

FOREST CURTAINS - ONE OF THE SHIELDS AGAINST CLIMATE CHANGES IN ROMANIA'S AGRICULTURE

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Abstract. *The paper highlights the importance of forest curtains in Romania and especially in Dobrogea region, Constanta County and Oltenia region, Dolj county where agricultural crops are deeply affected by climate changes: long and severe drought, soil degradation and desertification. The paper presents the affected surfaces, and a history of protection curtains giving examples of research results of the experiments and good practices carried out in the year 2020 and 2023 at Amzacea Sport Agra Ltd. regarding the economic effect in terms of yield and production obtained from cultivated crops on areas protected by forest curtains compared to non protected crops. The results proved that the protected crops have performed production gains varying between 25-30% in the good agricultural years and between 29-40% in the bad dry years. The main conclusion is that forest curtains have to be planted on larger surfaces to protect agricultural crops and sustain production performance. They are urgently needed in the regions where irrigation systems are not operating.*

Keywords: forest curtains, agricultural crops, production gains, Sport Agra Ltd. Amzacea

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1. Introduction

Forests are "the lungs of the planet", a real treasure which produces oxygen and clear the air, a shield against strong winds, soil erosion, landslides, and degradation, air, soil and water pollution, for protecting agricultural crops and animals, settlements, transport ways, for preserving biodiversity, for providing shelter, jobs, food, fuel, medicines and incomes to the population.

Deforestation has a negative impact on human and animal life, increasing the risk of soil erosion, desertification, loss of animals habitats, diseases and destroying the balance within the ecosystems [22].

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The surface of forests fund in Romania covered 6,456.8 thousand ha in the year 2022 compared to 6,314.9 thousand ha in the year 2007. and it represents 27.7% of Romania's territory [21].

During the last decade, Romania was facing meteorological extreme phenomena due to climate change: low rainfalls, high temperatures, hot waves, aridity, desertification, storms, huge rainfalls, floods, powerful winds etc causing huge economic, social and environment damages and unbalance in the ecosystems, decreasing agricultural production and affecting farmers' income [23, 24, 26].

Spain, Portugal, Italy, Cyprus, Greece and Romania are the main countries where desertification is extending year by year causing economic losses to agriculturists and environment damages. That is why the EU needs to develop an effective strategy against desertification [20].

Researchers and farmers found solutions to adapt the technologies to diminish the negative effects on climate changes on yields and productions of sunflower [10, 13, 16, 18], barley [14], wheat [14], sorghum [13, 15, 17].

To sustain production development, a new strategy for land management is required to associate trees with crops leading to a benefic effect on farm economy, environment, life quality of the farmer's family and mitigating climate change negative impact [27].

Taking into account the negative impact of climate change on agriculture, Romania's Government established the National Strategy on reducing effects of drought, prevention and combat degradation land and desertification, term short, medium and long adopted in 2008 [19].

The most affected regions by climate change in terms of drought, aridity and desertification are South Muntenia, South East Romania, South Oltenia and South Moldavia, where these phenomena are frequently seen year by year [25].

One of the alternatives which could mitigate the negative impact of these unpleasant phenomena is the creation of forest curtains [11, 12].

In this context, in Romania it was created a legal framework consisting of Law 289/15 May 2002 regarding the protection curtains, Government Decision 994/25 June 2004 for approving the establishment of forest curtains for protecting communication ways, Government Decision 1343/2007 for approving the establishment of forest curtains for protecting the fields in Constanta, Ilfov, and Tulcea, Law 46/2008 The forest code, Emergence Ordinance of the Government 38/2014 for modifying and completing Law 289/2002 regarding the forest curtains, and Government Decision 36/31 August 2022 which regard modifying and completing Law 289/2002 regarding the forest curtains to diminish or mitigate the negative effects of climate change.

However, the process to extend the surfaces covered by protection curtains is slowly carried out and even at present in the zones of high risk mentioned above they are not enough.

In this context, the goal of the paper is to present why the forest curtains are important to be extended on larger areas and mainly in the regions where the irrigation systems are not enough or are missing and to give examples of research experiments and good practices in Dobrogea and Oltenia which proved the positive impact of protection curtains on agriculture.

