



Development of a GTAP Land Use Data Base for 2011

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1. Background and motivation

The GTAP land use data bases provide data on land cover items including accessible forest, pasture, cropland, inaccessible forest, shrubland, savannah, and build up land areas at the Agro-Ecological Zone (AEZ) level by country. In addition, they provide data on harvested area and crop production at the AEZ level by crop and country. Avetisyan et al. (2011) documented all the data sources, methods, and assumption used in developing land use data bases for 2001 and 2004. Those data sources, methods, and assumptions were used to generate a land use data base for 2007 as well (Avetisyan, Baldos, and Hertel 2011).

To develop a land use data for 2011, we encountered a major obstacle. We do not have available the spatial global land cover data for 2011 by AEZ and country, which was available for the development of the previous versions of the data set (Ramankutty 2012). The gridded data base by Ramankutty (2012) cover a long time period starting from 1700 and ending in 2007. In order to solve this problem, we use the FAOSTAT data base developed by the Food and Agricultural Organization (FAO) of the United Nations. Currently, this data base provides land cover data at the country level up to 2011.

Following the earlier versions of the GTAP land use data bases, we also rely on the FAOSTAT data to update the GTAP data on harvested areas and crops produced in 2011. This paper is divided into sections with each one covering a particular part of the update for land use database. Following are the main components:

- o Land cover development items by country, region and AEZ
- o Comparison in land cover data between 2004 and 2011
- o Harvested area and crop production by country, region and AEZ
- o Crop production and harvested area by crop, region and AEZ
- o Changes in harvested area and crop production for 2004-2011

Thus, this document provides a complete description of the new land use database and compares 2004 with 2011.

2. Development of land cover data

The FAO data for crop harvested area is identical to the GTAP data. However, that is not the case for land cover data, because somewhat different definitions are used by FAO and GTAP. Thus, we needed to develop a method for using the FAO data despite these differences.

The approach selected was to assume that the percentage changes in FAO land cover data between 2007 and 2011 would be applied to the 2007 GTAP data to produce 2011 data for GTAP. We estimated the percentage changes in cropland, pasture land, and forest areas for the time period

of 2007-2011 by country using the FAOSTAT data base¹. In this process we used the matches in Table 1 to link the percentage changes in land cover items of GTAP with the percentage changes in land categories from FAOSTAT.

Table 1. Match Between Previous GTAP and FAO Land Cover Categories

GTAP land cover categories	FAO land cover categories
Accessible forest	Forest
Pasture land	Permanent meadows and pasture
Cropland	Arable land and permanent crop

The percentage changes were incorporated to the three GTAP land cover categories to project forest, pasture, and cropland areas by country and AEZ for 2011 using the following formula:

$$LANDCOVER_{2011,i,z,r}^{GTAP} = LANDCOVER_{2007,i,z,r}^{GTAP} \left(\frac{LANDCOVER_{2011,i,r}^{FAOSTAT}}{LANDCOVER_{2007,i,r}^{FAOSTAT}} - 1 \right)$$

Here: i denotes land cover types including forest, cropland, and pasture land; z stands for AEZ from 1 to 18, and r represents countries including 134 regions listed in GTAP data base version 8. Note that we also assume that the AEZ proportions in each country remain the same between 2007 and 2011. Savannah and shrubland were adjusted in order to keep constant the total land cover per AEZ and region². The other land cover categories (i.e. builtupland and other land) were assumed no change for the short time period of 2007-2011. Then we aggregated the results into the 19 regions used in the GTAP-BIO modeling framework. We now present the 2011 land cover data bases for these 19 regions.

2.1 Forest land

Columns 2, 5, and 8 of table 2 report the accessible forest land in millions of hectares (Mha) by region in 2011, the shares of global forest per region, and share of forest per regional accessible land, respectively. Also, figure 1 shows the forest area in 2011 by region. Overall, global forest cover was 1,680 million of hectares, which represents 28.2% of the sum of forest, cropland, and pasture land at the global scale.

In Europe, the regions with the highest intensities of forest land in 2011 were Russia (15.9% of global forest cover), and the European Union (9.2%). In North America, the forest was more concentrated in Eastern U.S. (13.8%) and Canada (6.0%); whereas in South America (6.4%), forest land was mainly in the Amazon region (Brazil, Colombia and Peru). In Africa, forest was concentrated in Sub Saharan Africa (10.9%). For the case of Asia, the regions with the largest forest area were China (9.1%) and South East Asia (5.6%).

¹ FAO presents 239 nations which were aggregated in 134 GTAP regions (as established in the 2007 land data).

² The adjustment is further explained in Annex A.

Table 2. Land cover in 2011

Region	Land cover in 2011 (mil. ha.)			Share of each region (%)			Share of each land category (%)		
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
USA	232	165	229	13.8	10.6	8.5	37.1	26.4	36.6
European Union	155	123	60	9.2	7.8	2.2	45.9	36.3	17.8
BRAZIL	154	63	174	9.1	4.0	6.4	39.4	16.1	44.5
Canada	101	36	20	6.0	2.3	0.7	64.3	23.0	12.7
JAPAN	18	4	0	1.1	0.2	0.0	82.2	15.9	1.8
China	152	144	277	9.1	9.2	10.2	26.6	25.1	48.3
India	18	172	10	1.1	11.0	0.4	9.0	85.8	5.2
Central America	49	57	84	2.9	3.7	3.1	25.6	30.2	44.2
South America	107	64	256	6.4	4.1	9.5	25.1	15.0	59.9
East Asia	17	5	76	1.0	0.3	2.8	17.2	4.9	78.0
Malaysia & Indonesia	40	75	2	2.4	4.8	0.1	34.1	63.8	2.0
South East Asia	94	59	5	5.6	3.7	0.2	59.5	37.3	3.2
South Asia	8	48	37	0.5	3.0	1.4	8.2	51.5	40.3
Russia	267	124	79	15.9	7.9	2.9	56.9	26.4	16.7
Central Europe	54	110	280	3.2	7.0	10.3	12.1	24.8	63.1
Other European countries	30	1	1	1.8	0.1	0.0	93.8	2.8	3.4
Middle and North Africa	2	54	129	0.1	3.4	4.8	0.9	29.0	70.1
Sub Saharan Africa	184	227	732	10.9	14.6	27.1	16.1	19.9	64.0
Oceania	5	34	251	0.3	2.1	9.3	1.8	11.6	86.6
Total	1,686	1,562	2,704	100.0	100.0	100.0	28.2	26.3	45.4

The countries with the highest forest land share were European countries that are not members of the European Union, Japan, Canada and South East Asia in which forest represented 93.8%, 82.2%, 64.3% and 59.5% of their total land, respectively.

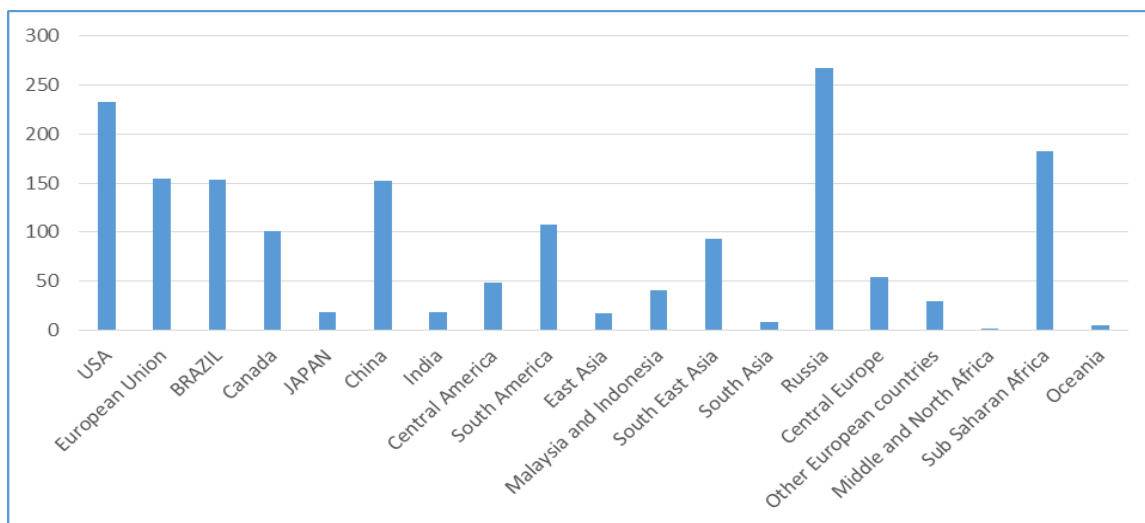


Figure 1. Forest land in 2011 (in Mha)

2.2 Cropland

Columns 3, 6, and 9 of table 2 display the cropland in Mha by region in 2011, the shares of global cropland per region, and share of cropland in total accessible land of each region, respectively. Figure 2 shows the cropland area by region in 2011. Global cropland area was 1,566 million hectares (i.e. 26.3% of global land).

The region with highest cropland share was Sub Saharan Africa (14.6% of global cropland), whereas Middle and North Africa only represented 3.4% of global cropland. In Asia, cropland area was clustered in India (11.0%), China (9.2%) and Russia (7.9%). In North America, United States has one of the highest shares in cropland (10.6%), followed by the European Union (7.8%). In the case of Latin America, South America (4.1%) and Central America (3.7%) have relatively small shares.

In terms of cropland share of total land, the regions with highest cropland shares were found in Asia: India (85.8%), Malaysia and Indonesia (63.8%) and South Asia (51.5%).

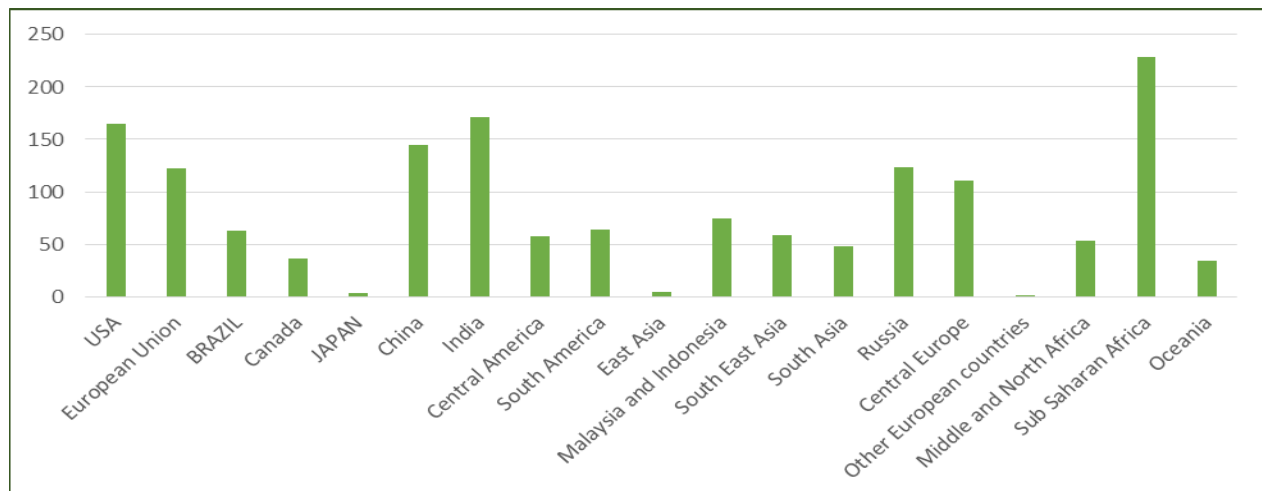


Figure 2. Cropland area by region in 2011 (in Mha)

2.3 Pasture land

Columns 4, 7, 10 of table 2 report pasture in Mha by region in 2011, the shares of global pasture per region, and share of pasture in total accessible land of each region, respectively. Also, figure 3 shows the pasture land in 2011 by region. Global pasture area was 2,704 million hectares. The highest concentrations of pasture are found in Africa (clustered in Sub Saharan region), China, Western U.S., South America (Brazil and Argentina), and Oceania (mainly Australia). In terms of pasture share in total land, the regions with highest pasture shares were found in Oceania (86.6%) and Middle East and North Africa (70.1%).

