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YIELDS IN IRRIGATED AND NON-IRRIGATED SYSTEMS. CASE STUDY BRAILA COUNTY

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Abstract

The climate changes represent constraining factors for crops growth and development. The progressive warming of the atmosphere, resulting from the synergic action of several natural and anthropic factors, has contributed to the diminution of rainfall at soil level. The irrigation of crops, a technique by which the soil is directly supplied with a supplementary water input, besides the water received naturally, is absolutely necessary in the conditions of arid weather. The present study refers to the influence of the climate changes and the need for irrigations in Braila county, a county with a high agricultural potential, but also to the yields obtained on the main crops in irrigated and non-irrigated systems. In the period 2006-2015, the effective utilization of agricultural areas equipped with irrigation systems was maximum 33%, while in the years 2006 and 2010 respectively, the utilization degree was under 15%. In all the investigated crops, the average yields per hectare obtained under irrigated system were higher than those obtained under non-irrigated system.

***Key words*:** climate, irrigations, yields, Braila county

INTRODUCTION

Irrigations create favourable conditions for the growth and development of crops, ensuring better and more stable crop harvests, regardless of the natural rainfall and temperature conditions.

In the droughty regions, mainly those subject to the so-called desertification phenomenon, the water consumption of crops is higher than the water quantity stored in soil, and most crops cannot manage in the absence of water.

In the current context marked by deeper climate change „the use of irrigation in agriculture is not only an option, but a necessity to ensure a higher yield of agricultural products" [1], such as "irrigation is a great efficiency measure, by the help of which it can influence the level, the constant and quality of the crops" [6].

The main goal of the hydro-meliorative developments for agriculture and land reclamation works is the preservation and improvement of agricultural land quality. The land reclamation works contribute to the removal of the negative effects of extreme weather phenomena (drought, moisture excess) „have a favourable impact upon the environment by the diminishing the drought risk and aridization control" [5] and to the prevention of soil degradation due to soil erosion. By damming up, drainage and erosion control works, the respective land areas can be used for farming purposes, and the first effect is the increase of the arable land area.

Romania's south-eastern area, where Braila county is located, is subject to significant climate change risk, its effect being reflected in the modifications of temperature and rainfall volume, this contributing to the limitation of the opportunities for economic development, despite the existing agricultural potential.

In order to characterize the climate of a region is necessary to describe the multiannual regime of all the weather elements, in strong connection with the influence of the physical-geographical changing factors

The spatial distribution of Martonne aridity index values on the territory of Romania has been the subject of several researchers' studies [2]; [3]; [4].

MATERIALS AND METHODS

The methodology included the statistical analysis of primary data, using the Excel quantitative analysis software as working tool. The statistical data on which the analysis was based were at the level of Braila county and had the following sources: i) NIS statistical data available on-line – www.tempo-online; ii) statistical data of the Environment Protection Agency Braila, available online – www.apm.braila.ro; iii) statistical data supplied by DADR Brăila and iv) other official data sources.

In order to highlight the continental type of climate variation degree, as well as the need to use hydro-meliorative measures in Braila county, in the period 2006-2015, the aridity index (Em de Martonne) was calculated according to the formula: $I_{ar} = P/T+10$, where P = annual average rainfall, T = annual average temperatures, to which 10 points have been added in order to avoid negative values.

The irrigation system performance in Braila county was analyzed by the calculation of its utilization degree, in the period 2006-2015.

In order to highlight the differences in yields between the crops grown under irrigated and non-irrigated system, on the basis of the official data from DADR Brăila referring to cultivated areas and productions obtained in wheat, maize, barley, two-row barley and sunflower, the average yields obtained under both systems were calculated.

RESULTS AND DISCUSSIONS

Brăila county, located in the eastern part of the Romanian Plain, has two relief units in its componency, namely plain (51%) and river meadow (49%). The low rainfall and non-uniform rainfall distribution result in a water input under the drought limit throughout the vegetation period, mainly in the months of July and August. There are torrential rains in summer time, sometimes with hail, leading to crop damage on extended areas. In the summer time there are also long periods of drought (60-90 days).

