

LAND USE FOR ANIMAL FEED IN ROMANIA IN THE PERIOD 2013-2022

Agatha POPESCU^{1,2,3}, Cristina TINDECHE¹, Alina MARCUTA¹, Liviu MARCUTA¹,
Adelaida HONTUS¹, Mirela STANCIU⁴

¹University of Agronomic Sciences and Veterinary Medicine Bucharest, 59 Marasti Blvd, District 1, 011464, Bucharest Romania, Phone: +40213182564, Fax: +40213182888, Emails: agatha_popescu@yahoo.com, tindecche_cristina@yahoo.com, alinamarcuta@yahoo.com, liviumarcuta@yahoo.com, adelaidahontus@yahoo.com

²Academy of Romanian Scientists, 3, Ilfov Street, District 5, Bucharest, Romania, E-mail: agatha_popescu@yahoo.com

³Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Sisesti", 61, Marasti Boulevard, District 1, Bucharest, Romania, E-mail: agatha_popescu@yahoo.com

⁴"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 7-9, Dr. Ion Rațiu Street, 550003, Sibiu, Romania, Phone:+40269211338; E-mail: mirela.stanciu@ulbsibiu.ro

Corresponding author: agatha_popescu@yahoo.com

Abstract

The goal of the paper is to analyze the land use as cultivated area and grasslands for producing animal feed in Romania in the interval 2013-2022 utilizing the data from National Institute of Statistics (NIS) and Eurostat. The dynamics was highlighted as graphical trend lines, regression equations and R square, fixed basis and structural indices reflecting the changes across the time. The results showed that the surface with green forages in arable land was 847,978 ha in 2022 representing 10.59% of the total cultivated area and also reflected a reduction by 1.26% versus 2013. The perennial forages covered 675,207 ha in 2022 (+3.7% vs. 2013). Alfalfa accounted for a larger surface with a share of 62.52% in 2022(vs. 52.39% in 2013), while the clover area decreased its weight from 18.5% to 14.2%. In 2022, annual green forages covered 179,952 ha, by 13.35% less than in 2023. Fodder maize was cultivated on only 48,634 ha in 2022 (-13.36% vs. 2013) and root crops on only 3,033 ha, a surface smaller by 79.32% in 2022. The declined is justify by the negative influence of climate change which reduced forage production and also by the decreasing trend in livestock. Romania has also 5,172,800 ha grasslands, coming on the 3rd position in the EU after France and Germany. This area plays an important role in animal nutrition at a lower cost, in soil conservation, mitigating the effects of climate change, preserving biodiversity and the beauty of the landscapes.

Key words: land use, cultivated forage crops, grasslands, trends Romania

INTRODUCTION

The need of a balanced nutrition, food safety and health at the global level has led to a higher demand of food products both of vegetal and animal origin.

This reality resulted in a high pressure on land use, even though land surface is limited, but grace to the advanced agricultural technologies from a smaller utilized land area it is possible to obtain more food.

For obtaining more meat, milk and eggs, animal husbandry is called to raise and improve forage production on a smaller land

surface favouring cropland for human consumption [34].

Animal feed is assured by farmers using agricultural land for cultivating specific fodder crops and also utilizing the permanent grasslands.

At the world level, about 23% of agricultural land is used for cultivating crops destined to cover human consumption and 77% is used for animal feed.

In 2021, Fuglie *et al.* affirmed that 159 million ha are cultivated with forage crops whose production value, estimated at 2014-2016 prices, accounted for USD 63 Billion per year [10].

Ritchie and Roser (2024) sustain that 48 Million km², meaning 44% of the global habitable land, are utilized for agriculture. Of this surface, only 15.9 Million km² (33%) is cropland for humans and the remaining of 32.1 Million km² (67%) is land for grazing [35].

If we sum the cropland for animal feed and the grazing land, we may easily draw the conclusion that about 80% of agricultural land is used for animal growing.

But, having in mind the technological progress to produce more forages and animal products on a surface unit, larger land areas could be saved applying a strategy destined to:

-diminish the cropland for animal feed;

-to reduce the grazing land;

-to grow yields both on the cropland and in the grazing field. At the same time, a higher food production could be produced mitigating the impact of climate change and environment pollution, and preserving biodiversity.