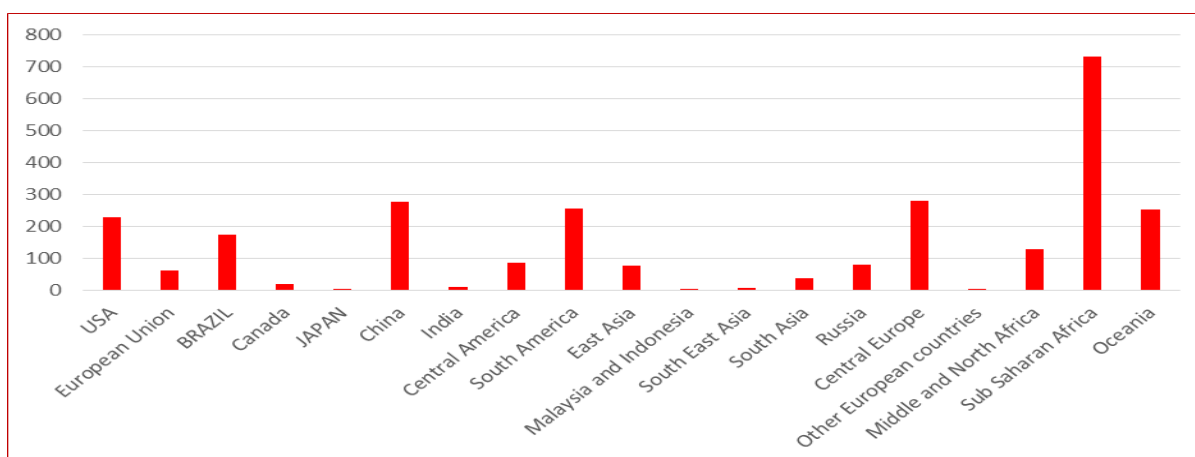


Figure 3. Pasture land by region in 2011 (in millions of hectares)

2.4 Global land cover by AEZ

The land cover categories in 2011 by AEZ are represented in table 3. Most of the accessible forest areas are found in in tropical (AEZs 4-6) and template (AEZs 9-12) climates with long growth periods. On the other hand, template climate with medium growth periods (AEZs 8-10) are the zones with highest shares of cropland. Template climate with short growing periods (AEZs 7-8) are the zones with highest shares of pasture. With respect of shares of each land category in total area of each AEZ, forest is largest in AEZs with long growth period (AEZs 6, 10-12, 14-15 and 17). Whereas, pasture cover share is highest generally for AEZs with short and medium growth periods (AEZs 1-2, 4-5, 7-8 and 18).

Table 3. Global land cover by AEZs in 2011

AEZ	Land cover in 2011 (mil. ha.)			Share of each AEZ (%)			Share of each land category (%)		
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
AEZ1	1	27	203	0.0	1.8	7.5	0.3	11.9	87.8
AEZ2	2	59	115	0.1	3.8	4.2	1.2	33.5	65.2
AEZ3	14	122	133	0.8	7.8	4.9	5.1	45.4	49.5
AEZ4	65	125	185	3.9	8.0	6.8	17.3	33.4	49.2
AEZ5	152	123	190	9.0	7.9	7.0	32.7	26.4	40.9
AEZ6	340	136	98	20.2	8.7	3.6	59.1	23.8	17.1
AEZ7	7	103	759	0.4	6.6	28.1	0.8	11.9	87.3
AEZ8	25	183	273	1.5	11.7	10.1	5.3	38.0	56.8
AEZ9	96	174	117	5.7	11.1	4.3	24.8	44.9	30.3
AEZ10	231	228	117	13.7	14.6	4.3	40.1	39.6	20.3
AEZ11	133	107	72	7.9	6.8	2.7	42.6	34.3	23.1
AEZ12	146	96	113	8.7	6.1	4.2	41.1	27.0	31.9
AEZ13	13	29	150	0.8	1.9	5.5	6.9	15.2	77.9
AEZ14	201	17	98	11.9	1.1	3.6	63.8	5.3	30.9
AEZ15	243	32	62	14.4	2.0	2.3	72.1	9.4	18.5
AEZ16	13	2	17	0.8	0.2	0.6	41.1	7.3	51.6
AEZ17	2	0	1	0.1	0.0	0.0	65.1	1.2	33.6
AEZ18	0	0	0	0.0	0.0	0.0	0.0	0.6	99.4
Total	1,684	1,564	2,704	100.0	100.0	100.0	28.3	26.3	45.4

Shares of other land categories are not shown in this table

3. Changes in land cover data between 2004 and 2011

We now present the comparison between 2004 and 2011 land cover data for forest, cropland, and pastureland. Total area summed across AEZs and regions for each land cover are listed in Table 4. In version 9, forest and cropland experiences area increases; whereas pastureland decreased by 41,673 thousands of hectares. The total of the three categories fell by 16.4 Mha which suggests that the sum of forest, pasture, and cropland fall by 3% in 2004 to 2011.

Table 4. Comparison of total area for the three different land covers

Land Cover (in thousand hectares)	Versions	
	2004 (V.7)	2011 (V.9)
Forest	1,678,148	1,683,937
Cropland	1,544,485	1,561,985
Pastureland	2,745,750	2,704,077
Total	5,968,383	5,951,998

The changes in global land cover by AEZ in the period 2004 - 2011 in absolute changes are presented in table 5. For most of the AEZs the changes in area are small, except for the temperate climate with short growth period (i.e. AEZs 7-8) which had noticeable decreases in terms of pastureland³. For tropical weather (AEZs 1-6), cropland increases, whereas the other two categories decrease. For AEZs 7-11 and 15-16, forest cover was expanded whereas cropland and pastureland fell. In the case of AEZ 14, the drivers of the increase are forest and pastureland whereas cropland fell in area. AEZs 17-18 remained constant over the time period.

Absolute changes in land cover must be complemented by their relative context. The percentage changes in forest, cropland and pastureland in 2004-2011 by AEZ are also reported in table 5. As we can observe, for the three land categories, the shares by AEZ have remained relatively constant, with changes less than 2% in all the land covers. During both periods, for AEZs 1-5, 7-8, 13, 16 and 18, most of their area is covered by pasture. Most of the area for AEZs 6, 14-15 and 17 are forest. For the case of AEZs 9-12, the land cover has been distributed for the three categories almost in the same proportion.

³ The decrease in pastureland in AEZ7 occurred mainly in the period 2004-2007, in which there was a reduction of 13.7 Mha. AEZ8 also had a significant reduction between 2004 and 2007 (13 Mha in pastureland), whereas in the period 2007-2011 there was only 1 Mha decrease in pasture.

Table 5. Absolute and relative changes in the land cover categories by AEZ in 2004-2011

AEZ	Total land cover by AEZ (Millions hectares)						Difference in millions hectares (V.9 less V.7)		
	Version 7			Version 9					
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
AEZ1	0.7	26.1	203.9	0.7	27.6	202.8	0.0	1.5	-1.1
AEZ2	2.3	55.4	115.8	2.2	58.8	114.8	-0.1	3.4	-1.0
AEZ3	13.8	117.9	134.1	13.6	121.7	133.5	-0.2	3.8	-0.6
AEZ4	66.6	119.1	185	65.2	124.9	184.6	-1.4	5.8	-0.4
AEZ5	156.3	117	190.8	152.9	122.1	190.3	-3.4	5.1	-0.5
AEZ6	344.3	130.4	98.1	340.5	136.4	98.3	-3.8	6.0	0.2
AEZ7	7.0	105.6	780	7.1	103.3	759.2	0.1	-2.3	-20.8
AEZ8	24.8	183.9	286	25.3	182.7	273.2	0.5	-1.2	-12.8
AEZ9	94.0	175.3	118.1	95.9	173.5	117.1	1.9	-1.8	-1.0
AEZ10	228.5	231.2	118.1	231.5	228.2	117.3	3.0	-3.0	-0.8
AEZ11	128.4	108.6	73.7	132.8	107.0	72.2	4.4	-1.6	-1.5
AEZ12	142	93.8	114.7	146.1	95.9	113.2	4.1	2.1	-1.5
AEZ13	13.2	28.4	149.3	13.2	29.1	149.6	0.0	0.7	0.3
AEZ14	200.2	16.8	97.4	200.9	16.7	97.6	0.7	-0.1	0.2
AEZ15	241.3	32.6	62.6	242.8	31.7	62.5	1.5	-0.9	-0.1
AEZ16	13.3	2.4	17.1	13.5	2.4	16.9	0.2	0.0	-0.2
AEZ17	1.7	0.0	0.9	1.7	0.0	0.9	0.0	0.0	0.0
AEZ18	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0
AEZ	Shares of land cover by AEZ (%)						Difference % change (V.9 less V.7)		
	Version 7			Version 9					
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
AEZ1	0.3	11.3	88.4	0.3	11.9	87.8	0.0	0.6	-0.6
AEZ2	1.3	31.9	66.8	1.3	33.5	65.3	0.0	1.6	-1.5
AEZ3	5.2	44.4	50.5	5.1	45.3	49.6	-0.1	0.9	-0.9
AEZ4	18	32.1	49.9	17.4	33.3	49.3	-0.6	1.2	-0.6
AEZ5	33.7	25.2	41.1	32.9	26.3	40.9	-0.8	1.1	-0.2
AEZ6	60.1	22.8	17.1	59.2	23.7	17.1	-0.9	0.9	0.0
AEZ7	0.8	11.8	87.4	0.8	11.9	87.3	0.0	0.1	-0.1
AEZ8	5.0	37.2	57.8	5.3	38.0	56.8	0.3	0.8	-1.0
AEZ9	24.3	45.3	30.5	24.8	44.9	30.3	0.5	-0.4	-0.2
AEZ10	39.6	40	20.4	40.1	39.5	20.3	0.5	-0.5	-0.1
AEZ11	41.3	35	23.7	42.6	34.3	23.1	1.3	-0.7	-0.6
AEZ12	40.5	26.8	32.7	41.1	27.0	31.9	0.6	0.2	-0.8
AEZ13	6.9	14.9	78.2	6.9	15.2	77.9	0.0	0.3	-0.3
AEZ14	63.7	5.3	31.0	63.7	5.3	31.0	0.0	0.0	0.0
AEZ15	71.7	9.7	18.6	72.0	9.4	18.5	0.3	-0.3	-0.1
AEZ16	40.5	7.3	52.2	41.1	7.3	51.6	0.6	0.0	-0.6
AEZ17	64.7	1.2	34.0	65.1	1.3	33.6	0.4	0.1	-0.4
AEZ18	0.0	0.8	99.2	0.0	0.8	99.2	0.0	0.0	0.0

