

## LAND USE - AT THE GLOBAL AND EUROPEAN UNION LEVEL IN THE PERIOD 2000-2021

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### Abstract

*The aim of this study is to analyze the land use at the global level and in the European Union in the period, 2000-2021, in order to identify the changes and trend pointing out the status of agricultural land and by category of use. Fixed and structural indices and suggestive illustration were used to show the variations and trends for agricultural land, arable land, crop land and permanent meadows and pastures at the global level, for the top countries with the largest agricultural area and in the EU-27 by member states. The global agricultural land decreased, in 2021, being 4,787.5 Million ha, by 1.8% smaller. The world crop land increased to 1,579.8 Million ha in 2021, being by 5.7% larger. Of the global agricultural land, 33% is cropland and 67% permanent grasslands. The larger cropland is in Asia, Americas and Europe. The largest countries in cropland represent 39.3%, while the largest countries in grasslands 23.2%. About 40% of the EU's territory is represented by agricultural land and belongs to France, Spain, Sweden, Germany, Poland, Finland, Italy, and Romania. The EU agricultural land decreased to 162,905.8 thousand ha, being by 10.83% smaller. Cropland declined by 9.4%, and permanent grasslands declined by 13.71%. Cropland accounts for 68%, while permanent grasslands for 32% in the EU. The EU keeps 3.4% of the global agricultural land, 7.01% of crop land and 1.62% of grasslands. In the most EU countries agricultural land declined. In the EU, it is a high concentration of agricultural land, but no concentration in arable land, cropland and permanent grasslands. The world agricultural land per capita declined from 0.24 ha in 2000 to 0.20 ha in 2021. The highest cropland per capita is in Oceania 0.77 ha, Europe 0.39 ha, Americas 0.37 ha, Africa 0.21 ha and Asia with only 0.13 ha. In the EU-27, the average is 0.37 ha agricultural land per capita. The expand of the agricultural land has to be stopped, as it is enough food to nourish the global population. New agro-eco technologies are called to increase crop yield and productivity to protect environment and biodiversity. The reduction in meat production and consumption will protect forests and cropland, and stopping deforestation will orient the people to a healthier and green diet.*

**Key words:** land use, agricultural land, arable land, crop land, pastures and meadows, world, European Union

### INTRODUCTION

The Earth is our home which offers us conditions to live! It was nick named the Blue Planet as seen from the satellite it has a blue color, grace to large surface covered by water (oceans, seas, lakes, rivers etc) accounting for 361,132,000 km<sup>2</sup>, representing 70.8% of the total Terra area of 510,072,000 km<sup>2</sup> [12]. Only 148,940,000 km<sup>2</sup>, that is 29.2% represents land cover which belongs to the

five continents and millions of islands [28, 29].

Therefore, land is our "golden treasure" representing the main resource which sustains the development of agriculture destined to provide food to humans and feed for farm animals.

The countries with the largest land area in the world, in the decreasing order are Russia, Canada, China, USA, Brazil, Australia, India, Argentina, Kazakhstan and Algeria, which

together keep 70,837,771 km<sup>2</sup>, representing 47.5% of the land cover.

In the total area of these countries, land represents: 99.9% in Algeria, 99.8% in Australia, 99% in Kazakhstan, 98.4% in Argentina, 98.1% in Brazil, 97.5% in USA, 96.7% in China, 95.7% in Russia, 91% in Canada, and 90.4% in India.

The share of these ten countries having the largest area in the global land is shown in Fig. 1.

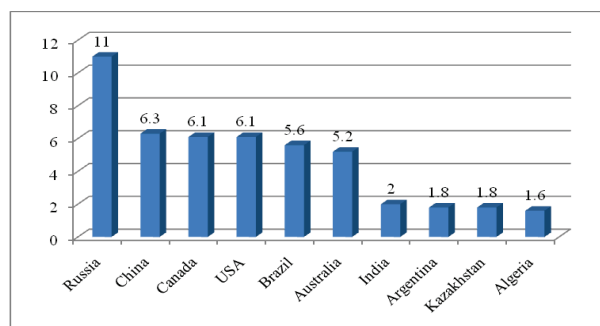


Fig.1. Share of top 10 countries with the largest area in the world land surface (%)

Source: Own design based on the data from [31].

However, only 38.17% of land cover is suitable for agriculture, that is 56.59 million km<sup>2</sup>, calculated for 193 countries in the year 2021 for the period 1961-2021. The highest weight is 81.89% in Burundi and the lowest percent is 0.5% in Suriname [24].

Only this surface could offer good conditions in terms of topography, soil features and quality, climate (temperatures and precipitations), vegetation type and composition.

According to FAO (2020) and Anderson (2023), agricultural land is used for two purposes: 33% as crop land and 67% for grazing livestock (Fig. 2) [1, 4].

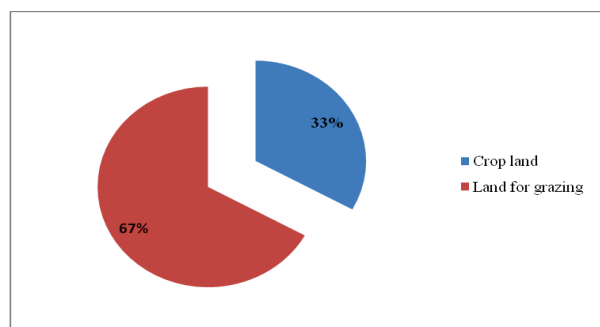


Fig. 2. Agricultural land destinations (%)

Source: Own design based on the data from [1, 4].

FAO (2020) divides agricultural land into two groups:

-*Arable land*, where both annual and perennial crops are cultivated to grow production providing products for human consumption and also a part of arable land for producing forages needed by animals;

-*Permanent grasslands*, which are used for grazing livestock.

Therefore, agricultural land is shared between crops for human consumption 23% and 77% for animal feed (Fig. 3) [1, 6].