The large diversity of the fodder plants is explained by the geographical distribution in various regions of the globe characterized by specific soil features (structure, quality, fertility), climate conditions (tropical, temperate, equatorial, continental, alpine etc) which have a deep impact on forage production and trade.

The climate change has a deep impact on forage production which imposed new strategies in various countries to mitigate the negative effects and maintain a high level of forage production and nourish the livestock for attaining the yield performance [37].

Ates *et al.* (2015) presented new solutions to stimulate animal production in the agro-pastoral farming systems in small farms of the South Mediterranean countries where rainfalls are smaller than 500mm/year [1].

In Türkiye, Tan and Yolcu (2021) emphasized the need of a strategy to expand the cultivated area with forage crops and use more resistant crops to drought [36].

Muhammad, I.R. (2019) studied the problem of animal protein shortage and malnutrition in and tried to give solutions for grazing ruminants through the provision of adequate

fodder that can be converted to high meat and milk in Nigeria [21].

Phelps and Kaplan (2017) gave a reply to the poor literature on land use in connection to livestock production and developed a framework for suitable for application in land use inventory and scenarios and studies on sustainable land use [25].

Franzluebbers and Martin (2022) sustained integrated crop-livestock agricultural systems which could be an efficient solution to increase animal production, protecting soil health, water quality and enhancing biodiversity [9].

King *et al.* (2024) pointed out that the high request of land for farming, climate change negative effects, the discrepancies existing between various nations regarding land resources, increased competition between and uses and land users, have deepened "land crisis" and for creating a "sustainable land-wealthy world" it is needed "to diminish humanity's land footprint, to develop a systemic and cooperative land resource management and strategy by governments, changing the methodology how land is valued and financed" [11].

Demand/offer ratio is of a high variability which influences forage market structure and price elasticity has a deep impact on export, import and forage trade balance.

Analyzing international forage trade in the period 1997-2020, Wang *et al.* (2023) revealed that the USA and Australia are the top forage exporting countries, while Japan, China and South Korea are the main importing countries [38].

In this context, the paper aimed to present in brief the general situation of land use at the global and EU level and then to analyze the situation of land area used for producing forages in Romania, regarding the evolution of surfaces cultivated with fodder crops in arable land and also the areas of grasslands (pastures and meadows) in the last decade 2013-2022 for which the data from the National Institute of Statistics are available at present. The trends in land use by category and structural aspects have been highlighted in order to point out if Romania is aligned to

the EU policy according to the quota "to produce more using less land".

MATERIALS AND METHODS

For setting up this study, it was started from the literature regarding land use based on official documents and research articles published in well known journals.

The data were picked up from various official information sources such as: National Institute of Statistics and Ministry of Agriculture and Rural Development of Romania, Eurostat, OEC World, World Bank, The European Feed Manufacturers Federation - FEFAC and other sources.

The period of analysis is 2013-2022 for which the data were available.

The fixed basis index and also the structural index were used for comparisons.

Also, graphical illustrations are destined to help the readers to easier understand the dynamics and the regression equations to highlight the main trend lines, while the R square value to reflect in what measure the variations of the studied indicators depends on the time changes.

Tables present the synthetic results reflecting the image of land use for animal feed at the world level, the EU and in Romania as well.

The paper contains in its structure the following aspects:

- the global land use for animal feed in brief in the recent years;

- a short overview on land use for animal feed in the EU at present;

- a detailed land use for animal feed in Romania in the last decade, 2013-2022.

The situation of land use was firstly analyzed in arable land, for the cultivated forage crops and then by category: perennial crops, of which alfalfa and clover, and annual crops, of which: fodder maize and fodder root crops.

Then, it was approached the situation of the land use as grasslands in Romania, by category: pastures and meadows.

Finally, there were extracted the main ideas reflected by the obtained results in order to conclude in what manner in Romania land is used for sustaining forage production and implicitly livestock farming.

RESULTS AND DISCUSSIONS

Land use for animal feed at the global level

The surface used for animal feed at the world level accounts for 3.75 Billion ha, representing 78.5% of the global agricultural land of 4.78 Billion ha in the year 2021 [7].

Of the 3.75 Billion ha for animal feed, 3.2 Billion ha are grasslands, accounting for 85.3% of the land use for animal feed and 67% of the world agricultural land.

The remaining of 0.55 Billion ha from the land use for animal feed represent arable land for fodder crops. This small surface accounts for 14.7% in the global land use for animal feed and for 11.5% in the world agricultural land.