2. Materials and Methods

The paper is based on the study of literature in the field, checked and picked up from Google Scholar, statistical data provided by official authorities and data bases, National Institute of Statistics and other information sources.

The own conception stayed at the basis of this paper in organizing the collected information and giving a logical structure of the main aspects approached.

The main aspects analyzed in this research have been:

- the situation of the surfaces where irrigation systems are installed in Romania and in its territory,
- the areas affected by desertification,
- the climate characteristics in the Eastern extremity of Dobrogea, in Constanta county, which justify why forest protection curtains are so important to be extended;
- the surface covered by forest curtains in Constanta County along the time.

Examples of good practices regarding reforestation and mainly the setting up of forest curtains as a protection mean for agriculture have been given in order to show their benefits and prove why it is needed to expand their surface in the regions affected by low precipitations level, drought, lack of irrigation systems, soil erosion, landslides, desertification and strong winds like Dobrogea and Oltenia.

3. Results and Discussions

Surface with irrigation systems

In the year 2022, Romania had irrigation systems on only 3,060 thousand ha, of which 1,164 thousand ha in South Eastern area (38.03%), of which 430,800 ha in Constanta County, representing 14.07% of the total irrigated area in the country.

From this point of view, Constanta is on the top position in Romania, being followed by other counties, which in the decreasing order have smaller irrigated surfaces: Braila, Calarasi, Dolj, Teleorman, Olt, Giurgiu, Tulcea, Galati, Mehedinti, Iasi and the list could continue.

And taking into account that in 2014, there were 3,046 thousand ha irrigated, the surplus of 14,000 ha after 8 years is very small and does not cover the requirements of agriculture.

Discussing about the irrigated arable land which in 2022 accounted for 2,904 thousand ha compared to 2,893 thousand ha in 2014, this means just a surplus of + 0.39%, of which 37.7% is situated in the South East part of the country.

But, if we take into consideration, the surface which is effectively arranged for irrigation with at least one watering, the situation is critical indeed! Compared to 145,000 ha in the year 2014, in the year 2022 there were 538,000 ha, of which 68.4% are situated in South East regions of Romania. At present, Constanta county has only 5,900 ha, coming on the 6th position in Romania from this point of view, after Braila, Galati, Dolj, Iasi and Buzau counties [21].

And if we compare with the year 1990, when in the Constanta county were 422.3 thousand ha irrigated, representing 72.6% of the 581.5 thousand ha irrigated area in Dobrogea, we could understand how critical the reality is.

Surface affected by drought

Drought has been the key weather factor with the worst impact on agriculture in Romania. The surfaces affected by drought varied from a year to another, but the worst years have been 2015, 2016 and 2020 and 2022 as shown in Table 1.

Table 1. Romania's area affected by drought in the periods 2016-2019 (ha)

	2015	2016	2017	2018	2019	2020	2022
Drought	1,584,088	1,040,002	298,365	187,101	74,503	1,200,000	1,110,000

Sources: [2, 5, 9].

Surface affected by desertification

More than this, in Romania, over 400,000 ha of land are affected by desertification, most of them being situated in Southern Oltenia, Dobrogea and Moldavia. Climate changes, the intensification of conventional agricultural systems, extreme land use, deforestation, wood fires, unsustainable agricultural practices have led to the emergence of desertification. Year by year, more and stronger extreme climate events like droughts, heat waves, powerful winds, floods etc have had a negative impact on the productivity of farming lands, decreasing production by 30-50% [6].

Climate features of the Eastern extremity of Dobrogea

The Eastern extremity of the Dobrogea region is the most arid area of Romania. Here, the climate features are the following: average annual air temperature varying between 10.7-11.7°C, the average annual precipitations level is 426 mm, and winds are very strong, and for this, the region wears the nickname "The country of the winds".

Since 2015, in this part of the Constanta county, there were recorded the driest years, where drought, aridity, and desertification have become common phenomena, as a result of climate change caused by technological progress and intensification of industrialization.