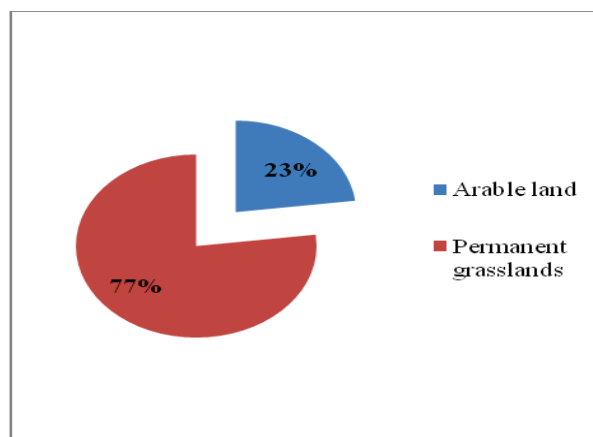


Fig. 3. The distribution of agricultural land by arable land and permanent grasslands

Source: Own design based on the data from [1, 6].

Ritchie and Moser (2019) affirmed that the agricultural land is divided into 28% arable land, 3% for permanent crops and 69% for grasslands [21].

In this context, the purpose of this paper is to analyze the distribution of agricultural land at the global level and in the European Union for showing the importance of land use in connection to the population growth and food security.

## MATERIALS AND METHODS

The study is based on a short literature review selected on the topic.

Land use is analyzed at the global level, by continents and in the European Union, using FAOSTAT and World Bank data and also from other information sources and regard the last two decades in the interval 2000-2021 for which the data are available.

The data was studied using fixed basis indices whose well known formula is  $I_{FB} = (y_i/y_0) * 100$ , where  $y_i$  is the value of the variable taken into consideration in the year  $i$ , where  $i = 1, 2, 3, \dots, n$ , and  $y_0$  is the value of the variable  $y$  in the first year, expressed in percentages.

Also, in certain cases, it was determined the absolute deviation,  $\Delta y = y_n - y_0$ , reflecting the difference between the value of the variable in a specific year and its value in another year, usually considered a term of reference.

The structural index was utilized to calculate and interpret the share of a region or continent or a country in the global value of a variable or in case of the EU, the share of each member state in the total EU level for a certain land indicator.

The concentration of land was determined only in the EU regarding agricultural land and also crop land and the land covered by permanent meadows and pastures.

For this purpose, there were used the specific concentration indices: Herfindhal-Hirschman index (HHI), Gini-Struck index (GSI) and Concentration coefficient ( $CC_j$ ), whose formulas are shown below.

$$HHI = \sum_{i=1}^n g_i^2 \dots\dots\dots(1)$$

where:

$g$  is the square of the share of each country in the EU level for the analyzed indicator.

$$GSI = \sqrt{\frac{n \sum_{i=1}^n g_i^2 - 1}{n-1}} \dots\dots\dots(2)$$

$$CC_j = [n/(n-1)] * GSI \dots\dots\dots(3)$$

The results were illustrated in tables and graphics and were correspondingly commented and interpreted.

Finally, the most important conclusions resulting from this research were presented at the end of the paper.

## RESULTS AND DISCUSSIONS

### Agricultural land surface

Agricultural land is very important for assuring food for the globe population and

also its distribution by continent, region and country has also a high impact [20].

Analyzing agricultural land at the global level, it was registered a reduction by 1.8% from 4,873.6 Million ha in the year 2000 to 4,787.5 Million ha in 2021.

Africa is the only continent where agricultural land increased by 6.82 % reaching 1,161 Million ha in 2021.

In the Americas, agricultural land decreased to 1,124.6 Million ha in 2021, being by 2.4% smaller than in the year 2000.

Asia had 1,664.8 Million ha used for agriculture in 2021, by 1% less than two decades ago.

In Europe, the reduction was 5%, so that in 2021, agricultural land accounted for 460.2 Million ha.

The highest declined was registered in Oceania, -20%, so that in 2021, agricultural land accounted for only 376.2 Million ha (Table 1).

Table 1. Agricultural land by continent in 2021 versus 2000 (Million ha)

	2000	2021	2021/2000 %
World	4,873	4,787.5	98.2
Africa	1,087.3	1,161.7	106.8
America	1,151.5	1,124.6	97.6
Asia	1,680.1	1,664.8	99.0
Europe	484.6	460.2	95.0
Oceania	470.0	376.2	80.0

Source: Own calculations based on the data from [5].

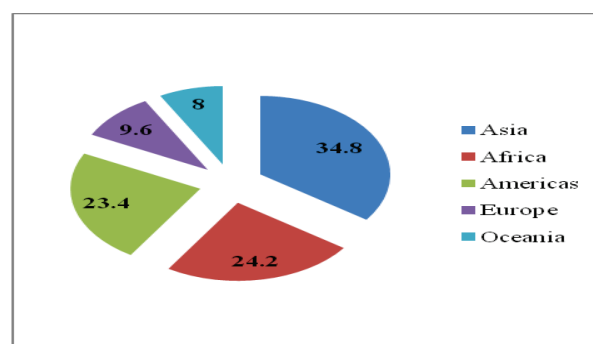


Fig. 4. Distribution of agricultural land by continent in 2021 (%)

Source: Own design based on the data from [5].

As a result, the share of the regions in the global agricultural land in 2021 reflects that the largest surface is, in the decreasing order, in Asia, Africa, Americas, Europe, and Oceania (Fig. 4).

## Distribution of agricultural land by permanent grasslands and cropland

### Grasslands

At the global level, the permanent grasslands registered a decrease by 5.1% from 3,379.7 Million ha in 2000 to 3,207.6 Million ha in 2021. Crop land increased by 5.7% from 1,493.9 Million ha in 2000 to 1,579.8 Million ha in 2021 (Table 2).

Table 2. Distribution of agricultural land by permanent grasslands and crop land at the global level (Million ha)

Land category	2000	2021	2021/2000%
<b>World</b>	<b>4,873.6</b>	<b>4,787.4</b>	<b>98.2</b>
-Permanent grasslands	3,379.7	3,207.6	94.9
-Cropland	1,493.9	1,579.8	105.7

Source: Own calculation based on the data from [5].

Table 3. Share of permanent grasslands and crop land in the global agricultural land by continent in 2021 versus 2000 (%)

Region	Permanent grasslands			Crop land		
	2000	2021	Difference pp	2000	2021	Difference pp
Africa	25.4	27.1	+1.7	15.4	18.5	+3.1
Americas	23.1	23.3	+0.2	24.7	23.9	-0.8
Asia	33.0	33.5	+0.5	37.7	37.1	-0.6
Europe	5.3	5.4	+0.1	20.3	18.2	-2.1
Oceania	13.2	10.7	-2.5	1.7	2.2	+0.5

Source: Own calculations based on the data from [5].