Table 6. Absolute and relative changes in the land cover categories by region in 2004-2011

Region	Land cover by region (Mha)						Difference in millions hectares (V.9 less V.7)		
	Version 7			Version 9					
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
USA	228.8	175.8	228.8	232.5	165.3	229.2	3.7	-10.5	0.4
European Union	152.7	124.8	60.0	155.0	122.6	60.1	2.3	-2.2	0.1
BRAZIL	156.1	60.7	175.5	153.5	62.7	173.7	-2.6	2.0	-1.8
Canada	100.4	39.6	20.4	100.5	35.9	19.9	0.1	-3.7	-0.5
JAPAN	18.3	3.7	0.4	18.4	3.6	0.4	0.1	-0.1	0.0
China	143.9	140.6	277.0	152.3	144.1	277.0	8.4	3.5	0.0
India	17.9	171.4	10.8	18.1	171.6	10.4	0.2	0.2	-0.4
Central America	49.0	56.7	84.3	49.0	57.2	83.8	0.0	0.5	-0.5
South America	109.1	58.6	254.3	107.4	64.1	256.4	-1.7	5.5	2.1
East Asia	17.5	5.2	76.3	17.1	4.9	76.7	-0.4	-0.3	0.4
Malaysia & Indonesia	40.4	71.6	2.4	39.9	74.7	2.4	-0.5	3.1	0.0
South East Asia	95.9	53.2	4.9	93.5	58.6	5.1	-2.4	5.4	0.2
South Asia	7.7	47.0	37.3	7.6	47.6	37.3	-0.1	0.6	0.0
Russia	267.2	124.5	78.6	267.4	123.9	78.5	0.2	-0.6	-0.1
Central Europe	51.4	111.5	280.3	53.7	110.1	279.7	2.3	-1.4	-0.6
Other European countries	28.4	0.9	1.1	29.6	0.9	1.1	1.2	0.0	0.0
Middle East and North Africa	1.3	53.6	151.9	1.6	53.8	129.5	0.3	0.2	-22.4
Sub Saharan Africa	187.2	211.0	729.2	183.6	226.8	731.6	-3.6	15.8	2.4
Oceania	5.2	34.0	272.2	5.1	33.6	251.3	-0.1	-0.4	-20.9
Region	Share of total land cover by region (%)						Difference in shares (V.9 less V.7)		
	Version 7			Version 9					
	Forest	Cropland	Pasture	Forest	Cropland	Pasture	Forest	Cropland	Pasture
USA	36.1	27.8	36.1	37.1	26.4	36.6	1.0	-1.4	0.5
European Union	45.2	37.0	17.8	45.9	36.3	17.8	0.7	-0.7	0.0
BRAZIL	39.8	15.5	44.7	39.4	16.1	44.5	-0.4	0.6	-0.2
Canada	62.6	24.7	12.7	64.3	23.0	12.7	1.7	-1.7	0.0
JAPAN	81.7	16.5	1.8	82.2	15.9	1.8	0.5	-0.6	0.0
China	25.6	25.0	49.3	26.6	25.1	48.3	1.0	0.1	-1.0
India	8.9	85.7	5.4	9.0	85.8	5.2	0.1	0.1	-0.2
Central America	25.8	29.8	44.4	25.8	30.1	44.1	0.0	0.3	-0.3
South America	25.9	13.9	60.3	25.1	15.0	59.9	-0.8	1.1	-0.4
East Asia	17.7	5.3	77.1	17.4	4.9	77.7	-0.3	-0.4	0.6
Malaysia & Indonesia	35.3	62.6	2.1	34.1	63.8	2.0	-1.2	1.2	-0.1
South East Asia	62.3	34.5	3.2	59.5	37.3	3.2	-2.8	2.8	0.0
South Asia	8.4	51.1	40.5	8.2	51.5	40.3	-0.2	0.4	-0.2
Russia	56.8	26.5	16.7	56.9	26.4	16.7	0.1	-0.1	0.0
Central Europe	11.6	25.2	63.2	12.1	24.8	63.1	0.5	-0.4	-0.1
Other European countries	93.4	3.0	3.6	93.8	2.8	3.4	0.4	-0.2	-0.2
Middle East and North Africa	0.6	25.9	73.5	0.9	29.1	70.0	0.3	3.2	-3.5
Sub Saharan Africa	16.6	18.7	64.7	16.1	19.9	64.1	-0.5	1.2	-0.6
Oceania	1.7	10.9	87.4	1.8	11.6	86.6	0.1	0.7	-0.8

The table shows the shares of three categories with respect to total area.

Table 6 shows the changes in global land cover by region in the period 2004 - 2011 in absolute (millions hectares) and relative values (percentage change). In terms of forest, United States, the European Union and China experienced an expansion in area, whereas Sub Saharan Africa, Brazil and South East Asia reduced forest. The highest concentration of cropland is found in both periods in the Sub Saharan Africa, this region increased its cropland by 15.8 Mha (+7.5%), whereas the United States decreased its area by 10.5 Mha (-5.9%), India cropland area remained relatively constant. In terms of pastureland, Sub Saharan Africa represents approximately 27% of the total pasture cover in 2004 and 2011, evidencing a small increase in the eight year period of 2.4 Mha (+0.3%). South America also increased its pasture area by 2.1 Mha, whereas Oceania and Middle East and North Africa regions faced a reduction of 20.9 Mha and 22.4 Mha respectively⁴.

In relative terms, most of the regions did not change significantly its shares in the land categories. The United States has increased its forest and pasture shares whereas cropland share experienced a reduction of 1.4%. The European Union did not change its share in pasture, but forest had a share increase of 0.7%. Canada also increased its forest land share (+1.7%) but decreased its cropland share. South East Asia and the region of Malaysia and Indonesia experienced the opposite situation, the regions had an increase cropland share (+2.8% and +1.2% respectively) whereas forest share decreased (-2.8% and -1.2% respectively). For all the other regions the changes were less than 1%.

4. Data on crop production and area

The harvesting area (in hectares) and crop production (in metric tons) by country and crop were obtained from the FAOSTAT database for 2011. Then the FAO crop categories were aggregated into GTAP crop categories⁵ and the following formulas used to develop harvested areas and crop production by country and AEZ for 2011:

$$H_AREA_2011_{i,z,r}^{GTAP} = H_AREA_2011_{i,r}^{FAOSTAT} \left(\frac{H_AREA_2007_{i,z,r}^{GTAP}}{\sum_{z \in AEZ18} H_AREA_2007_{i,z,r}^{GTAP}} \right)$$

$$PROD_2011_{i,z,r}^{GTAP} = PROD_2011_{i,r}^{FAOSTAT} \left(\frac{PROD_2007_{i,z,r}^{GTAP}}{\sum_{z \in AEZ18} PROD_2007_{i,z,r}^{GTAP}} \right)$$

Here: H_AREA and PROD represent harvested area and crop production; *i* denotes the 175 crop types in GTAP data base; *z* stands for AEZ from 1 to 18, and *r* represents countries including 226 regions listed in GTAP data base version 8. Essentially this process just allocates the 2011 crop production and harvested area into AEZs in each country under the assumption that the proportions did not change between 2007 and 2011.

Following Avetisyan et al. (2011) for special cases, where we observed non-zero harvested area or production in FAOSTAT data base but zero AEZ shares in the GTAP version 8 land use

⁴ For the case of Middle East and North Africa region, pasture land decreased by 22.5 Mha during the period of 2004-2007 and only 0.1 Mha increase in the period 2007-2011. Also, Sub Saharan Africa increased most of its cropland during the period 2004-2007.

⁵ The appendix B contains the aggregation map to the 8 crop sectors.

data base, we applied the cropland cover shares⁶. Finally, the database was aggregated into 8 crop sectors and 19 regions by AEZ.

Table 7. Production by crop and region in 2011 (millions of tons)

Region	Paddy Rice	Wheat	Coarse Grains	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	8.4	54.4	324.0	85.0	87.7	52.9	8.3	669.1
European Union	3.1	137.9	149.7	192.2	42.4	124.0	1.2	693.4
Brazil	13.5	5.7	58.4	86.4	79.6	734.0	5.4	4.5
Canada	0.0	25.3	22.0	11.0	18.9	0.8	0.0	31.5
Japan	10.5	0.7	0.2	17.8	0.2	4.5	0.0	27.7
China	201.0	117.4	200.4	864.5	48.9	125.2	20.0	70.1
India	157.9	86.9	43.1	251.5	41.7	342.4	21.1	125.7
Central America	2.9	3.6	29.5	60.6	7.2	118.5	0.8	44.4
South America	12.8	20.0	47.9	74.8	74.1	112.6	1.5	130.2
East Asia	8.8	0.6	2.3	22.4	0.5	0.0	0.0	0.3
Malaysia and Indonesia	68.3	0.0	17.7	57.6	216.0	25.0	0.2	5.3
South East Asia	134.5	0.2	20.7	116.7	33.8	155.3	0.8	7.5
South Asia	68.9	31.3	9.1	44.4	3.8	63.9	8.2	2.4
Russia	1.1	56.2	34.5	54.2	13.1	47.6	0.0	189.1
Central Europe	1.8	84.7	71.0	140.0	19.5	44.9	7.1	138.1
Other European countries	0.0	0.8	1.2	2.0	0.1	1.8	0.0	16.2
Middle and North Africa	8.7	39.4	21.6	133.7	5.9	38.8	1.7	104.9
Sub Saharan Africa	20.3	6.3	101.0	364.2	38.5	68.9	3.4	36.3
Oceania	0.7	27.8	12.5	14.8	5.5	25.5	2.2	197.5
Total	723.2	699.4	1166.8	2593.9	737.5	2086.6	82.0	2494.1

4.1 Crop production

Figure 4 displays crop production for 2011 by GTAP crop categories. Likewise, table 7 reports production in millions of tons (Mt) in 2011. Table 8 reports the shares of every region in the production of every sector.