The annual rainfall was under the optimum threshold for the development of crops (450 mm) in four out of the ten years of the investigated period (Table 1).

Table 1. The multi-annual average quantity (1975 – 2000) and the annual quantity of rainfalls in the period 2006 – 2015 in Braila county – mm

1975-2000 average	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
425.	350.	478.	338.	420.	653.	356.	633.	491.	479.	525.

Source: Agency for Environmental Protection Brăila, Annual reports regarding environmental state for Braila county, 2009-2015

The aridity index, which reflects the variation degree of the continental climate type and of the weather conditions favourability for the green cover was largely below 22, which is a value characteristic for the maximum aridity areas (Table 2).

Table 2. The aridity index at Braila county level, in the period 2006-2015

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Aridity index	16.5	21.3	15.2	19.1	30.2	16.7	29.8	23.5	21.9	23.6

Source: own calculations after the Em de Martonne method

In the periods when the annual rainfall is low and cannot contribute to obtaining high yields, the water deficit must be covered by irrigations. The irrigation utilization represents the indispensable hydro-technical measure, under the conditions of arid and droughty weather in Braila county.

The arable land prevailed in the agricultural land structure in Braila county, accounting for 90%; the arable land area was by 2,381 ha larger in the year 2015 compared to that in the year 2006, which was mainly due to the diminution of areas under orchards and vineyards (Table 3).

In the year 2015, the non-agricultural land in Braila county was smaller by 1,811 ha compared to that in the year 2006, due to the drastic diminution of areas under waters and ponds.

The hydro-melioration system of Braila county was organized into two administration units and one zonal system: Administration Unit North Brăila, Administration Unit South Braila and the zonal system Big Island of Braila.

Table 3. The lands' utilization structure in the period 2015 opposed to 2006, in Braila county – ha

	2006	2015	2015 vs 2006
Agricultural, of which:	388,100	389,907	1,807
- arable	349,401	351,782	2,381
- pastures	33,144	33,151	7
- vineyards and orchards	5,555	4,287	-1,268
Nonagricultural, of which:	88,476	86,665	-1,811
- forests and other forest vegetation	27,919	30,047	2,128
- waters and ponds	32,662	26,417	-6,245
- constructions	12,297	14,094	1,797
- communication and rail ways	8,490	8,136	-354
- degraded and unproductive lands	7,108	7,971	863

Source: Own calculations after data supplied by ARDD Brăila, March 2017

The irrigation and drainage works were distributed by 13 hydro-meliorative developments, with a total area equipped with irrigation facilities of 357,488 ha as well as areas equipped with drainage facilities, out of which 226,331 ha for pumping and 41,769 ha for drainage (Table 4).

Table 4. The agricultural settled area in Braila county, in 2015

	Agricultural arranged area ha	No. IWUO	Agricultural area contracted for irrigations by IWUO ha
Total, of which :	357,488	113	91,549
North Braila Terrace	122,338	43	28,627
South Braila Terrace	170,489	57	14,401
The Big Island of Braila	64,661	3	48,521

Source: MARD, The National Register of Land Improvement Organization, July, 3 2015

South Braila Terrace had the largest area equipped with irrigation facilities, accounting for 48% of total area, followed by North Braila Terrace, with 34%, while the remaining 18% was represented by the zonal system the Big Island of Braila.

In the year 2015, 113 Irrigation Water Utilizers Organizations (IWUO) operated in Brăila county, which contracted to irrigate only 25.6% of the agricultural area equipped with irrigation facilities at county level.

The zonal system the Big Island of Braila, although with the smallest number of IWUOs, these had signed contracts to irrigate over 75% of the agricultural area equipped for irrigation of the respective system.