## Top 10 countries with the largest agricultural land at the global level, in the decreasing order

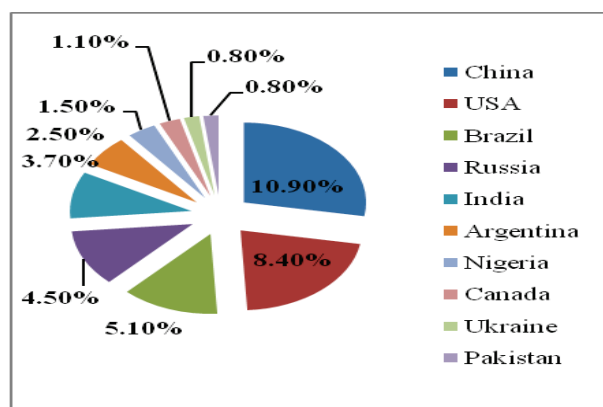


Fig. 5. Top 10 countries in the world based on their share in the global agricultural land (%)

Source: Own calculations based on the data from [5, 9].

Figure 5 shows that the largest agricultural land belongs to the following ten countries, in the decreasing of their market share, which

By region, based on the surface with permanent grasslands, Asia comes on the top position with 33.5%, being followed by Africa with 27.1%, Americas with 23.3%, Oceania with 10.7% and finally Europe with 5.4%.

In almost all the regions, the area of grasslands increased, except in Oceania.

### Cropland

The largest cropland is in Asia (37.1%), Americas (23.9%), Africa (18.5%), Europe (18.2%) and only 2.2% in Oceania.

The cropland registered a decline in Europe, Americas, and Asia, but an increase in Africa (+3.1%) and Oceania (Table 3).

are the following ones: China, USA, Brazil, Russia, India, Argentina, Nigeria, Canada, Ukraine, and Pakistan (Table 4).

Analyzing the dynamics of the agricultural land in these top 10 countries, it was noticed that in 2021 versus 2000, the agricultural area increased only in Brazil (+4.8%) and Nigeria (+4.7%), while in the other countries declined: Argentina (-8.3%), Canada (-1.8%), USA (-2.1%), India (-1.4%), Pakistan (-1.1%), Russia (-0.8%) China (-0.4%), Ukraine (-0.3%) (Table 4).

All these 10 countries together have a share of 39.3% in the global agricultural land in 2021, which is by 0.3 pp higher than in the year 2000.

The share of each country from the top 10 based on the agricultural land by type: permanent grasslands and cropland is shown in Table 5. From this table, it is easy to identify that China, followed by USA and Brazil have the highest share in the global

grasslands in 2021, accounting for 12.2%, 7.6% and, respectively, 5.4%.

Table 4. The top countries with the largest agricultural area at the global level (Million ha)

	2000	2021	2021/2000 %
World	4,873.0	4,787.5	98.2
1.China	523.7	521.5	99.5
2.USA	414.4	405.8	97.9
3.Brazil	228.3	239.4	104.8
4.Russia	217.2	215.5	99.2
5.India	180.9	178.5	98.6
6.Argentina	128.5	117.9	91.7
7.Nigeria	65.5	68.6	105.7
9.Canada	58.0	57.0	98.2
8.Ukraine	41.4	41.3	99.7
10.Pakistan	36.7	36.3	98.9
Total 10	1,894.6	1,881.8	99.32

Source: Own calculation based on the data from [5].

Table 5. Distribution of the agricultural land by type in the top 10 countries with the largest agricultural area (Million ha)

	Permanent grasslands			Crop land		
	2000	2021	2021/2000%	2000	2021	2021/2000%
1.China	392.8	392.8	100.0	130.8	128.6	98.3
2.USA	236.3	245.3	103.6	178.0	160.4	90.1
3.Brazil	173.4	173.3	99.9	54.8	66.0	120.4
4.Russia	90.9	92.0	101.2	126.3	123.4	97.7
5.India	10.8	10.4	96.2	170.1	168.1	98.7
6.Argentina	99.8	74.6	74.7	28.6	43.2	151.0
7.Nigeria	24.7	25.1	101.6	40.8	43.4	106.3
9.Canada	20.1	18.5	92.0	37.8	38.4	101.5
8.Ukraine	7.9	7.5	94.9	33.4	33.7	100.8
10.Pakistan	5.0	5.0	100.0	31.6	31.3	99.0

Source: Own calculation based on the data from [7].

Table 6. The share on the top 10 countries in the global agricultural land by type (%)

	Permanent grasslands			Crop land		
	2000	2021	Difference 2021-2000 (pps)	2000	2021	Difference 2021-2000 (pps)
1.China	11.6	12.2	+0.6	8.7	8.1	-0.6
2.USA	6.9	7.6	+0.7	11.9	10.1	-1.8
3.Brazil	5.1	5.4	+0.3	3.6	4.2	+0.6
4.Russia	2.6	2.8	+0.2	8.4	7.8	-0.6
5.India	0.3	0.3	-	11.3	10.6	-0.7
6.Argentina	2.9	0.2	-2.7	1.9	2.7	+0.8
7.Nigeria	0.7	0.8	+0.1	2.7	2.7	-
9.Canada	0.6	0.6	-	2.5	2.4	-0.1
8.Ukraine	0.2	0.2	-	2.2	2.1	-0.1
10.Pakistan	0.1	0.1	-	2.1	1.9	-0.2

Source: Own calculation based on the data from [7].

Regarding the share in the global cropland, it was noticed that India has 10.6%, followed by USA 10.1%, China 8.1%, Russia 7.8% and Brazil 4.2%, being on the top five positions. While the share in the permanent grasslands increased in China, Brazil, Russia, Nigeria, it

declined in Argentina, and in the other countries remained at the same level

The share in the global cropland declined in almost all these countries, except Argentina and Brazil when it increased and Nigeria where it remained the same (Table 6).