The permanent grasslands area is divided into two categories:

- permanent grasslands for grazing (pastures), which accounts for 2 Billion ha (62.5%); of this surface, 1.3 Billion ha are used for livestock farming (65%) and 0.7 Billion ha is land converted into arable cropland; the surface destined for livestock farming is used for cattle, buffaloes, sheep and goats growing;
- meadows, whose surface is 1.2 Billion ha (37.5%), are destined for producing hays and also for carbon sequestration.

The arable land for fodder crops of 0.55 Billion ha is cultivated mainly with cereals on 0.13 Billion ha (23.6%), with oilseeds crops also on 0.13 Billion ha (23.6%) and the remaining is destined for other crops (52.8%) (Table 1).

The secondary products remained after harvesting the cropland can be used by cattle, buffaloes, sheep and goats. But, the main products are used for humans.

Therefore, livestock consume 33% of the global cereals production as feed and 11% of the total feed.

The animals have the advantage that they are able to transform and convert cellulose from the forages they consume, which in fact could be considered wastes from vegetal cropping, into high value digestible nutrients included in food products like milk, meat and eggs [8].

Table 1. Global land use for animal feed in 2024

Global land use for animal feed 3.75 Billion ha					
Grasslands area 3.2 Billion ha			Arable land for fodder crops 0.55 Billion ha		
PASTURES 2 Billion ha		MEADOWS 1.2 Billion ha	Land for cultivating cereals 0.13 Billion ha	Land for cultivating oils seeds crops 0.13 Billion ha	Land for other crops 0.29 Billion ha
Land for livestock farming 1.3 Billion ha	Land converted into arable cropland 0.7 Billion ha	Land for hays and carbon sequestration 1.2 Billion ha			

Source: Own conception based on the data from [7, 8, 34].

Land use for animal feed in the EU

The EU has 157.4 Million ha utilized agricultural area (UAA), representing 3.2 % of the global agricultural land. The UAA is differently distributed among the member states and it is deeply linked to the farm structure and its physical size [26, 28, 29].

The largest surface in the EU is represented by arable land which accounts for 98.1 Million ha, meaning 62.3% of the EU total UAA and 6.3% of the global crop land.

A surface of 59.1 Million ha is used for animal feed. Of this area, 48 Million ha are permanent grasslands (30.5%) of the EU UAA and 1.5% of the global grasslands, and 11.1 Million ha are permanent crops for animal fodder. The remained 0.2 Million ha UAA (0.1 %) represent the kitchen gardens (Table 2). Compared to the year 2010, there

were noticed important differences in the EU UAA structure [6].

In 2020, the surface covered by permanent grasslands was by 2 Million ha smaller and also the surface of arable land declined by 1.5 Million ha. Therefore, this reduction is in accordance of the EU Green deals which provide a Green Europe by 2050 [3].

This means a huge effort for improving agricultural technologies so that with less land to obtain higher agricultural production of high quality to sustain food safety and to mitigate negative impact of agriculture on environment and the negative impact of climate change.

Therefore, it is very important as land to be efficiently used in terms of agricultural production value, value added, labour productivity [30, 27, 31, 32].

Table 2. Land use for animal feed in the EU in 2020

Land use in the European Union 157.4 Million ha agricultural land (UAA)			
Arable land 98.1 Million ha 62.3%	Permanent grasslands 48 Million ha 30.5%	Permanent crops for animal feed 11.1 Million ha 7.1%	Kitchen gardens 0.2 Million ha 0.1 %

Source: Own conception based on the data from [4].

Land use for animal feed in Romania

Romania is an important agricultural country in the EU where it comes on the 5 position for UAA 12.9 Million ha representing 8.1% of the EU UAA. It is ranked after France, Spain, Germany and Poland.

Also, Romania is ranked the 4th in the EU for 3.7 Million ha permanent grasslands, accounting for 7.7% of the EU grasslands area, after France, Spain and Germany.

Taking into consideration the allocation of arable land, permanent grasslands and permanent crops, Romania is situated on the 15th position in the EU after Finland, Denmark, Sweden, Hungary, Malta, Lithuania, Cyprus, Poland, Bulgaria, Slovakia, Estonia, Czechia, Germany and Latvia [4].

