	1111	1060	5082	6567	6550	10722	4875	8552	17058	24577	20652	15495	277	265	1494	233	2	0	124572
5 osd	150	1205	3045	1828	1561	2611	508	2146	2350	3988	2719	2231	30	40	136	17	0	0	24565
6 c_b	136	76	2227	1162	753	1090	389	429	972	1701	896	429	8	11	52	7	0	0	10338
7 pfb	241	1236	901	318	428	103	1648	854	1068	1063	1126	1329	34	15	10	6	0	0	10378
8 ocr	307	707	2998	3332	4970	6238	1208	1106	2431	15196	12278	5359	21	48	160	126	0	0	56486
Total	2548	4922	19123	19929	20062	26567	11319	19350	31007	59930	48829	30929	666	664	2666	513	3	0	299025
V8:2004																			
1 pdr	221	85	1145	3542	3953	4080	291	599	620	2339	5327	4868	14	19	55	14	0	0	27171
2 wht	175	98	763	212	65	100	1413	2385	3061	8887	7210	1386	193	118	357	75	0	0	26498
3 gro	188	332	894	1179	1162	1386	836	2170	4210	10559	5773	1549	104	188	869	145	0	0	31543
4 v_f	1084	1221	5447	7159	6697	10823	4511	8621	15282	17542	15040	17425	254	252	952	142	2	0	112453
5 osd	144	536	1194	934	1185	4586	371	1524	2085	6205	4226	2341	29	78	208	41	0	0	25688
6 c_b	137	55	1005	702	805	1110	399	288	596	1202	477	411	8	11	26	6	0	0	7237
7 pfb	211	747	575	405	479	111	1358	631	853	2436	1377	1044	27	11	12	13	0	0	10289
8 ocr	420	666	3667	2746	2844	5024	2375	2915	3469	11736	8971	2705	98	118	629	140	0	0	48521
Total	2579	3741	14689	16879	17189	27220	11553	19132	30176	60906	48400	31728	726	796	3108	575	3	0	289399
V8:2007																			
1 pdr	331	139	1894	5206	5788	6757	434	962	886	2517	6319	7754	20	25	82	18	0	0	39132
2 wht	254	157	1210	317	81	160	1968	4003	3986	5999	3513	1125	397	247	503	63	1	0	23984
3 gro	296	555	1400	1862	1946	2308	1350	3822	5585	10495	4275	1837	217	357	890	81	1	0	37277
4 v_f	1658	1810	8638	11384	11266	17047	6596	14424	25499	27317	21326	27848	489	460	1492	202	2	0	177458
5 osd	214	868	2028	1414	1782	7515	503	2347	2987	5756	3797	3275	46	81	224	31	1	0	32869
6 c_b	200	81	1714	1092	1231	1925	502	417	869	1115	456	499	9	14	27	7	0	0	10158
7 pfb	290	1371	1023	669	737	181	1460	835	1302	976	710	960	40	15	5	4	0	0	10578
8 ocr	583	1091	6081	4398	4665	8102	2496	3242	3968	14884	8264	3625	93	342	3909	1425	0	0	67168
Total	3826	6072	23988	26342	27496	43995	15309	30052	45082	69059	48660	46923	1311	1541	7132	1831	5	0	398624

Figure A.1. Methods used in constructing the land use and land cover data for version 8