### Top 10 countries in the world ranked by the surface of arable land in 2023

In 2023, the arable land belonging to the top 10 countries with the largest agricultural area is shown in Table 7. USA, India, Russia and China have over 1 million km<sup>2</sup>, while Brazil, Canada, Nigeria, Ukraine, Argentina and Pakistan have between over 300,000 km<sup>2</sup> up to 560,000 km<sup>2</sup>.

Table 7. Arable land in the top countries with the largest agricultural land in the world (km<sup>2</sup>)

Country	Arable land	Rank in the world
1.USA	1,577,368	1
2.India	1,553,690	2
3.Russia	1,216,490	3
4.China	1,188,810	4
5.Brazil	557,620	5
6.Canada	382,340	6
7.Nigeria	350,000	7
8.Ukraine	329,240	8
9.Argentina	326,328	9
10.Pakistan	309,300	10

Source: [30].

### Land use in the EU's agriculture

In the EU-27, the largest surface belongs to France, Spain, Sweden, Germany, Poland, Finland, Italy, and Romania and about 40% of the EU's territory is represented by agricultural land. About 75% of agricultural land is used by France, Spain, Germany, Poland, Romania and Italy [13, 15].

Most of the EU member states apply modern technologies assuring high land performance regarding yields and production. About 70% of agricultural output is produced by France, Germany, Italy, Spain, Netherlands, Poland and Romania. A higher agricultural production and value added per unit of utilized agricultural land was achieved in the EU during the last decades [16, 17].

And this is also sustained not only by modern technologies which have started to be environment friendly and to assure a healthy diet, but also by the rural population [14], especially by farmers who are more conscious of their duty to produce more and high quality food [18, 19], diminishing the negative impact of climate change according to Green Deal [2].

In the EU-27, agricultural land has registered a general downward trend from 182,673.3 thousand ha in the year 2000 to 162,905.8 thousand ha in 2021, meaning by 10.83% less. Cropland also declined from 122,279.8 thousand ha in 2000 to 110,785.4 thousand ha in 2021, reflecting a decrease by 9.4%.

Also, the surface covered by permanent grasslands declined by 13.71% from 60,393.5 thousand in 2000 to 52,119.4 thousand ha in 2021.

This tendency is explained by the increased production performance per ha and animal and by the need to diminish the negative impact of agriculture on environment.

Therefore, in the EU-27, cropland accounts for 68%, while permanent grasslands for 32% in total agricultural land, reflecting a slight growth of 1.1 pp in cropland and a reduction by 1.1 pp in grasslands (Fig. 6).

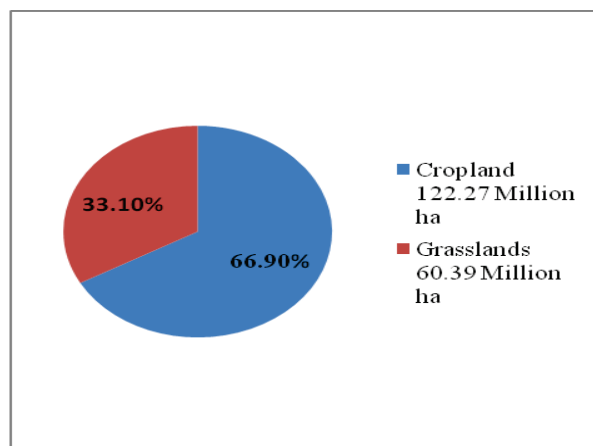


Fig. 6. Distribution of cropland and grasslands in the EU-27 in the year 2021

Source: Own design and calculation based on the data from [7].

In 2021, the weight of the EU-27 agricultural land in the world land was 3.4%.

The cropland represented 7.01% and the land with pastures and meadows accounted for 1.62% in the global level of these categories of land.

### The EU-27 countries with the largest agricultural area

Figure 7 shows the EU countries with the largest agricultural area in the descending order based on their surface and share in the year 2021: France, Spain, Germany, Poland, Romania, Italy, Greece, Hungary, Bulgaria,

and Ireland, all together accounting for 90.81%.

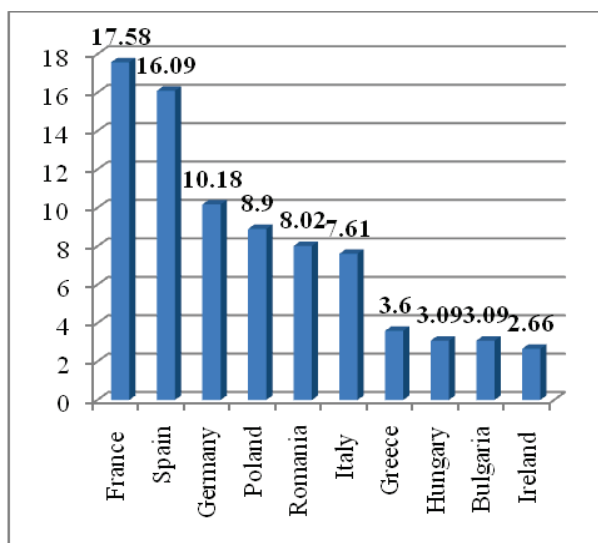


Fig. 7. Top 10 member states in EU-27 agricultural land in the year 2021

Source: Own design and calculation based on the data from [27].

Of the total area of the country, the agricultural land has the highest share in Denmark and Ireland 65.5% and, respectively, 63%.

Also, in land area, an important share of over 55% of agricultural land exists in Romania 56.8%, Hungary 55.3%, Netherlands 53.8%, Spain 52.5%, France 52.1% and Luxembourg 51.6%.

A share between 40 and 40% agricultural area in the country land territory have Poland 47.4%, Germany 47.3%, Lithuania 46.9%, Bulgaria 46.5%, Czechia 45.7%, Greece 45.5%, Belgium 45.1%, Portugal 43.3% and Italy 41.9%.

The smallest share of the agricultural land in the total surface of the county exists in Sweden 7.4%, Finland 7.5% and Cyprus 13.3% (Fig. 8).