The lack of precipitation and their low level have led to a lower water level into the soil, and the water reserve was consumed by crops and evapotranspiration which caused cracks in the ground.

In two localities situated in Constanta County, Viisoara and Amzacea villages, in 2022 compared to 2018, the annual precipitations declined by 56.1% and, respectively, by 50.5%, as shown in Fig.1.

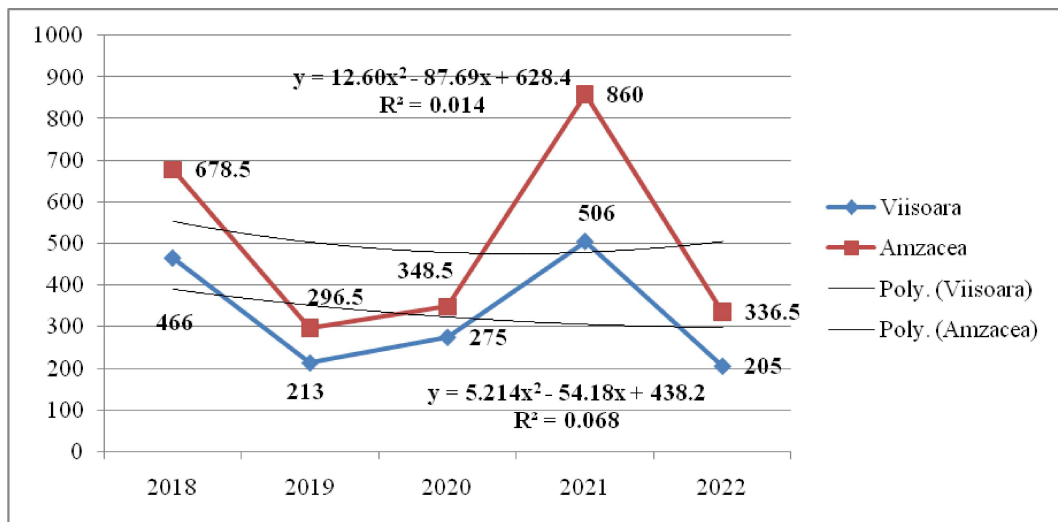


Fig. 1. Dynamics of annual precipitations in Viisoara and Amzacea localities, Constanta County, 2018-2022 (mm)

Source: Amzacea Meteorological Station [4].

In the year 2023, in Amzacea locality, in the period January-November, there were registered 244.2 mm cumulated precipitations compared to 315.5 mm in the same interval in the year 2022, which means by 71.3 mm or by 22.6% less.

The monthly variation of precipitations in Amzacea locality in 2023 versus 2022 is presented in Fig. 2. Except January, April and July when the amount of precipitations was higher in the year 2023 versus 2022, in all the other months it was much lower.