Taking into account the data from the National Institute of Statistics, and Ministry of Agriculture and Rural Development, and

National Institute of Statistics in 2013 and 2014, Romania had a surface of 4,813.8 thousand ha grasslands, of which 3,273.9 thousand ha pastures and 1,541.9 thousand ha meadows, representing 22.38% and, respectively, 10.57% in the total agricultural area [20, 22].

Category of forages in Romania

Forages are of a large diversity taking into consideration the geographical localization of the country in the Eastern part of Europe, soil structure, quality and fertility, climate condition in the temperate area with Mediterranean influences in the Western part, the relief zones: mountain, hilly and plain areas, the species and categories of plants which could be grown in arable land and which are specific in grasslands floristic structure, the potential in forage yield and production [33].

Also, the forage production is correlated with the livestock size in terms of LU (livestock unit) for covering nutritional and energy requirements to assure vital functions and production in accordance with the species, breed, category, age, physiological status, and production potential.

In Romania there are raised the main farm species: cattle for milk and meat and mixed purposes, buffaloes, sheep and goats, pigs, poultry, horses etc.

Fodder production covers in general the quantitative and qualitative needs of these animals and also assures their health and expected production using technologies which are in general friendly with the environment.

The cultivated fodder crops are classified in two categories: *perennial crops*, having as main representatives: alfalfa and clover, and *annual crops* such as: maize, wheat, barley, oats, rye, triticale, Sudan grass, sorghum, sunflower, fodder cabbage and peas, root crops (carrots, pumpkin etc) [2].

Grasslands are used especially for grazing (70%) and the rest of 30% for mixed purposes and producing hay.

The permanent grasslands are continuously covered by a grass vegetation with a

diversified floristic composition, production amount and quality along the altitude zones in accordance with the soil type, fertility and maintenance works.

The temporary grasslands represent a very small area, in general being degraded grasslands, where it is required to be sown with a mixture of grass and leguminous crops for recovering the soil natural structure and productivity.

The used area for producing forages and grazing in Romania

The cultivated area with forage crops in arable land

In Romania, the total cultivated area reached 8,006 thousand ha in the year 2022, being by 1.98% lower than in the year 2013 when it accounted for 8,167 thousand ha. The reduction is justified by the increased yields achieved in the last decade. The largest cultivated area accounting for 8,737 thousand ha was registered in the year 2020.

The cultivated area with fodder crops also decreased from 859 thousand ha in the year 2013 to 848 thousand ha in the year 2022, meaning a reduction by 1.28% (Figure 1).

These aspects reflect that a part of cropland destined to produce animal feed is saved and could be used for human consumption.

We mention that there are differences between the data displayed by NIS Tempo online data base and the data mentioned by NIS in 2022 after the General Agricultural Census, presented by Press Release no.74/24 March 2022 [23].

These differences are determined by the change in methodological procedures used for establishing the inventory in land use.

The share of fodder crops in the cultivated arable land accounted for 10.51% in 2013 and for 10.59% in the year 2022 in the total cultivated area in the country. The slight increase accounts for just +0.08 pp.

The fodder crops are perennial crops and also annual crops, which have been cultivated on different surfaces.