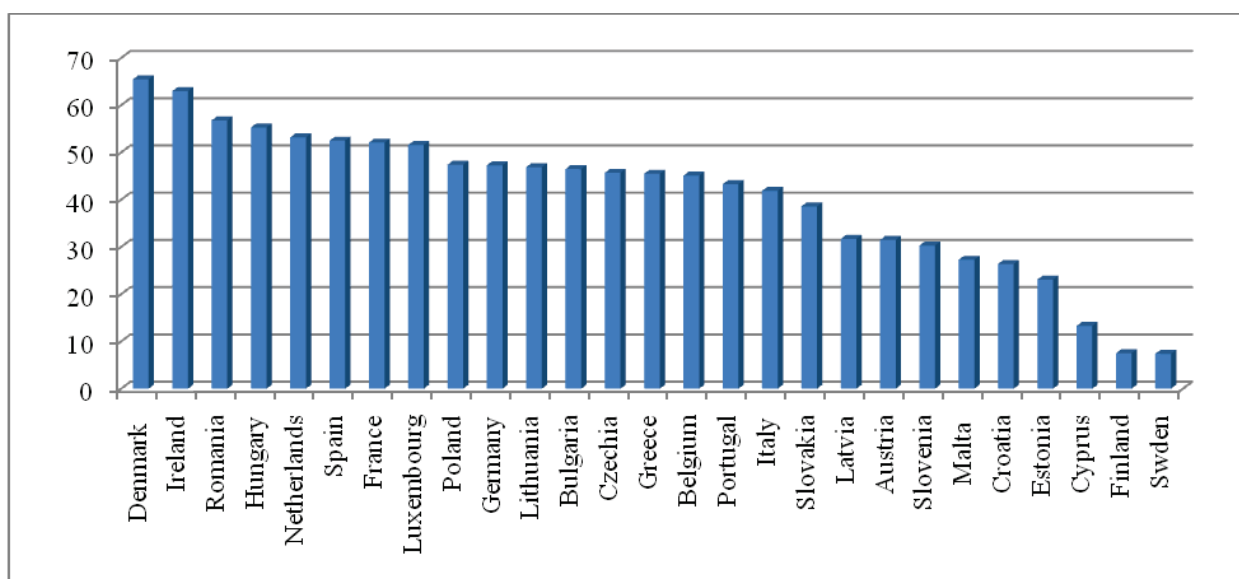


Fig. 8. The hierarchy of the EU countries based on the share of the agricultural land in the total land of the country (%)

Source: Own design and calculation based on the data from [27, 26].

Agricultural land had a general decreasing trend in almost all the EU states, except seven countries where it increased in 2021 compared to the year 2000. It is about: Croatia +26.2%, Latvia +24%, Spain +17.9%, Luxemburg +3.5%, France +2.2%, Sweden +0.9%, Estonia +0.1% and Portugal +0.1%. In the other countries, the decline ranged between -31.3% in Greece, the highest loss, and Belgium -1.8%, the smallest loss.

In Table 8 is presented the agricultural area by EU member state in the year 2021 (The year 2000 = 100).

**Arable land in the EU-27** accounted for 986,528.75 km<sup>2</sup> in the year 2023.

The top 10 EU countries with the largest arable area, in the decreasing order based on their share in the EU arable surface are: France, Germany, Spain, Poland, Romania,

Italy, Hungary, Bulgaria, Sweden and Czechia (Fig. 9).

Table 8. Agricultural area by EU member state in the year 2021 - Thousand ha ( The year 2000=100)

	2021	2021/2000 %
<b>EU- Total Agricultural land</b>	<b>162,905.8 thousand ha</b>	
Austria	2,587.5	88.3
Belgium	1,365.7	98.2
Bulgaria	5,046.6	90.4
Croatia	1,476	126.2
Cyprus	123.1	86.9
Czechia	3,529.8	82.4
Denmark	2,618	98.9
Estonia	987	100.1
Finland	2,268	102.2
France	28,553.7	95.7
Germany	16,590	97.1
Greece	5,867.2	68.7
Hungary	5,047.7	86.1
Ireland	4,338	98.16
Italy	12,403	79.3
Latvia	1,970	124
Lithuania	2,937.8	85.9
Luxemburg	132.5	103.5
Malta	8.8	97.7
Netherlands	1,811	92.3
Poland	14,499.5	78.7
Portugal	3,962.3	100.1
Romania	13,079	88.0
Slovakia	1,856	76.0
Slovenia	611	117.9
Spain	26,228.4	80.1
Sweden	2,002.2	100.9

Source: Own calculations based on the data from [26].

The distribution of arable land by EU country in 2023 is shown in Table 9.

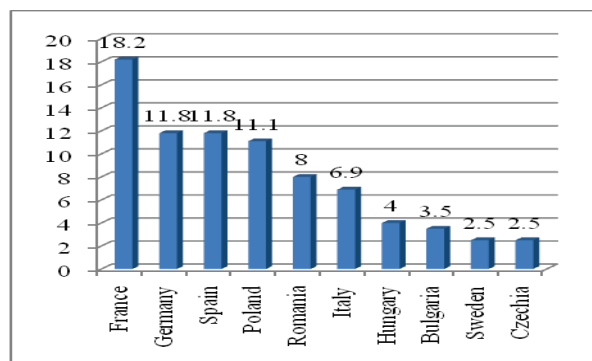


Fig. 9. The EU-27 top 10 countries with the largest arable land (% of the EU arable area)

Source: Own calculation based on the data from [25].

Table 9. Arable land by EU country (km<sup>2</sup>) in 2023 and rank in the EU

	2023	Rank
<b>EU-Total arable land</b>	<b>986,528.75</b>	<b>-</b>
Austria	13,210.8	17
Belgium	8,648.77	21
Bulgaria	34,920	8
Croatia	8,890	20
Cyprus	1,024.02	25
Czechia	24,841.54	10
Denmark	23,709.3	11
Estonia	6,940	22
Finland	22,430	13
France	179,565.6	1
Germany	116,640	2
Greece	21,319.3	14
Hungary	40,120	7
Ireland	4,440	23
Italy	68,310	6
Latvia	13,340	16
Lithuania	22,494	12
Luxemburg	621.3	26
Malta	90.7	27
Netherlands	10,048.3	18
Poland	109,210	4
Portugal	9,515.34	19
Romania	89,150	5
Slovakia	13,460	15
Slovenia	1,810.3	24
Spain	116,393	3
Sweden	25,385.52	9

Source: Own calculations based on the data from [30].

**The EU-27 cropland** accounted for 110,786.4 thousand ha in 2021, being by 9.4% smaller than 122,279.8 thousand ha in the year 2000.