As shown in tables 7 and 8, Paddy rice production is concentrated in Asia, mainly in China (27.8%), India (21.8%) and South East Asia (18.6%). With respect to wheat, the main producers are the European Union, China, India and Central Europe with a production of 137.9 Mt (19.7%), 117.4 Mt (16.8%), 86.9 Mt (12.4%) and 84.7 Mt (12.1%), respectively. Maize represented the 76% of production of coarse grains, where the United States had the highest production of corn (35%) followed by China (22%). Barley and sorghum represented 11% and 5% of coarse grain production, respectively. Russia has the highest production in barley (16.9 million of tons), whereas India is the leader in production of sorghum with 7.0 million tons (Mt).

The vegetable and fruit sector has the largest share in global production (24.5%). China, Sub Saharan Africa and India have the highest production with 864.5 Mt (33.3%), 364.2 Mt (14.0%), 251.5 Mt (9.7%), respectively.

⁶ The appendix C describes the adjustments to land and production when special cases such as production and no land occurred.

Table 8. Crop shares of production of each region and sector in 2011 (in %)

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	1	8	28	3	12	3	10	27
European Union	0	20	13	7	6	6	1	28
BRAZIL	2	1	5	3	11	35	7	0
Canada	0	4	2	0	3	0	0	1
JAPAN	1	0	0	1	0	0	0	1
China	28	17	17	33	7	6	24	3
India	22	12	4	10	6	16	26	5
Central America	0	1	3	2	1	6	1	2
South America	2	3	4	3	10	5	2	5
East Asia	1	0	0	1	0	0	0	0
Malaysia and Indonesia	9	0	2	2	29	1	0	0
South East Asia	19	0	2	5	5	7	1	0
South Asia	10	4	1	2	1	3	10	0
Russia	0	8	3	2	2	2	0	8
Central Europe	0	12	6	5	3	2	9	6
Other European countries	0	0	0	0	0	0	0	1
Middle and North Africa	1	6	2	5	1	2	2	4
Sub Saharan Africa	3	1	9	14	5	3	4	1
Oceania	0	4	1	1	1	1	3	8

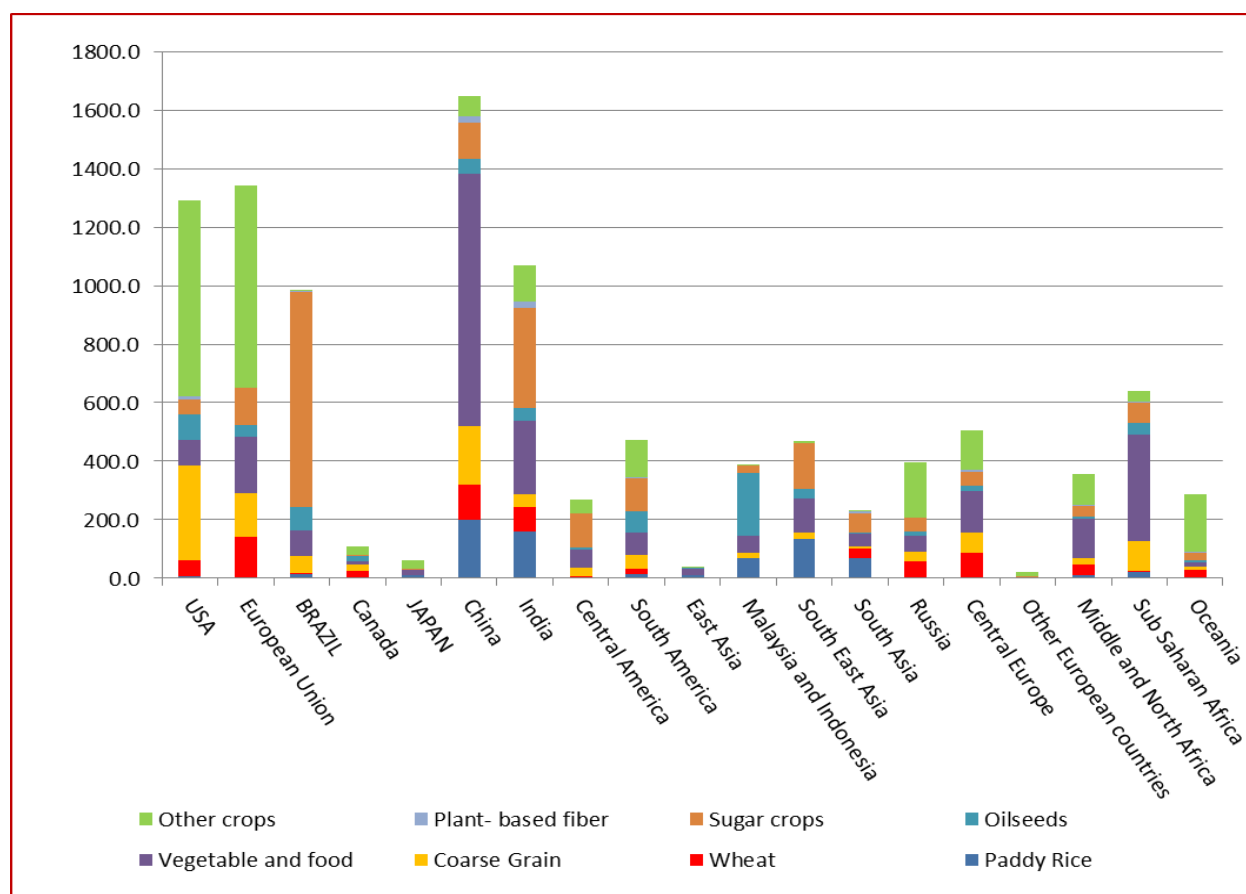


Figure 4. Production by crop and region in 2011 (in millions of tons)

In the oilseed sector, Malaysia & Indonesia, South America (including Brazil), and the United States are the leaders, representing the 29.3%, 20.9% and 11.9% of production, respectively. Among the crops that are in the sector, two are the most representative: palm oil and rapeseed, which represented the 32.7% and 8.5% of oilseed production respectively. In terms of palm oil; the production is clustered in Indonesia (42% of palm oil) and Malaysia (39%); whereas for rapeseed, the leaders in production were Canada (23%), China (21%), India (13%) and France (9%).

In the sugarcane sector, Brazil, India and South East Asia are the most important producers, with a share of the global production of 35.2%, 16.4% and 7.4%, respectively. Plant-based fiber is the sector with the lowest share in global production (0.8%), where the main producers are also clustered in Asia: China (24%), India (26%) and South Asia (10%).

4.2 Harvested area

Figure 5 displays the composition of every region according to crop categories for 2011. Likewise, table 9 reports the harvested area in millions of hectares. Overall, the global harvested area was 1,459 million hectares (Mha).

Table 9. Harvested area per crop and region in 2011 (in millions of ha)

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	1.06	18.50	37.18	4.06	31.45	0.84	3.83	28.93
European Union	0.48	26.09	29.99	12.35	16.74	1.62	0.46	25.12
BRAZIL	2.75	2.14	14.32	9.37	24.79	9.60	1.69	3.44
Canada	0.00	8.54	4.86	2.34	9.43	0.01	0.02	3.24
JAPAN	1.58	0.21	0.12	0.80	0.15	0.08	0.00	0.78
China	30.06	24.27	36.68	48.61	22.05	1.95	5.15	5.81
India	43.97	29.07	27.48	46.04	28.93	4.94	12.98	15.31
Central America	0.78	0.67	11.01	6.44	1.05	1.90	0.28	3.28
South America	2.38	6.29	10.58	6.17	26.86	1.33	0.94	8.46
East Asia	1.42	0.37	0.74	1.64	0.45	0.00	0.04	0.09
Malaysia and Indonesia	13.89	0.00	3.87	4.59	14.76	0.52	0.15	8.20
South East Asia	35.49	0.10	6.24	14.06	8.77	2.21	0.54	3.64
South Asia	17.39	12.28	3.71	6.32	2.11	1.20	3.61	0.90
Russia	0.21	24.84	15.56	4.92	9.67	1.22	0.05	24.96
Central Europe	0.33	33.69	19.58	10.93	11.50	1.07	2.92	16.95
Other European countries	0.00	0.16	0.28	0.08	0.03	0.02	0.00	0.56
Middle and North Africa	1.24	16.73	10.44	10.29	4.79	0.55	0.57	4.42
Sub Saharan Africa	10.21	2.78	85.06	64.87	27.29	1.19	4.01	12.91
Oceania	0.08	13.55	5.59	2.49	2.56	0.32	0.59	16.91
Total	163.31	220.27	323.29	256.37	243.39	30.57	37.82	183.91