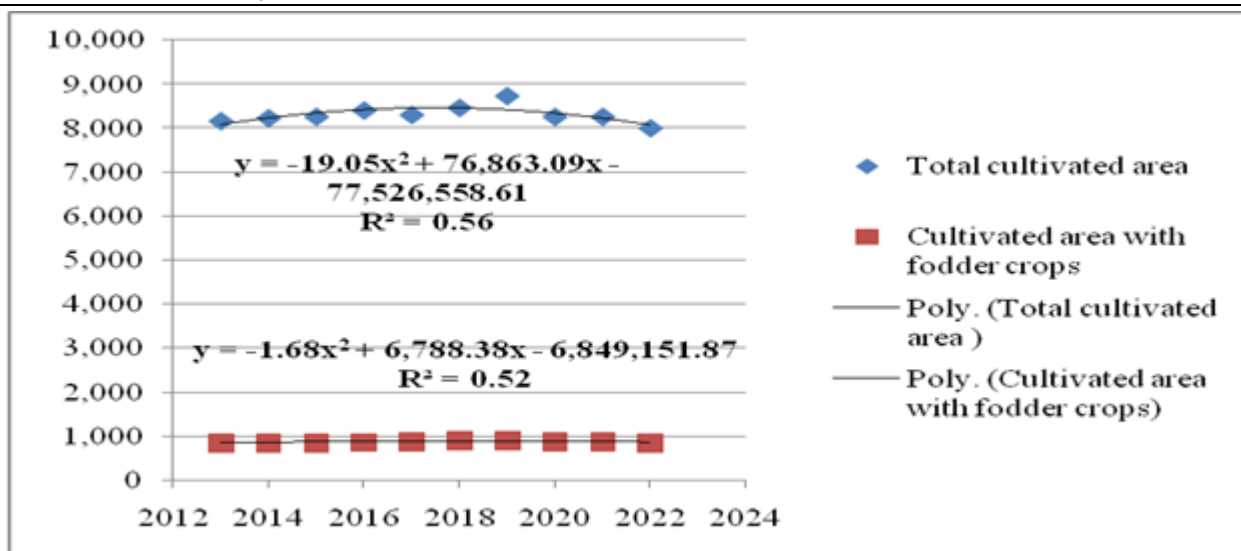


Fig. 1. Dynamics of the cultivated area in Romania and the cultivated area with fodder crops (Thousand ha)
 Source: Own design based on the data from [24].

The cultivated area with perennial fodder crops registered an increasing trend from 651 thousand ha in the year 2013 to 675 thousand ha in the year 2022, reflecting a growth by 3.68%.

The main perennial crops cultivated for forages are alfalfa and clover.

Alfalfa was cultivated in the analyzed interval on a larger and larger surface, increasing from

341 thousand ha in the year 2013 to 422 thousand ha in the year 2022, meaning a surplus of 23.75%.

But the surface cultivated with clover decreased by 21.67% from 121 thousand ha in the year 2013 to only 96 thousand ha in the year 2022 (Figure 2).

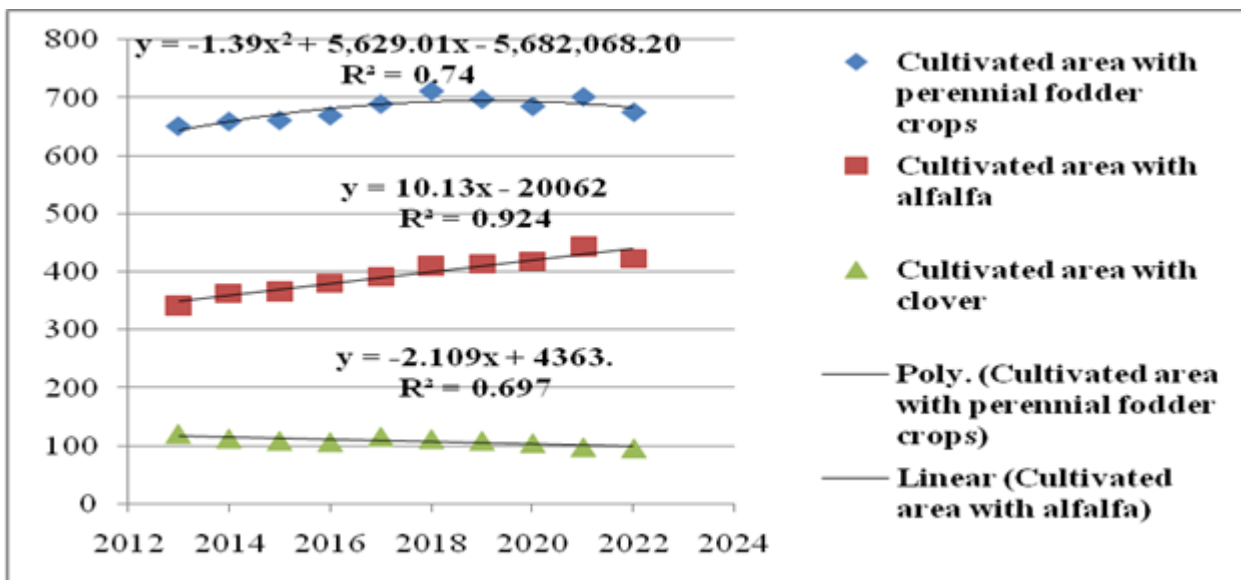


Fig. 2. Dynamics of the cultivated area with perennial fodder crops, alfalfa and clover (Thousand ha)
 Source: Own design based on the data from [24].

In 2013, the share of alfalfa cultivated area in the total area cultivated with perennial fodder crops was 52.39%, and in 2022 increased to 62.52%.