The countries with the largest cropland, in the decreasing order of their share: France, Spain, Germany, Poland, Italy, Romania, Hungary. Bulgaria, Greece and Sweden, these top 10 countries representing 92% of the EU-27 cropland.

In the interval 2000-2021, cropland in the EU registered a decreasing percentage which varied between -24% in Czechia, the highest level and -1.4% in Germany, the lowest level. In other five countries, cropland increased as follows: +39.6% in Latvia, +14.4% in Slovenia, +4% in Denmark, +2.5% in Finland, and +1.5% in Luxemburg (Table 10).



Table 10. Crop land by EU country in 2021 (Thousand ha) and changes versus the year 2000=100 (%)

	2021	2021/2000 %
<b>EU-27</b>	<b>110,786.4</b>	<b>90.6</b>
Austria	1,387.5	94.3
Belgium	889.4	100.7
Bulgaria	3,648.5	95.5
Croatia	936.0	102.7
Cyprus	120.9	86.1
Czechia	2,524.3	76.0
Denmark	2,384.0	104.1
Estonia	705.0	82.4
Finland	2,247.0	102.5
France	18,970.5	97.3
Germany	11,860.0	98.6
Greece	3,220.2	83.5
Hungary	4,289.2	89.3
Ireland	437.0	89.1
Italy	9,861.4	82.9
Latvia	1,371.0	139.6
Lithuania	2,315.2	79.2
Luxemburg	64.0	101.5
Malta	8.8	97.7
Netherlands	1,040.0	98.2
Poland	11,458.8	79.9
Portugal	1,831.8	72.1
Romania	8,989.0	90.7
Slovakia	1,344	85.3
Slovenia	233.4	114.4
Spain	16,609.8	90.7
Sweden	2,538.7	97.5

Source: Own calculations based on the data from [32].

### EU-27 permanent meadows and pastures

In the year 2021, the EU-27 surface covered by grasslands accounted for 52,119.4 thousand ha, being by 13.71% smaller than 60,393.5 thousand ha in the year 2000.

The countries keeping the largest areas with permanent meadows and pastures and their share in the Total EU-27, in the descending hierarchy are the following ones: Spain, France, Germany, Romania, Ireland, Italy, Poland, Greece, Portugal, and Bulgaria (Fig. 10).

In the analyzed interval 2000-2021, the surface covered by permanent meadows and pastures in the EU-27 declined in almost all the EU member states.

The highest decrease was noticed in Greece (-43.4%) and Slovakia (-40.9%) and the smallest decline was registered in Ireland (-0.2%) and Latvia (-1.2%).

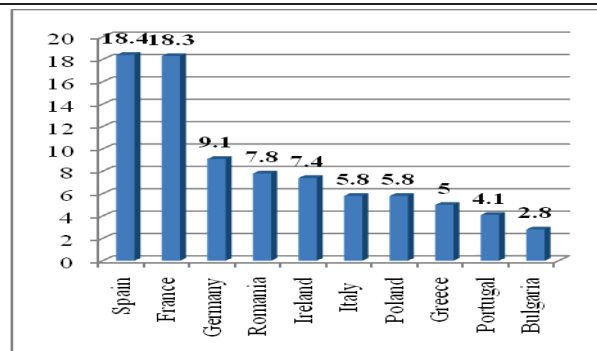


Fig. 10. The EU-27 top 10 countries with the largest area of permanent meadows and pastures in the year 2021 versus 2000 (% of the EU area with grasslands)

Source: Own calculation based on the data from [10].

Table 11. EU-27 land with permanent meadows and pastures by member state in 2021 versus 2000 (%) (2000=100)

	2021	2021/2000 %
<b>EU-27</b>	<b>52,119.4</b>	<b>86.29</b>
Austria	1,210	82.3
Belgium	476.3	93.9
Bulgaria	1,397.1	77.4
Croatia	540.0	209.3
Cyprus	2.2	200.0
Czechia	1,005.5	104.6
Denmark	234	65.3
Estonia	282.0	215.2
Finland	21.0	80.7
France	9,583.2	92.9
Germany	4,730.0	93.7
Greece	2,647.0	56.6
Hungary	754.5	71.7
Ireland	3,901.0	99.8
Italy	3,014.6	69.8
Latvia	599.0	99.8
Lithuania	622.6	125.2
Luxemburg	68.5	105.3
Malta	-	-
Netherlands	771.0	85.4
Poland	3,040.7	74.4
Portugal	2,130.5	150.3
Romania	4,090.0	82.6
Slovakia	512.0	59.1
Slovenia	377.6	120.2
Spain	9,618.6	83.9
Sweden	463.5	124.6

Source: Own calculations based on the data from [10].

In nine EU countries, the surface with permanent grasslands increased as follows; 2.09 times in Croatia, 2 times in Cyprus, by +4.6% in Czechia, 2.15 times in Estonia, by +25.2% in Lithuania, +5.3% in Luxemburg, +50.3% in Portugal, +20.2% in Slovenia and +24.6% in Sweden (Table 11).

**The concentration degree of agricultural land, arable land, cropland and the land with permanent meadows and pastures in the EU-27 in the year 2021 is shown in Table 12.**

The result for Herfindhal-Hirschman index reflected a high concentration of agricultural land in the EU-27. In case of the arable land, we cannot affirm that this category of land is concentrated, on the contrary, we may say that

it is a lack of concentration as HHI has a very low value and GSI and CC as well.

Also, in case of cropland, there is no concentration as the value of the calculated HHI, GSC and CC are very small.

For permanent meadows and pastures, the land use for this purpose is small, close to the limit to a weak concentration degree (  $HHI < 0.15$ ) as shown in Table 12.

Table 12. Concentration degree of land by category in the EU-27 in the year 2021

Land use	HHI-Herfindhal-Hirschman Index	GSI- Gini-Struck Index	CCj -Coefficient of concentration	Remarks
Agricultural land	0.3192	0.5413	0.5618	High concentration
Arable land	0.0933	0.2418	0.2509	No concentration
Cropland	0.0943	0.2438	0.2530	No concentration
Permanent meadows and pastures	0.1322	0.3143	0.3263	Below the limit of Weak concentration

Source: Own calculations.

### Crop land per inhabitant

Crop land per inhabitant is a synthetic indicator which links the agricultural land to the number of the population at the global level, but also by region and country.