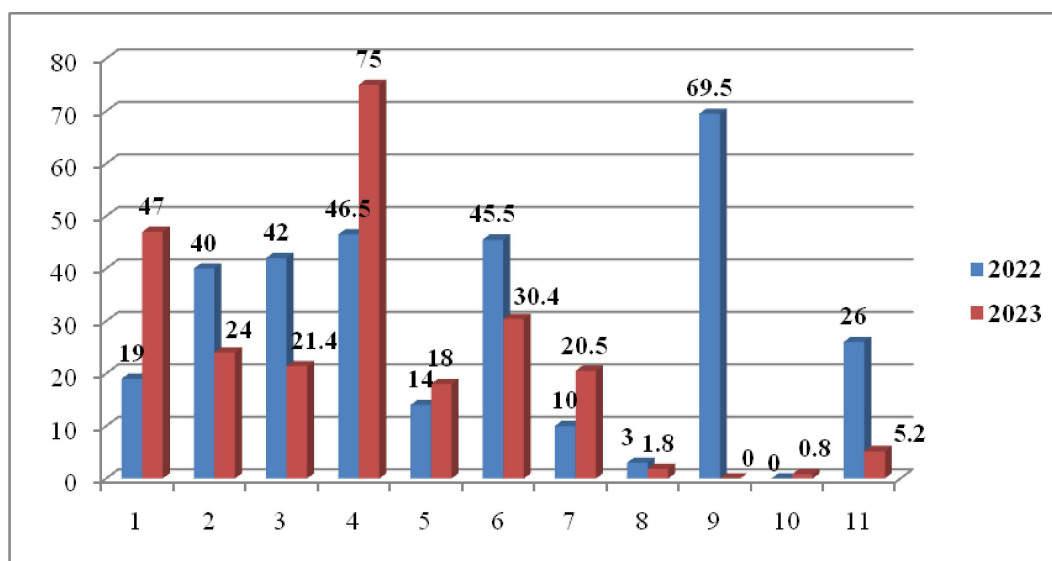


Fig. 2. Dynamics of monthly precipitations in Amzacea locality, Constanta County, in the interval January -November, 2023 versus 2022 (mm)
Source: Amzacea Meteorological Station [4].

Surface covered by forest curtains

In the year 1963, Constanta county had 4,049.04 ha covered by forest curtains, of which 3,388.39 ha (83.68%) in the districts and the difference of 660.35 ha in the cities.

At present, large surfaces of protection trees were cut, a destructive aspect with a deep negative impact on agriculture and not only.

In 18 August 2007, it was organized a symposium on the topic "*Dobrogea in the context of desertification*", which gathered 200 participants from the interested counties Constanta, Tulcea, Ialomita and Calarasi, who agreed that agro-forest curtains are compulsory to be installed because they have a high **importance for agricultural crops** as mentioned below:

- change the microclimate in the protected area by reducing the wind intensity and speed;
- avoid the shattering the top layer of soil in the winters without snow, and, in the winters with snow, they avoid shattering snow;
- improve the soil and air thermal regime, which has a positive influence on crop productivity, due to a faster seed germination, a faster and richer branching of the root system of the cultivated plants;
- increase the number of plants per surface unit and grow the production of the protected crop;
- avoid settling crops during the vegetation period;

-increase yield assuring a surplus of 16-40% compared to the harvest difference registered for longer periods of dry, middle dry and good years.

As a result, *an example of good practice and experience* was made with the support of the Constanta County Council, since 2008, when it started a programme destined to plant agro-forest curtains for the first time after the year 1921. For this purpose, it was founded a nursery in Plopeni Village, Chirnogeni Commune, where the biological material to be produced on a surface of 8 ha.

Because at that moment, there were not certified seeds from the tree species (brumarium oak, downy oak, black pine etc), which had to be used to set up the forest curtains, the nursery was founded using only acacia species, the seeds being supplied by Romsilva Bihor, Sacuieni Forest District.

In spring 2009, the acacia seedlings were distributed to the agricultural producers from Amzacea, Lipnita, Cobadin, Viisoara Villages. This programme continued till the year 2012 when it stopped because the planted area did not receive the unique payment per ha. At that moment, the agro-forest curtains covered about 350 ha in Lipnita, Cobadin and Amzacea villages [8].

Also, *another crucial moment when the researchers tried to sound the alarm* and emphasize the need of forest curtains was the "Transboundary Debate of Regional interest between Romania and Bulgaria" on the topic "*Forest curtains in the context of climate changes*", which was run within the Academy of Agricultural and Forest Sciences on May 22-23, 2008. The unanimous conclusion was that forest curtains have a regulator role of the meteorological phenomena, in accumulating water, calming the winds and blizzards.



Photo 1. Protected land by forest curtains in Bulgaria (Left) and nonprotected in Romania (right)
Source: Original from Sport Agra Ltd. Amzacea [28].

Another example of good practice and experience to protect crops from Dobrogea against powerful winds and achieve better yields, was given by Albu et al. (2020),

who installed 20 coastal protective forest belts which consist of 15 mixtures of locust and acacia, in Mangalia area in the Village Ciocârlia. The results proved the benefic effect on agricultural production, protection against soil erosion caused by wind, which proved that the extension of forest curtains in Dobrogea si justified [3].