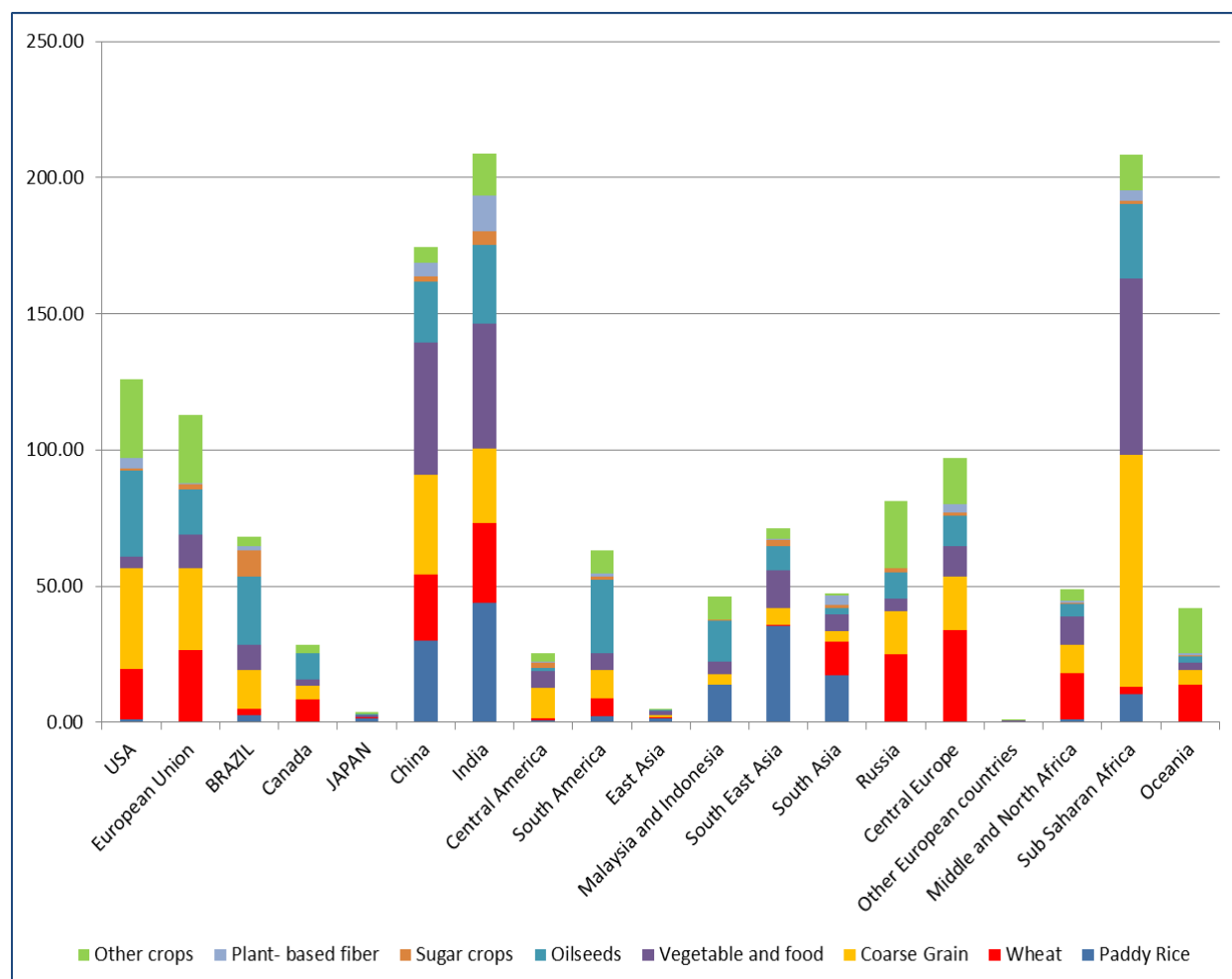


Figure 5. Harvested area by crop and region in 2011 (in millions of has)

Coarse grain, vegetables and fruits, oilseeds and wheat are the sectors with the highest shares (Table 10) in global harvested area (22%, 18%, 17% and 15%, respectively). A total of 1,043 Mha are distributed among these four sectors.

In the paddy rice sector, the highest intensity in harvested area are clustered in Asia where India, South East Asia, China and South Asia harvested 44.0 Mha (27% of rice area), 35.5 Mha (22%), 30.1 Mha (18%) and 17.4 Mha (11%), respectively. For wheat, Europe has the highest concentration of area, Central Europe, the European Union and Russia represented 15%, 12% and 11% of global wheat area, respectively; whereas in Asia, the area is clustered in India (13%) and China (11%).

Maize represented 53% of area of coarse grains, and the United States had the largest harvested area of corn (20%) followed by China (11%). Barley and sorghum represented 15% and 13% of coarse grain area, respectively. Russia has the highest area in barley (7.6 million of hectares), whereas India, Sudan and Nigeria are the regions with the greatest area of sorghum with

7.3 Mha, 7.3 Mha and 4.9 Mha, respectively. Overall, in the coarse grain sectors, Sub-Saharan Africa is the region with the highest share of area in 2011 with 85 Mha (26%) of land.

Table 10. Share of harvest area of each GTAP region and sector in 2011 (%)

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	1	8	11	2	13	3	10	16
European Union	0	12	9	5	7	5	1	14
BRAZIL	2	1	4	4	10	31	4	2
Canada	0	4	2	1	4	0	0	2
JAPAN	1	0	0	0	0	0	0	0
China	18	11	11	19	9	6	14	3
India	27	13	8	18	12	16	34	8
Central America	0	0	3	3	0	6	1	2
South America	1	3	3	2	11	4	2	5
East Asia	1	0	0	1	0	0	0	0
Malaysia and Indonesia	9	0	1	2	6	2	0	4
South East Asia	22	0	2	5	4	7	1	2
South Asia	11	6	1	2	1	4	10	0
Russia	0	11	5	2	4	4	0	14
Central Europe	0	15	6	4	5	3	8	9
Other European countries	0	0	0	0	0	0	0	0
Middle and North Africa	1	8	3	4	2	2	2	2
Sub Saharan Africa	6	1	26	25	11	4	11	7
Oceania	0	6	2	1	1	1	2	9
Total	11	15	22	18	17	2	3	13

Vegetable and fruit sector represented 17% of the global harvested area, in which Sub Saharan Africa represented the 25% of the total harvested area, followed by China (19%) and India (18%). Likewise, in China and India, area for vegetable and fruit are the 28% and 22% of the total harvested land of those two regions, respectively.

In the oilseed sector, the United States, India, Middle East and North Africa, and South America are the regions with the largest area (31.5 Mha, 28.9 Mha, 27.3 and 26.9 Mha, respectively). Among the oilseed crops, rapeseed and palm oil are two of the most representatives; where Canada, China and India represented 22%, 22% and 19% of the rapeseed area, respectively. Palm oil represented 6.8% of oilseed area, in which Indonesia and Malaysia had the highest areas, equivalent to 37% and 26% of the global palm oil area, respectively.

In the sugarcane sector, Brazil and India has the largest areas with 9.6 Mha and 4.9 Mha, respectively. Plant-based fiber only represented 3% of the global harvested area, and India and China had the largest harvested areas (13.0 Mha and 5.2 Mha, respectively).

4.3 Productivity

Productivity is defined as production divided by area and is measured in tons per hectare. Table 11 reports the productivity per crop and region in 2011. Figure 6 shows that overall, the global productivity for sugar cane is the highest among all the sectors, with global sugarcane productivity of 68.2 tons/ha; mainly driven by the European regions. For paddy rice, the most productive regions are China, Japan, Sub Saharan Africa and Oceania. Global wheat average yield is 3.2 ton/ha. Central America and the European countries have the highest productivity (5.4 ton/ha and 5.3 ton/ha, respectively). East Asia has the lowest yield (1.7 ton/ha).

Table 11. Productivity per crop and region in 2011 (ton/ha)

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	7.9	2.9	8.7	20.9	2.8	62.6	2.2	23.1
European Union	6.5	5.3	5.0	15.6	2.5	76.3	2.6	27.6
BRAZIL	4.9	2.7	4.1	9.2	3.2	76.4	3.2	1.3
Canada	0.0	3.0	4.5	4.7	2.0	64.0	1.2	9.7
JAPAN	6.7	3.5	1.7	22.3	1.7	54.7	0.0	35.5
China	6.7	4.8	5.5	17.8	2.2	64.3	3.9	12.1
India	3.6	3.0	1.6	5.5	1.4	69.2	1.6	8.2
Central America	3.7	5.4	2.7	9.4	6.9	62.5	2.9	13.5
South America	5.4	3.2	4.5	12.1	2.8	84.6	1.6	15.4
East Asia	6.2	1.7	3.1	13.7	1.2	0.0	1.2	3.0
Malaysia and Indonesia	4.9	0.0	4.6	12.5	14.6	47.9	1.1	0.7
South East Asia	3.8	1.8	3.3	8.3	3.8	70.3	1.5	2.1
South Asia	4.0	2.6	2.4	7.0	1.8	53.3	2.3	2.7
Russia	5.1	2.3	2.2	11.0	1.4	39.2	0.9	7.6
Central Europe	5.5	2.5	3.6	12.8	1.7	42.0	2.4	8.1
Other European countries	0.0	5.2	4.1	24.8	3.0	94.3	0.0	29.2
Middle and North Africa	7.0	2.4	2.1	13.0	1.2	71.0	2.9	23.8
Sub Saharan Africa	2.0	2.3	1.2	5.6	1.4	57.7	0.9	2.8
Oceania	9.5	2.1	2.2	6.0	2.1	80.6	3.6	11.7
Global average	4.4	3.2	3.6	10.1	3.0	68.2	2.2	13.6

In the case of coarse grains the average productivity was 3.6 tons/ha, with a vast range from 1.2 ton/ha (Sub Saharan Africa) to 8.7 ton/ha (United States). Regions such as the European Union, South America, Canada and China have productivities higher than the global averages. For the vegetables and fruits sector, the average yield is 10.1 ton/ha. The European countries that are not part of the EU, Japan and the United States have the highest yields (24.8 tons/ha, 22.3 tons/ha and 20.6 tons/ha, respectively), followed by China (17.8 tons/ha). India has one of the lowest yields (5.5 ton/ha) together with Sub-Saharan Africa (5.6 ton/ha).

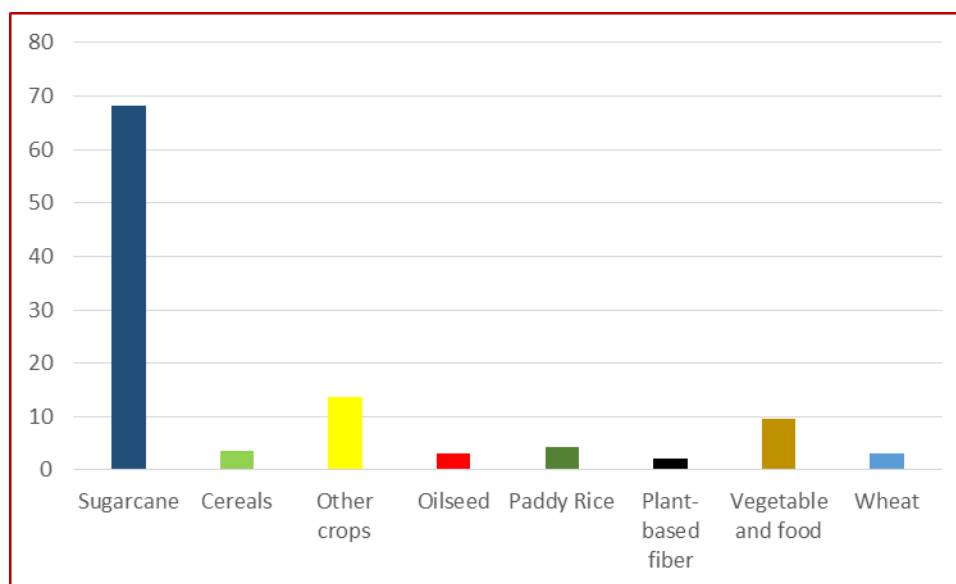


Figure 6. Global average productivity levels in 2011 (ton/ha)

For oilseeds, average global productivity is 3.0 tons/ha. However, the range is very large, with Malaysia and Indonesia region having a productivity of 14.6 tons/ha (mainly because the productivity of palm oil), and East Asia, Middle East and North Africa, Sub Saharan Africa and Russia quite low (1.2 ton/ha, 1.2 ton/ha, 1.4 ton/ha and 1.4 ton/ha, respectively). In contrast, the range in productivity for the plant-based fiber sector is not very wide compared to the other sectors, the lowest value is 0.9 ton/ha (Sub Saharan Africa), whereas the highest is 3.6 tons/ha (Oceania). The overall yield in this sector in 2011 was 2.2 tons/ha.