In case of clover, its weight declined by -4.3 pp, from 18.51% in 2013 to 14.21% in 2022. If we take into account the cultivated area with these two crops, in 2013 it accounted for

70.96 % and in 2022 for 79.70% in total cultivated surface with perennial fodder crops. The cultivated area with annual fodder crops carried out a decline from 208 thousand ha in the first year of this study and 173 thousand ha in the last year, which means a loss of 16.83% (Fig. 3).

The major annual fodder crops cultivated in Romania are maize and roots.

The surface is higher for maize compared to roots.

Maize for fodder recorded a reduction in its cultivated area from 56 thousand ha in 2013 to

49 thousand ha in 2022, reflecting a loss of 12.5%.

The roots crops were cultivated only on 3,000 ha in 2022 compared to 14,000 ha in 2013 (-80%) (Figure 3).

The cultivated area with annual fodder crops represented 28.19% in the year 2013 and 20.39% in the year 2022 in the total cultivated fodder surface.

Maize share in the cultivated area with annual fodder crops accounted for 26.92% in 2013 and for 28.32% in 2022, while the share of root crops registered a deeper decline from 7.21% in 2013 to 1.73% in 2022.

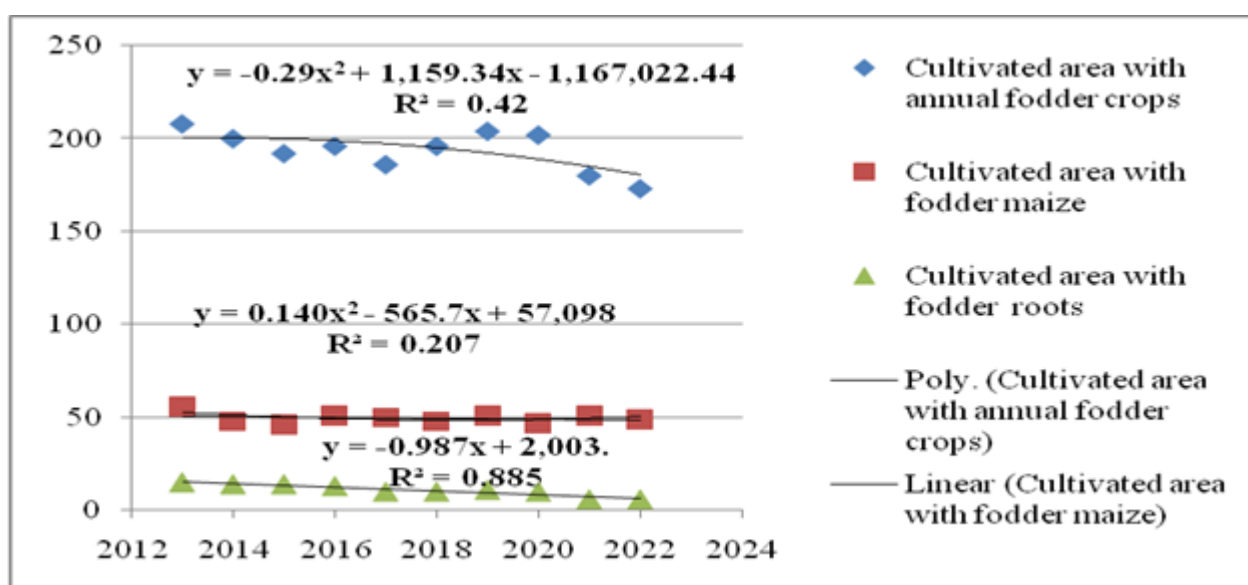


Fig. 3. Dynamics of the cultivated area with annual fodder crops, maize and roots (Thousand ha)
 Source: Own design based on the data from [24].

Table 3. Land use for cultivated fodder crops in Romania in 2022

Land use for cultivated fodder crops in Romania 848,000 ha			
Perennial fodder crops 675,000		Annual fodder crops 173,000 ha	
Alfalfa 422,000 ha	Clover 96,000	Maize 49,000	Roots 3,000

Source: Own synthesis based on the data from [24].

A synthetic presentation of the cultivated area with fodder crops is shown in Table 3.

The area of grasslands in Romania

According to Knoema (2022), in 2021, Romania had 4,090 thousand ha permanent grasslands (pastures and meadows) [12].