While the agricultural land is decreasing at the world level, and the number of the population is on an ascending trend, we are worry about food security asking the question: Is it enough food to nourish the globe population?

On February 18, 2024, the world population reached 8,118, 835,999 inhabitants and day by day it continuous to grow [33]. Between 1961-2016, as affirmed FAO data, the population of the globe doubled its number and this means higher demand for food.

Of course, agricultural production increased due to the modernization of technologies but

land is limited and taking into account the population growth, the land per capita declined from 0.45 ha in the year 1961 to 0.21 ha in the year 2016 [6, 8].

In the year 2021, after two decades, the level declined by 0.04 ha reaching the level of 0.20ha/capita at the global level.

This situation is a reflection of the changes in arable land and also in the surface for permanent crops in various countries and also due to the population trend.

The reduction in cropland per capita is an alarm bell regarding food security.

The highest cropland per capita is in Oceania 0.77 ha/inhabitant, followed by Europe with 0.37 ha/capita, Americas with 0.37 ha/capita, Africa 0.21 ha and finally with Asia with only 0.13 ha/capita (Fig. 11).

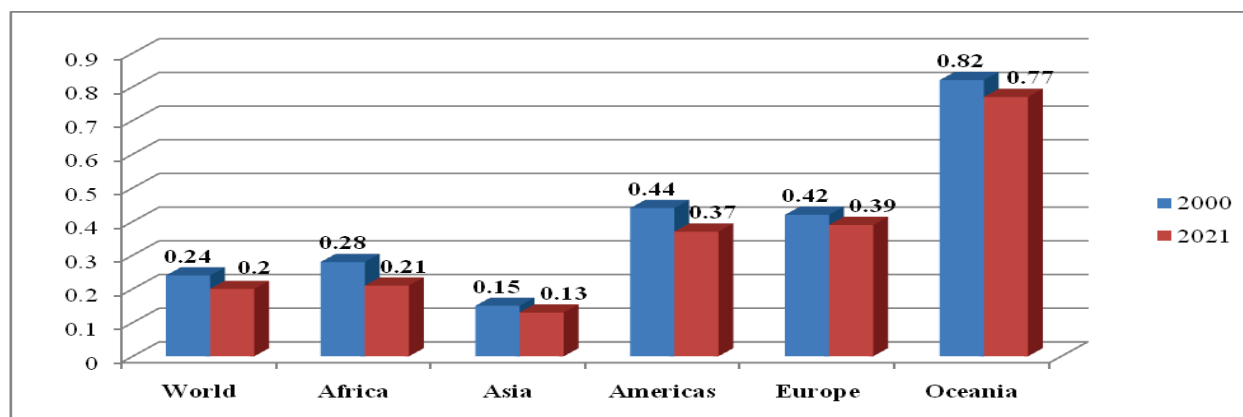


Fig. 11. Crop land (arable land plus permanent crops) per capita by continents in 2021 versus 2009 (ha/capita)

Source: Own design based on the data from [7].

The land per capita in the top 10 countries with the largest arable land registered important reduction in the last two decades, except two countries Ukraine and Argentina, as presented in Table 13.

The data reflect a critical situation in China, India and Pakistan where it is recorded a very low crop land per capita below the world average.

A good situation is in USA, Ukraine and Argentina and a very good situation in Canada.

Table 13. Crop land per capita in the countries with the largest arable land in 2021 versus 2000 (ha)

	2000	2021	2021-2020
<b>World</b>	<b>0.24</b>	<b>0.20</b>	<b>-0.04</b>
1.USA	0.63	0.48	-0.15
2.India	0.16	0.12	-0.04
3.Russia	0.86	0.85	-0.01
4.China	0.10	0.09	-0.01
5.Brazil	0.31	0.31	-
6.Canada	1.34	1.01	-0.33
7.Nigeria	0.33	0.20	-0.13
8.Ukraine	0.69	0.78	+1.13
9.Argentina	0.77	0.96	+0.19
10. Pakistan	0.21	0.14	-0.07

Source: Own processing based on the data from [32].

**Crop land per capita in the EU-27** is in average 0.37 ha agricultural land per inhabitant, but the level of this indicator differs from a member state to another.

In 2021, in the decreasing order, the top 10 EU countries with the largest cropland per capita were: Lithuania 0.83, Latvia 0.73, Estonia 0.53, Bulgaria 0.53, Romania 0.47, Denmark 0.41, Finland 0.41, Spain 0.35, Greece 0.31 and Poland 0.30.

In the last two decades, cropland per capita declined in the majority of the EU countries.

The highest decrease was recorded in Spain (-0.10 ha) and the smallest decline was 0.01 ha in Belgium, Finland, Germany and Netherlands.

In Malta there is no change, the crop land per capita remaining stable at 0.02 ha. However, in a few countries, the crop land per capita increased like in Bulgaria (+0.06), Croatia (+0.03), Latvia (+0.32), Lithuania (+0.02), Romania (+0.02), and Slovenia (+0.01) (Table 14).

Table 14. Cropland per capita in the EU-27 by member state in the year 2021 versus 2000 (ha/capita)

	2000	2021	Difference 2021-2000
Austria	0.18	0.16	-0.02
Belgium	0.09	0.08	-0.01
Bulgaria	0.47	0.53	+0.06
Croatia	0.20	0.23	+0.03
Cyprus	0.15	0.10	-0.05
Czechia	0.32	0.24	-0.08
Denmark	0.43	0.41	-0.02
Estonia	0.61	0.53	-0.08
Finland	0.42	0.41	-0.01
France	0.33	0.29	-0.04
Germany	0.15	0.14	-0.01
Greece	0.35	0.31	-0.04
Hungary	0.47	0.44	-0.03
Ireland	0.13	0.09	-0.04
Italy	0.20	0.16	-0.04
Latvia	0.41	0.73	+0.32
Lithuania	0.81	0.83	+0.02
Luxemburg	0.14	0.10	-0.04
Malta	0.02	0.02	-
Netherlands	0.07	0.06	-0.01
Poland	0.37	0.30	-0.07
Portugal	0.25	0.18	-0.07
Romania	0.45	0.47	+0.02
Slovakia	0.29	0.25	-0.04
Slovenia	0.10	0.11	+0.01
Spain	0.45	0.35	-0.10
Sweden	0.29	0.24	-0.05

Source: Own calculation based on the data from [32].