5. Changes on Crop Production and Harvested Area

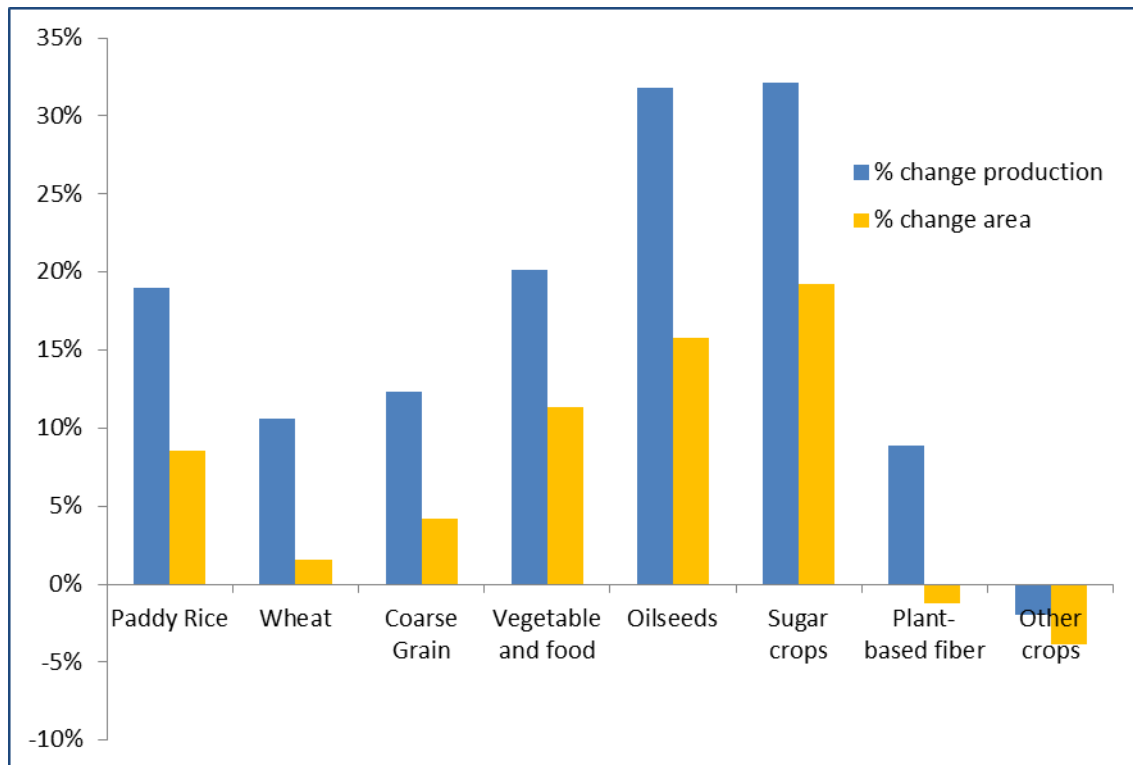
In this section we discuss the changes of production, harvested area and productivity during the period of 2004-2011. The 2004 land use database was used to comparison because it is the base of the previous GTAP-BIO version. Details of production, area and productivity in 2004 are presented in the Annex D.

5.1 Changes in Production in the eight-year period

Table 12 and figure 7 shows significant growth in production for the following crop categories: sugarcane (+32%), oilseeds (+32%), vegetable and fruits (+19%) and paddy rice (+19%). In terms of harvested area, the global area increased from 1373 Mha to 1459 Mha (+6.2%). There was a significant expansion in area for sugarcane (+19%), oilseeds (+16%), vegetable and food (+11%) and paddy rice. For the coarse grains and wheat, the increase in harvested area is modest (+4% and +2%, respectively). There was a decline in area for the plant-based fiber and other crops category (-1% and -4%, respectively). From figure 1, we can observe that for the first six categories the increase in production (in %) are higher than the expansion of harvested area (in %).

Table 12. Global production and harvested area by crop

Crops	Production (in million of tonnes)			Harvested Area (in million hectares)		
	2004	2011	% change	2004	2011	% change
Paddy Rice	607.7	723.2	19%	150.5	163.3	9%
Wheat	632.5	699.4	11%	216.8	220.3	2%
Coarse Grain	1039.1	1166.8	12%	310.4	323.3	4%
Vegetable and food	2159.1	2593.9	20%	230.2	256.4	11%
Oilseeds	559.5	737.5	32%	210.2	243.4	16%
Sugar crops	1579.5	2086.6	32%	25.6	30.6	19%
Plant- based fiber	75.3	82.0	9%	38.3	37.8	-1%
Other crops	2544.7	2494.1	-2%	191.3	183.9	-4%
Total	-	-	-	1373.3	1458.9	6%

**Figure 7. Global production and harvested area per region (% change)**

Viewed at a regional level, Table 13 and Figure 8 show that crop production have increased almost everywhere except in a few regions such as Canada and Japan. Likewise, all sectors raised production except the ones considered in the other crops category. In contrast, the highest increase in production (in %) are sugar crops, oilseeds, wheat and coarse grains.

Table 13. Global production and harvested area per region

Regions	Production (in million of tonnes)			Harvested Area (in million hectares)		
	2004	2011	% change	2004	2011	% change
USA	1321.1	1289.8	-2%	128.0	125.9	-2%
European Union	1343.3	1343.9	0%	115.7	112.9	-2%
BRAZIL	618.9	987.4	60%	62.9	68.1	8%
Canada	177.9	109.5	-38%	33.5	28.5	-15%
JAPAN	76.7	61.7	-20%	4.2	3.7	-11%
China	1322.4	1647.5	25%	161.3	174.6	8%
India	765.2	1070.3	40%	187.2	208.7	11%
Central America	250.7	267.5	7%	26.7	25.4	-5%
South America	458.1	473.9	3%	56.6	63.0	11%
East Asia	36.9	35.0	-5%	4.9	4.7	-2%
Malaysia and Indonesia	298.1	390.2	31%	39.9	46.0	15%
South East Asia	374.3	469.5	25%	62.5	71.1	14%
South Asia	191.7	232.1	21%	43.9	47.5	8%
Russia	377.0	395.9	5%	81.2	81.4	0%
Central Europe	443.3	507.0	14%	95.0	97.0	2%
Other European countries	21.1	22.1	5%	1.2	1.1	-2%
Middle East and North Africa	312.9	354.8	13%	49.9	49.0	-2%
Sub Saharan Africa	511.3	639.0	25%	176.4	208.3	18%
Oceania	296.4	286.4	-3%	42.2	42.1	0%
Total	-	-	-	1373.3	1458.9	6%

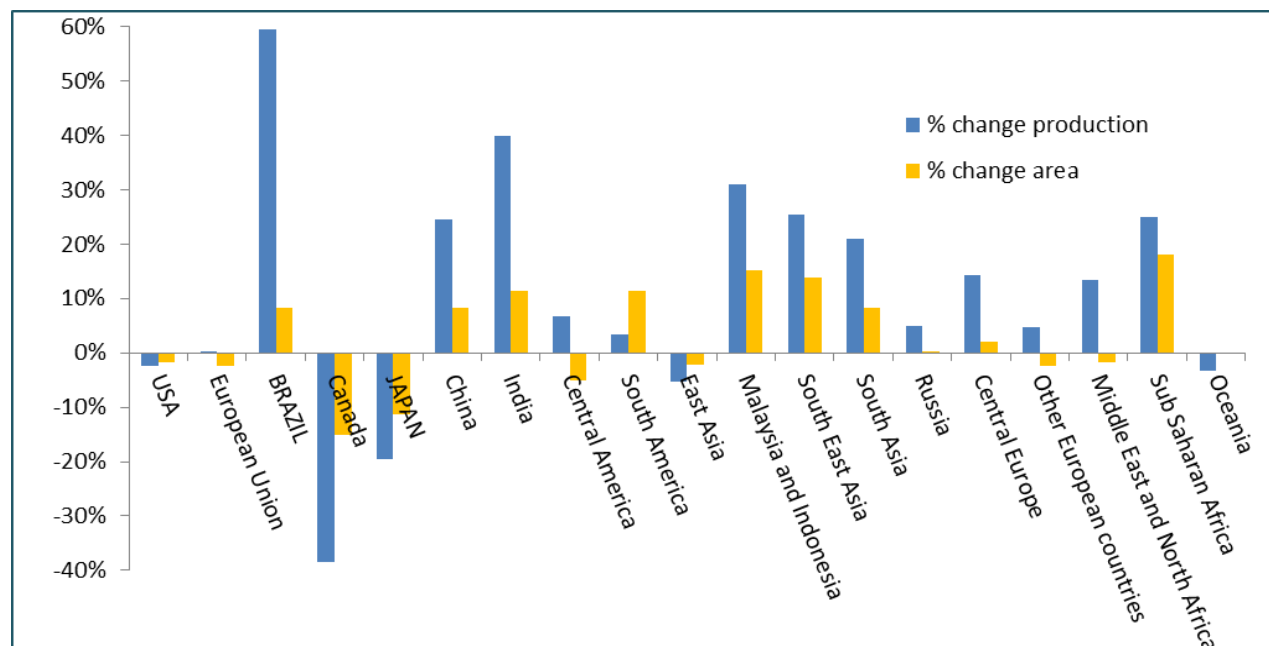


Figure 8. Global production and harvested area per region (% change)

Figures 9 and 10 display the crop shares in total production of each region in 2004 and 2011 (in Mt). This figure shows that crop production shares remained relatively constant in this time period almost everywhere across the world. The most considerable changes in the crop production shares occurred in Canada, South America and Russia, where the other crops category had a significant decrease in production in the eight-year period. For Canada, wheat, oilseeds and coarse grain raised production. In the same way, oilseed shares increased in South America, and sugar crops production share for Russia.