The experience to extend the areas with forest curtains continued with *another example of good practice in Dobrogea*, recognized as a region with strong winds which intensify drought and desertification. Because in Constanța county, only about 5.4% is surface is covered by forests, in Crucea Commune, it was developed a project for planting various tree species (elm, linden, ash, dogwood, willow, jugaster and rose hip) for setting up a protection curtain against wind and drought and increase production on a plot of 8 ha around a surface cultivated with wheat. In 2028, it is expected that production will grow by 30-40% [1].

The most interesting experiment made at Amzacea Sport Agra Ltd was destined to assess the economic effect of agro-forest curtains in terms of yield level for the main cultivated crops: wheat, barley, sunflower, rape and maize comparing with the yield level obtained by the same crops on a plot which was not protected by forest curtains (control variant).

These experiments were made in order to identify in what measure forest curtains could contribute to the increase of yield in the local soil and climate conditions.

This was a decision taken as a result of the fact that in the period 2020-2023, Dobrogea region and especially its South East part in Amzacea area was facing with a severe drought (a pedological and atmospherical drought), and lack of precipitations.

Table 2 present the annual and monthly distribution of precipitations at Amzacea in the period 2018-2023. The data show that in the period January-November 2020, there were accumulated 248.5 mm/s.m., and in the year 2023 in the interval January - September only 244.2 mm/s.m.

Table 2. Monthly distribution and annual precipitations at Amzacea in the period 2018-2023 (mm)

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total year
2018	63	120	68	2	93	76	247	0	3	3	57.5	47	678.5
2019	36	8	16	35.5	18	14	44	7	37	44	9.5	27.5	296.5
2020	2	50	16	15	42	24	29	0	31	18.5	21	100	348.5
2021	122.5	34	61.5	35	22	270	18.5	0	40	115	49	92.5	860
2022	19	40	42	46.5	14	45.5	10	3	69.5	0	26	21	336.5
2023	47	24	21.5	75	18	30.4	20.5	1.8	0	0.8	5.2	-	244.2

Source: Amzacea Meteorological Station, 2023 [4].

The period 2020-2023 was very difficult for Dobrogea's agriculture due to the severe and long pedological and atmospheric drought, lack of precipitations as never before since in Romania the meteorological data are recorded.

In the year 2020, Sport Agra Ltd operating in Amzacea area, started a scientific experiment as follows:

(a) On the experimental plot, a cultivated surface of 49.61 ha situated within the agro-forest curtains, it harvested a production of 36,580 kg, which means an yield of 737.35 kg/ha.

(b) On the experiment control variant, where the cultivated surface was 37.26 ha with the same variety, but the crop was not protected by forest curtains, it was harvested only 215.24 kg/ha.

Making the comparison, we may easily identify the surplus of 522 kg/ha resulting from the plot protected by forest curtains, which means about +30% yield.

In the year 2023, the same company carried out another scientific experiment to assess the economic effect in terms of yield, using the forest curtains for sunflower crop as follows:

(a) On the experimental plot of 49.45 ha cultivated with sunflower and protected by agro-forest curtains, it was achieved 2,258 kg seeds/ha;

(b) On the control variant, cultivated with the same crop, but not protected by forest curtains, it was obtained only 1,950 kg seeds/ha.

Therefore, the yield was by +308 kg/ha higher on the plot protected by agro-forest curtains than on the non protected plot.

These experiments proved the fact that from the cultivated areas which are protected by agro-forest curtains, the farmers could achieve higher yields and productions, which justify the need to install and extend the areas with forest curtains in Constanta county, Dobrogea region and other parts of Romania affected by drought.

In Tables 3 and 4, there are shown the economic results in terms of production within a comparative experiment on areas protected by forest curtains and also on non protected areas, cultivated with the following crops: wheat, barley, sunflower, rape and maize, in a bad dry year and in a good agricultural year.