According to Eurostat, Land use and Land cover survey, it was made a classification of all the EU countries based on LUCAS data (Land Use/Cover Are frame Survey)

regarding the surface of permanent agricultural grasslands in km² and relative land cover area of permanent grasslands (%).

In this hierarchy, on the top position is situated France with 108,332 km² in the year 2015 and 107,781.1 km² in the year 2018 permanent grasslands, followed by a group of four member states: Germany, Romania, Poland and Spain with permanent grasslands over 40,000 km² [5, 6].

Romania is mentioned with 55,257.9 km² permanent grasslands in 2015 and with 51,728.8 km² in 2018.

The relative cover area of permanent agricultural grasslands is also specified in this survey which in case of France was 19.7% in

2015 and 16.3 % in 2018, while for Romania its value was 23.2 % in 2015 and 21.7% in 2018 (Table 4).

Of the 55,257.9 km² of grasslands, about two thirds are used for grazing and one third for producing hay (Table 4).

Table 4. Romania's position among the top member states regarding the area of permanent grasslands and relative land cover of permanent agricultural grasslands in the years 2015 and 2018

Country	2015		2018	
	Area of permanent grasslands (km ²)	Relative cover area of permanent agricultural grasslands (%)	Area of permanent grasslands (km ²)	Relative cover area of permanent agricultural grasslands (%)
1.France	108,332.9	19.7	107,761.4	19.6
2.Germany	59,442.7	16.6	58,331.4	16.3
3.ROMANIA	55,257.9	23.2	51,728.8	21.7
4.Poland	44,699.2	14.7	46,607.8	14.9
5.Spain	45,731.3	9.0	43,978.2	8.8
6.Ireland	37,0182.8	53.1	36,089	51.7
7.Italy	31,331.3	10.4	30,170	10.0

Source: Eurostat, Land use and Land cover survey [5].

Important achievements of the scientific research points out the production potential of Romania's grasslands and also offer a large variety of solutions to improve soil fertility, floristic composition, productivity, ecological reconstruction of the degraded grasslands, rational grazing, assessment of animal production obtained from grazing, efficient farming on the grasslands of Romania's mountains [13, 14, 15, 16, 17, 18, 19].

CONCLUSIONS

The main conclusions that could be drawn from this study are the following ones:

-At the global level, 3.75 Billion ha are used for animal feed, of which 85.3% for grasslands and the remaining for land for cultivating fodder crops. Grasslands accounts for 3.2 Billion ha, of which 62.5% are pastures and 37.5% are meadows. Arable land accounts for 0.55 Billion ha, of which 0.26 Billion ha are cultivated with cereals and oils seeds crops. Of the pastures area, 1.3 Billion ha are used for livestock farming and 0.7 Billion ha are converted into arable cropland.

-In the EU, the permanent grasslands cover 48 Million ha, and 11.1 Million ha are destined to cultivated fodder crops. This means 30.5%

and, respectively, 7.1% of the EU UAA accounting for 157.4 Million ha.

-Romania comes on the 4th position in the EU for 3.7 Million ha permanent grasslands, representing 7.7% of the EU grasslands. It also is ranked the 15th for arable land, permanent grasslands and permanent crops in the EU.

- In Romania, fodder crops were cultivated on 848 thousand ha in 2022, a smaller area by 1.28% versus 2013. Fodder crops area represents 10.59% in the whole cultivated area in Romania in 2022.

-Perennial fodder crops were cultivated on 675 thousand ha in 2022, an area by 3.86% higher than in 2013. Of this surface, alfalfa is cultivated on 422 thousand ha and clover on 96 thousand ha, meaning 76.7% of the surface with perennial fodder crops.

-The annual fodder crops were cultivated on 173 thousand ha, a surface by 16.83% smaller than in 2013. Maize is cropped on 49 thousand ha and roots on only 3 thousand ha, which means -12.5% and, respectively, -80% compared to 2013.

- Romania had 51,728.8 km² grasslands in 2018, with a relative cover area of permanent agricultural grasslands of 21.7%, coming on the 3rd position in the EU after France and Germany.

In conclusion, Romania follows the general trend at the global and EU level to diminish the surface allotted to animal feed as the modern technologies assures more fodder production per surface unit. Also, this trend is in the advantage of the cropland for human consumption, and, at the same time, it contributes to the maintenance of environment quality and conservation of biodiversity.

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