### Agricultural land and food production

The result of the agricultural land use is food production, which shows the agriculture technological level and its efficiency to nourish the people and animals.

The success in developing agricultural technologies and agri-food systems has led to a high rate in food production growth which exceeded the expand rate in agricultural land. The new implemented technologies have sustained and continue to increase land productivity in terms of yield and total production, which help us to draw the conclusion that it is not necessary to increase agricultural land in the future [3].

More than this, the last decades proved that the extend of the agricultural land for producing more food and animal feed had a negative impact on the environment and biodiversity.

The greenhouse gas emissions increased, the dioxide of carbon reached a high level, deforestation for various purposes reduced an important of oxygen, and all these have led to climate change, loss of biomass, biodiversity and habitats, and to communities loss of access to resources [11].

Therefore, to increase food production it is needed to pass to other alternatives based on a new orientation to a healthier and green diet of the consumers and resulting in beneficial consequences on the environment.

These are the reasons why the experts consider that it is the moment to stop the growth of the agricultural area and even to reduce it to an optimum dimension due to technological performance which enable agriculture to nourish a population of over 8 Billion inhabitants in the future.

The official statistical data proved that after the peak of agricultural land, agricultural production continued to raise strongly.

The only problem is that cropland have not yet reached its peak, but the grasslands have peaked, sustaining the growth of meat production in the last decades, especially coming from cattle which are grown and fattened on pastures but also in sheds where more intensive technologies based on grains produced on croplands are applied.

At present, more than 50% of cropland is used to produce foodstuffs for animals and also an important part of cropland is destined to produce more biofuels for diminishing pollution [22, 23].

## CONCLUSIONS

The global agricultural land registered a decreasing trend in the period 2000-2021, in the year 2021, accounting for 4,787.5 Million ha, being 1.8% smaller than in the year 2000. The largest surface is in Asia, Africa and Americas.

The world crop land increased and attained 1,579.8 Million ha in 2021, being by 5.7% larger. It accounts for 33% of the global agricultural land, while permanent grasslands represent 67% of 4,787.5 Million ha.

The share of each continent in the world cropland is: Asia (37.1%), Americas (23.9%),

Africa (18.5%), Europe (18.2%) and only 2.2% in Oceania. The cropland registered a decline in Europe, Americas, and Asia, but an increase in Africa and Oceania.

China, USA, Brazil, Russia, India, Argentina, Nigeria, Canada, Ukraine, and Pakistan are the largest countries which sum 1,881.8 Million ha agricultural land, representing 39.3% of the global agricultural land.

In 2021, China, USA and Brazil have the highest share in the global grasslands ( 12.2%, 7.6% and, respectively, 5.4%).

The cropland had a slight decline in USA, Russia, India, China and Pakistan, while in Brazil, Canada and Nigeria increased.

The permanent grasslands increased in USA, Russia, China and Nigeria and declined in Argentina, China, India and Canada.

About 40% of the EU's territory is represented by agricultural land and belongs to France, Spain, Sweden, Germany, Poland, Finland, Italy, and Romania. In the EU-27, agricultural land decreased by 10.83%, accounting for 162,905.8 thousand ha in 2021. This is because, cropland declined by 9.4% from 122,279.8 thousand ha in 2000 to 110,785.4 thousand ha in 2021, while permanent grasslands declined by 13.71% from 60,393.5 thousand in 2000 to 52,119.4 thousand ha. Therefore, cropland accounts for 68%, while permanent grasslands for 32% in the EU-27 agricultural land.

The EU-27 keeps 3.4% of the global agricultural land, 7.01% of the global crop land and 1.62% of the world grasslands.

About 90.81% of the EU agricultural area is in France, Spain, Germany, Poland, Romania, Italy, Greece, Hungary, Bulgaria, and Ireland. In almost EU member states the agricultural area declined, but in a few states it increased. The EU-27 arable land accounted for 986,528.75 km<sup>2</sup> in the year 2023. The largest arable surface is in France, Germany, Spain, Poland, Romania, and Italy, all together summing 67.8 % of the EU arable area.

The EU-27 had 110,786.4 thousand ha cropland in 2021, being by 9.4% smaller than in the year 2000. About 92% of the EU crop area is kept by France, Spain, Germany, Poland, Italy, Romania, Hungary. Bulgaria, Greece and Sweden.



In 2021, the EU-27 surface covered by grasslands was 52,119.4 thousand ha, by 13.71% smaller than in the year 2000. The largest areas with permanent meadows and pastures are in Spain, France, Germany, Romania, Ireland, Italy, Poland, Greece, Portugal, and Bulgaria. The surface covered by permanent meadows and pastures in the EU-27 declined in almost all the EU member states.

In the EU, it is a high concentration of agricultural land, but no concentration regarding arable land, cropland and permanent grasslands.

Because the world population exceeded 8.11 billion inhabitants and will continue to grow, the agricultural land per capita declined from 0.24 ha in the year 2000 to 0.20 ha at the global level in 2021.

The highest cropland per capita is in Oceania 0.77 ha, Europe 0.39 ha, Americas 0.37 ha, Africa 0.21 ha and Asia with only 0.13 ha.

Among the countries with the largest arable land, a critical situation in China, India and Pakistan where the cropland per capita is very small and below the world average. A good situation is in USA, Ukraine and Argentina and a very good situation in Canada.

In the EU-27, the average is 0.37 ha agricultural land per capita, and the countries with the largest cropland per capita are: Lithuania 0.83, Latvia 0.73, Estonia 0.53, Bulgaria 0.53, Romania 0.47, Denmark 0.41, Finland 0.41, Spain 0.35, Greece 0.31 and Poland 0.30.

The fact that agricultural production increased due to the better and better technologies, its growth rate exceeded the rate of expand in agricultural land.

The problem is that the expand of the agricultural land has to be stopped, as enough food could be produced to nourish the global population. This implies important changes to be achieved in adopting new agro-eco technologies called to increase crop yield and productivity but protecting environment and biodiversity. This means a reduction in meat production and consumption to protect forests and cropland, and to stop deforestation, which will encourage and orient the people to a healthier and green diet.

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