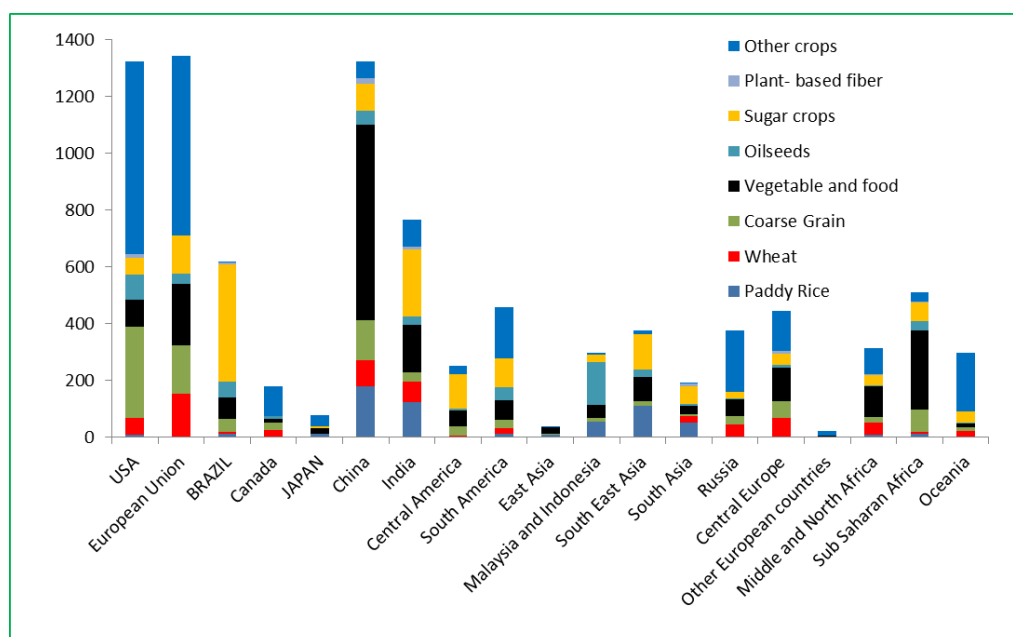


Figure 9. Production of crops (in million tonnes) per region in 2004

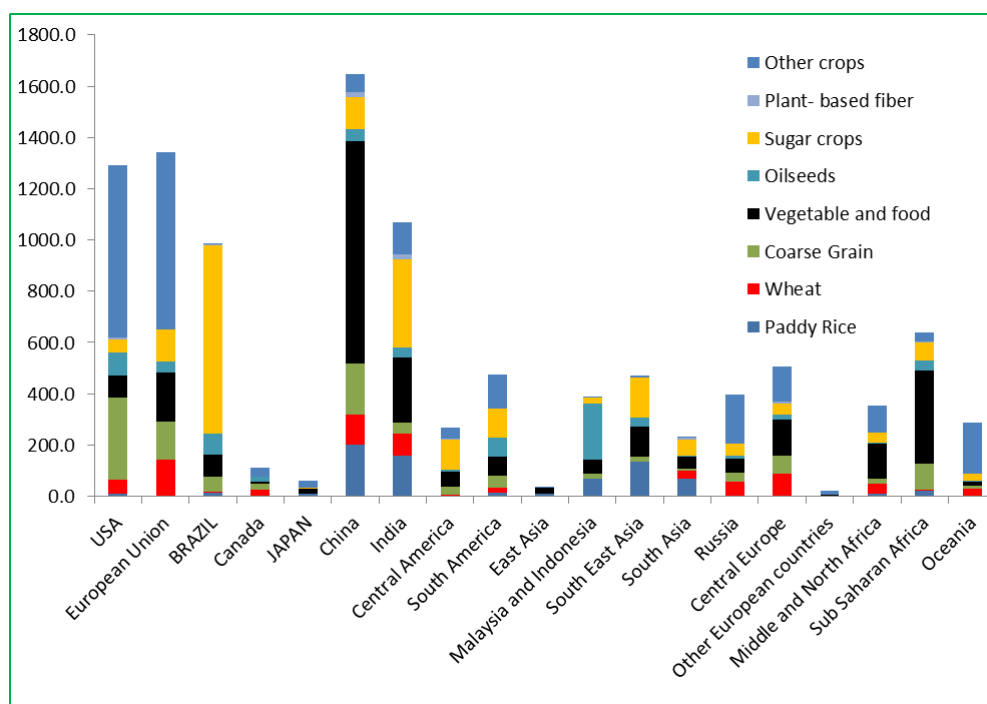


Figure 10. Production of crops (in million tons) per region in 2011

Table 14 reports the changes in production (millions of tons) in the period 2004 - 2011, respectively. In this time period, sugarcane production in Brazil rose by 319 Mt (+77%) while in India (the second largest sugarcane producer) the production increased by 109 Mt (+46%). The United States, the main coarse grain producer, faced a slight increase in production by 4 Mt (+1%) in the eight year period. China and Sub Saharan Africa were the regions with the highest increases in this sector in values of 60 Mt (+42%) and 21 Mt (+27%), respectively. In contrast, coarse grain production in Europe decreased by 23 Mt (-13%).

Table 14. Changes in production (millions tons) between 2004 and 2011

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	-2	-4	4	-9	-1	-6	-4	-9
European Union	0	-11	-23	-23	6	-9	-1	61
BRAZIL	0	0	14	9	26	319	1	-1
Canada	0	0	-4	-2	7	0	0	-71
JAPAN	0	0	0	-2	0	-1	0	-12
China	20	25	60	179	-1	28	0	13
India	33	15	10	87	10	109	11	30
Central America	1	1	-4	4	2	-3	0	15
South America	2	0	18	6	26	14	0	-50
East Asia	0	0	0	-1	0	0	0	-1
Malaysia and Indonesia	12	0	6	10	67	-3	0	0
South East Asia	24	0	6	30	7	33	0	-5
South Asia	18	7	3	15	0	0	0	-1
Russia	1	11	4	-2	7	26	0	-28
Central Europe	1	18	12	21	11	5	-1	-3
Other European countries	0	0	0	0	0	0	0	1
Middle East and North Africa	0	-2	2	25	1	4	-1	14
Sub Saharan Africa	8	1	21	86	7	4	-1	2
Oceania	0	6	0	1	2	-12	1	-8

Malaysia and Indonesia continued to be the main oilseed producers. The joint production of oilseeds in these two countries increased by 67 Mt (+44%). Paddy rice production in India, South East Asia, China and South Asia grew up by 33 Mt (+27%), 24 Mt (+22%), 20 Mt (+11%) and 18 Mt (+34%) respectively. Plant-based fiber sector had a significant increase in India of 12 Mt whereas in United States, Sub Saharan Africa, Middle East and North Africa, the European Union and Central Europe there were decreases in production of -4 Mt, -1.1 Mt, -0.7 Mt, -0.6 Mt and -1.2 Mt, respectively.

Interestingly, the largest changes have been in vegetable and fruits in almost all the regions, an increase of approximately 435 Mt at the global scale. The highest increases are found in China and India with a rise of 179 Mt and 87 Mt. Finally, with respect to wheat, China, India and Central Europe increased their production by 25 Mt (+28%), 15 Mt (+20%) and 18 Mt (+27%) respectively. The European Union, the wheat production leader, faced a slight reduction in its production of 11 Mt (-8%) in this period.

3.2 Changes in Harvested area

Since production depends on harvested area, it is not surprising that, on average, the global area also expanded for almost all of the crops (Table 12 and Figure 8). Harvested area increased for all the crop sectors, where global area went from 1,373 to 1,459 million of hectares (+6% increase). Significant growth in harvested area is observed for the following crop categories: sugarcane (+19%), oilseeds (+16%), vegetables and fruit (+11%) and paddy rice (+9%). Interestingly, the plant-based fiber sector had a slight reduction in area (-1%) although its production increased. For the other crops category, there was a decrease in area (-4%) and production (-2%).

The highest overall area increase occurred in Sub Saharan Africa (+18%), Malaysia and Indonesia (+15%), South East Asia (+14%), South America (+11%) and India (+11%). In contrast, significant reduction in area occurred in the following regions: Canada (-15%), Japan (-11%) and Central America (-5%).

Figures 5 and 6 display the composition of every region according to the crop categories for 2004 and 2011 respectively. The composition and distribution in share of area remained similarly constant over the eight year period for most of the regions. The most significant changes in the share of harvested area for agricultural crops occurred in Canada, which had a decrease in the share of area of the other crops sector (-12%) whereas an increase in share for oilseeds (+13%). Similar pattern occurred for South America and Russia where there were reductions in share area for the other sectors category whereas there were expansions of land for oilseeds.