Table 3. Productions by crop obtained in a bad dry agricultural year from protected areas by forest curtains versus non protected area (kg)

Crop	Production obtained from the unprotected plots (kg) Control variant=CV kg	Production obtained from the plots protected by forest curtains (kg) Experimental variant= EV kg	Difference of production	
			EV-CV (kg)	EV/CV x 100 (%)
Wheat	800	1,100	+300	137.50
Barley	2,140	2,760	+620	128.97
Sunflower	620	840	+220	135.48
Rape	1,800	2,520	+720	140.00
Maize	400	1,240	+840	310.00

Source: Own results at Sport Agra Ltd Amzacea [28].

In a bad dry agricultural year, from the cultivated areas protected by forest curtains versus the ones unprotected, it was registered a surplus of production as follows: +35.5% for wheat, +28.97% for barley, +35.48% for sunflower, +40% for rape and +210% for maize.

From Table 4, we may notice that in a good agricultural year, from the cultivated surfaces and protected by forest curtains the production gains have been the following ones: +29.69% for wheat, +23.25% for barley, +25.35% for sunflower, +30.21 % for rape and +29.05% for maize.

This experiment proved that both in an agricultural year which favor production and in a bad dry agricultural year, production performance is higher on the areas which are protected by agro-forest curtains [28].

Table 4. Productions by crop obtained in a good agricultural year from protected areas by forest curtains versus non protected area (kg)

Crop	Production obtained from the unprotected plots (kg) Control variant=CV kg	Production obtained from the plots protected by forest curtains (kg) Experimental variant= EV kg	Difference of production	
			EV-CV (kg)	EV/CV x 100 (%)
Wheat	5,860	7,600	+1,740	129.69
Barley	6,020	7,420	+1,400	123.25
Sunflower	2,840	3,560	+720	125.35
Rape	2,780	3,620	+840	130.21
Maize	5,920	7,640	+1,720	129.05

Source: Own results at Sport Agra Ltd Amzacea [28].

In 2021, it started to be implemented a project *AGREEN Cross-Border Alliance for Climate - Smart and Green Agriculture in the Black Sea Basin*, Subsidy Contract No. BSB 1135 financed by the EU, the Joint Operational Program for Cross-Border Cooperation under the European Neighbourhood Instrument "Black Sea Basin 2014-2020", under Priority 1.2 "Increasing cross-border opportunities for trade and modernization of agriculture and related sectors".

The project goal is "to build capacities for networking and transnational knowledge transfer, the development of smart agriculture and climate in the Black Sea basin, in order to increase trade opportunities, economic and social performance of the sector as a driver of development in the Black Sea basin" and the partners, who joined forces in running this project, are educational and institutions, administrative institutions, and agribusiness companies: Dobrudzha School of Agriculture and Business (BG), Ovidius University of Constanța (RO), Tekirdag Namik Kemal University (TR), International Center for Agricultural

Research and Education (RA), Business Support Organization - ELKANA (GE) and Eastern Thessaloniki (GR) Development Agency.

In this project are involved 6 counties from Romania: Constanta, Tulcea, Braila, Galati, Buzau and Vrancea [2].

In South Oltenia, a region also deeply affected by drought, in Dolj county, where sandy soils cover 100,000 ha, year by year the surface covered by sand is by 1,000 ha higher because the forest area decreased to 7% instead of 12% as it was 50 years ago.

Therefore, the installation of forest curtains is compulsory to protect the land and sustain production [20].

In the period 2006-2022, in Segarcea area, Cerealcom Dolj Ltd. started to plant agro-forest curtains, accounting at present for a surface of 600 ha [7].

Conclusions

(1). This research showed the importance of agro-forest curtains for protecting agricultural crops and increasing productivity in terms of yield and production.

(2). In order to combat the climate change and protect the soils from the Eastern part of Romania and also from the Romanian Plain it is needed to be developed a project destined to plant agro-forest curtains from Vama veche to Beba Veche.

(3). Romsilva will have the task to ensure the biological material (seedlings) from the suitable tree species adapted to each the geographical area and this has to be done together with ICAS- Research Institute for Forestry Arrangements.

(4). All the plans carried out in the period 2006-2008 in Romania were achieved from the own financial resources of the agricultural producers.

(5). The provisions of the Law 289/2002 regarding the establishment of forest curtains have not been fulfilled.

R E F E R E N C E S

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