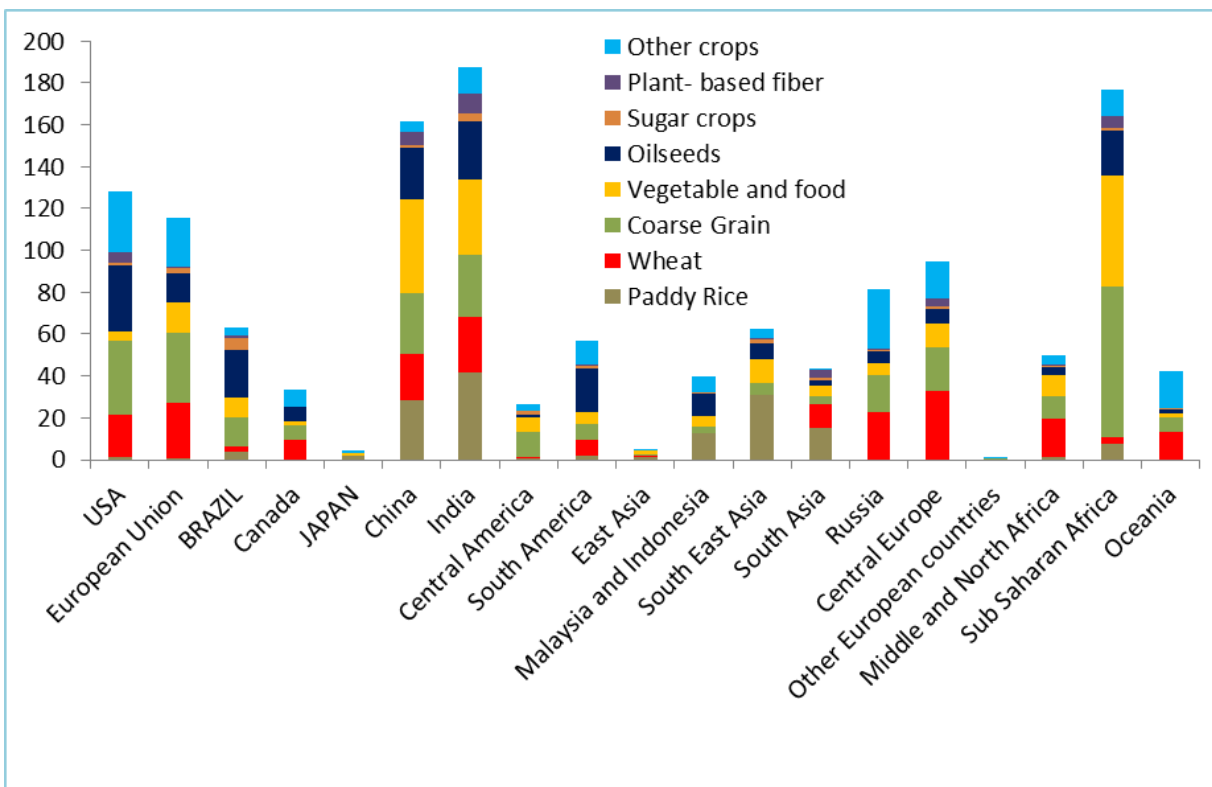


Figure 5. Harvested area of crops (in million hectares) per region in 2004

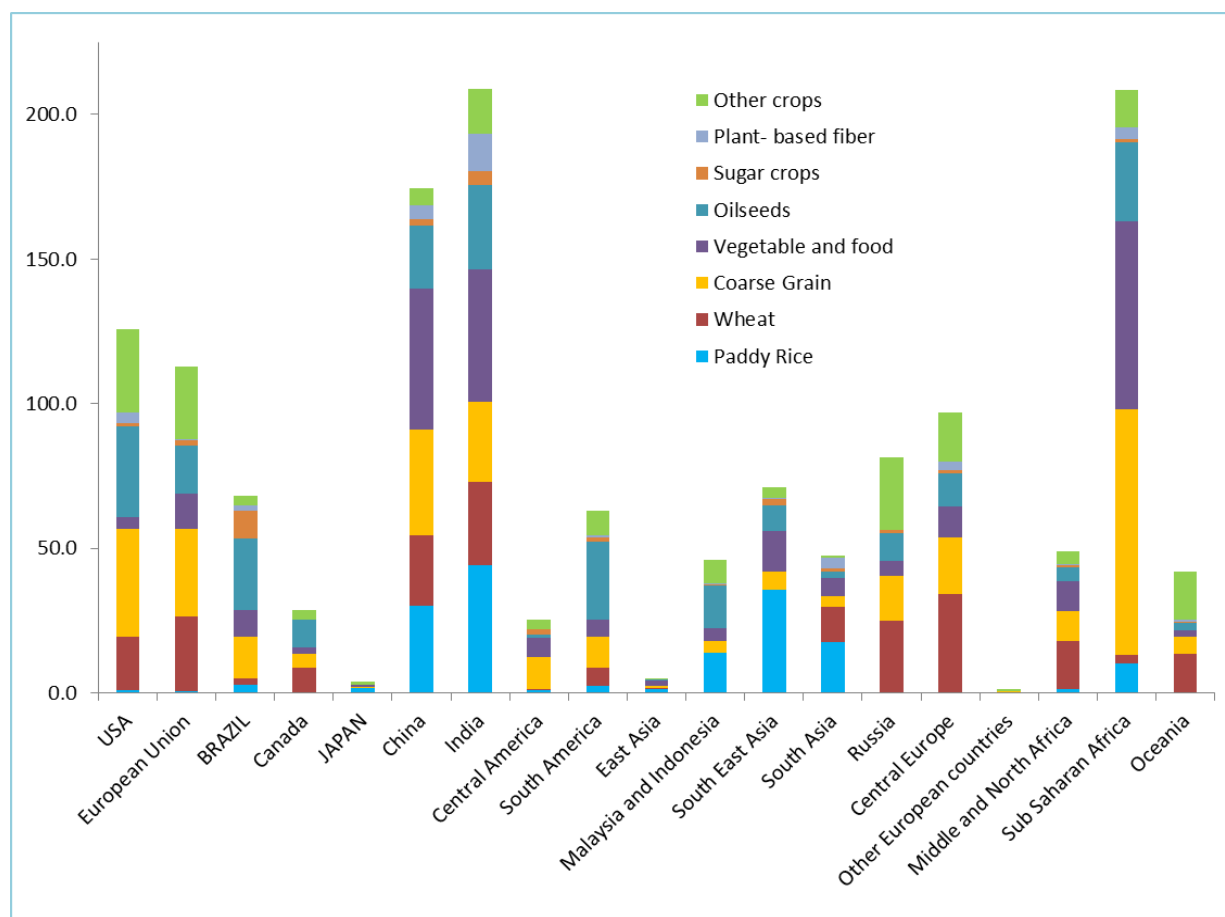


Figure 6. Harvested area of crops (in million hectares) per region in 2011

Table 15 shows the change in area per crop and region in the 2004-2011 period. As in the case of production, the regions with highest harvested area in 2004 retained that status in 2011. Nevertheless, the area per region and crop sector has changed (Table 15). In this eight year time period, significant expansion in the paddy rice area where China, India, South East Asia and South Asia grew up by 1.4 Mha (+5%), 2.1 Mha (+5%), 4.5 Mha (+15%) and 2.1 Mha (+14%) respectively. In the wheat sector, Central Europe had the largest area where this region increased its harvested area by 1.4 Mha (+4%), the same is true for China (+12%) and India (+9%). However, United States and South America experienced reductions in the area for wheat by 1.7 Mha (-9%) and 1.1 Mha (-14%) respectively.

Sub Saharan Africa and China were the regions with largest area for coarse grains in 2011, experiencing an expansion of 12.8 Mha (+18%) and 7.3 Mha (+25%) respectively. In contrast, the European Union and Canada faced a decrease in area devoted to cereals by 3.9 (-11%) and 1.9 Mha (-28%). The vegetable and fruits sector had a significant increase in different regions, mainly India, Sub Saharan Africa and China.

The United States and India continued to have the largest harvested area of oilseeds. In, India the area expanded by around 1.4 Mha (+5%). In contrast, United States slightly reduced the area

for oilseeds by 0.4 Mha (-1%). Likewise, significant changes in sugarcane area occurred in Brazil (+70%), Malaysia and Indonesia (+21%), South East Asia (+12%) while major decreases are seen in Canada (-15%), the European Union (-27%) and Oceania (-31%).

Plant-based fiber sector had an expansion in area for India of 3.3 Mha, whereas United States and Sub Saharan Africa suffered a reduction in area of 1.5 Mha and 1.4 Mha, respectively. For the other regions of the world, the areas for plant-based fiber remained almost constant in this eight-year period.

Table 15. Changes in harvested area (millions hectares) between 2004 and 2011

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant-based fiber	Other crops
USA	-0.3	-1.7	2.0	-0.2	-0.4	-0.1	-1.5	0.0
European Union	0.1	-0.5	-3.9	-2.1	2.9	-0.6	-0.2	1.4
BRAZIL	-1.0	-0.7	0.4	-0.1	2.5	4.0	0.3	-0.3
Canada	0.0	-0.8	-1.9	-0.1	2.5	0.0	0.0	-4.7
JAPAN	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	-0.3
China	1.4	2.6	7.3	3.7	-2.2	0.4	-0.9	0.9
India	2.1	2.5	-1.8	10.0	1.4	1.0	3.3	3.1
Central America	0.1	0.1	-1.3	-0.2	0.0	-0.1	0.1	0.0
South America	0.2	-1.1	3.0	0.3	6.5	0.1	0.0	-2.7
East Asia	-0.2	0.1	0.0	-0.1	0.0	0.0	0.0	0.0
Malaysia and Indonesia	1.3	0.0	0.5	-0.2	3.8	0.1	0.1	0.5
South East Asia	4.5	0.0	0.7	2.8	0.9	0.2	0.0	-0.5
South Asia	2.1	0.9	0.1	1.1	-0.1	-0.1	-0.1	-0.3
Russia	0.1	1.9	-1.9	-0.8	4.0	0.4	-0.1	-3.5
Central Europe	0.0	1.4	-1.6	-0.4	4.4	-0.2	-0.5	-1.2
Other European countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle East and North Africa	-0.1	-1.4	-0.2	0.2	0.6	0.0	-0.2	0.1
Sub Saharan Africa	2.6	-0.1	12.8	11.9	5.7	0.0	-1.4	0.5
Oceania	0.0	0.1	-1.3	0.7	0.7	-0.1	0.4	-0.6

3.3 Changes in productivity

Table 16 reports the changes in productivity per crop and region between 2004 and 2011. This table shows that global productivity increased for most of the crops, except for the category called other crops which had a slight yield reduction. The diminution in productivity in this category was mainly driven by the decrease in production by East Asia and Canada. In contrast, global sugarcane productivity increased significantly from 61.7 ton/ha to 68.2 ton/ha (+10.5%), most of this increment was due to the European regions and Canada. Global coarse grain and wheat productivities increased by 0.3 ton/ha, mainly driven by Brazil and the Central Europe.

Table 16. Change in productivity (ton/ha) during the period 2004-2011

Region	Paddy Rice	Wheat	Coarse Grain	Vegetable and food	Oilseeds	Sugar crops	Plant - based fiber	Other crops
USA	0.1	0.0	-0.4	-1.1	0.0	-2.3	-0.2	-0.3
European Union	-0.3	-0.3	-0.1	0.6	-0.1	16.8	-0.2	0.9
BRAZIL	1.3	0.6	0.8	1.1	0.8	2.7	0.3	-0.1
Canada	0.0	0.3	0.7	-0.4	0.3	11.7	0.0	-3.2
JAPAN	0.2	-0.5	-0.4	0.1	0.4	-9.4	0.0	-1.7
China	0.4	0.6	0.7	2.5	0.2	3.0	0.6	0.5
India	0.6	0.3	0.4	0.9	0.3	9.9	0.6	0.4
Central America	0.5	1.0	0.0	1.0	2.0	0.2	0.6	4.7
South America	0.2	0.5	0.6	0.4	0.4	4.6	0.2	-0.8
East Asia	0.4	0.3	-0.2	-0.2	0.0	0.0	-0.1	-4.3
Malaysia and Indonesia	0.4	0.0	1.2	2.8	1.1	-16.7	-0.2	-0.1
South East Asia	0.2	0.5	0.6	0.6	0.5	8.2	0.7	-0.9
South Asia	0.6	0.4	0.7	1.3	0.2	5.5	0.1	-0.4
Russia	1.3	0.3	0.5	1.2	0.3	11.5	0.0	-0.1
Central Europe	1.5	0.4	0.8	2.3	0.5	11.6	0.0	0.4
Other European countries	0.0	-0.3	-0.9	-0.2	0.0	16.2	0.0	1.7
Middle East and North Africa	0.2	0.1	0.2	2.2	0.1	2.2	-0.2	2.5
Sub Saharan Africa	0.3	0.5	0.1	0.4	-0.1	5.3	0.0	0.1
Oceania	1.2	0.4	0.4	-1.6	0.1	-1.5	-0.5	0.0
Global average	0.4	0.3	0.3	0.7	0.4	6.5	0.2	0.3
Increase in productivity (%)	9.7	8.8	7.8	7.9	13.8	10.5	10.3	2.0

Oilseed productivity went up from 2.7 ton/ha to 3.0 ton/ha (+14%), in which the regions with highest yield increase were Malaysia and Indonesia (+1.1 ton/ha), and Brazil (+0.8 ton/ha). The global paddy rice sector improved its yield from 4.0 ton/ha to 4.4 ton/ha (+4%), mainly driven by Brazil, Russia and Central Europe. Plant-based fiber did have an increase in productivity from 2.0 ton/ha to 2.2 ton/ha (+10%), mainly because an increase in productivity by South East Asia and the region of Malaysia and Indonesia. Finally, for the fruits and vegetable sectors there was an increase from 9.4 ton/ha to 10.1 ton/ha (+8%), where Central Europe, Middle East and North Africa, Malaysia and Indonesia, South Asia and Russia had significant yield improvements.

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