The most important parameter for the irrigation system performance is its utilization degree. In the period 2006-2015, the effective utilization degree of the agricultural areas equipped with irrigation systems was maximum 33%, and a utilization degree under 15% could be also noticed, in the years 2006 şi 2010 (Fig. 1).

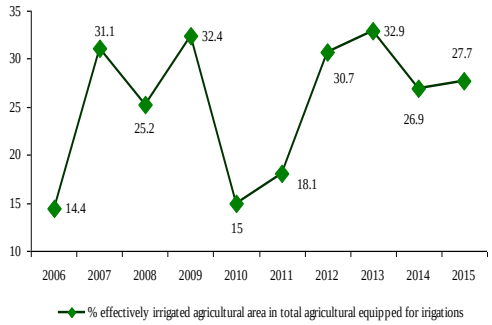

Fig. 1. Evolution of effective utilization degree of areas equipped with irrigation systems
Source: own calculations

There are significant variations of the effectively irrigated agricultural areas, in Braila county, from year to year, and these can be partially explained by the environmental conditions; but at the same time, they are also conditioned by the access to irrigation subsidies.

Throughout the investigated period, over 92% of the cultivated areas in the county were covered by two great categories of crops: grain cereals and oilseeds. For instance, in the year 2010, the grain cereals were cultivated on 60.2% and the oilseeds on 32.2% of total cultivated areas, while in the year 2015 the cereals were grown on 58.1% and the oilseeds on 34.4% of total cultivated areas. The high share of areas under cereals is specific for the extensive farming practice (Fig. 2).

Among the grain cereals, three crops were cultivated on the largest areas: maize grain, wheat and rye, barley and two-row-barley; among the oil crops, the largest areas were cultivated with three crops: sunflower, rapeseed and soybean.

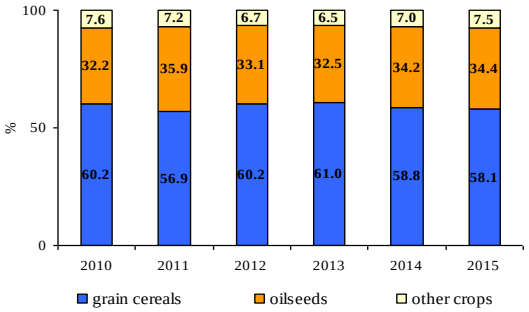

Fig. 2. Share of areas under grain cereals and oilseeds in total cultivated area
Source: NIS, data base www.tempoonline

On the basis of ARDD Brăila data referring to the evolution of cultivated areas and total productions, under irrigated and non-irrigated system, which were available only for the period 2010-2015 and only for the crops maize grain, wheat, barley, two-row barley and sunflower, we calculated the obtained average yields.

The differences between the yields per hectare under irrigated system and the yields under non-irrigated system were maximum 2 t/ha in wheat (2015), 1.8 t/ha in barley, 1.6 t/ha in two-row-barley (2015), 3.4 t/ha in maize (2012) and 1.4 t/ha in sunflower (2011).

In the whole investigated period, the yields per hectare were higher in all the five crops when the crops were irrigated.

However, in certain crops, the potential average yield of the area was not achieved.

(a)In non-irrigated wheat, only in the years 2011, 2013 and 2014 the average yields per hectare were higher than the potential average yield of the area for this crop, estimated at 4.2 t/ha; in irrigated wheat, in the whole analyzed period, the potential average yield of the area, estimated at 6 t/ha, was not reached.

(b)In non-irrigated barley, only in the years 2012 and 2014 the average yields reached the potential average yield of the area for this crop, estimated at 4.8 t/ha; in irrigated barley, in the whole analyzed period, the potential average yield of the area, estimated at 7.2 t/ha, was not reached.

c)In two-row barley, cultivated both under irrigated and non-irrigated system, the potential average yields of the area were not reached, estimated at 7.2 t/ha and 4.2 t/ha respectively;

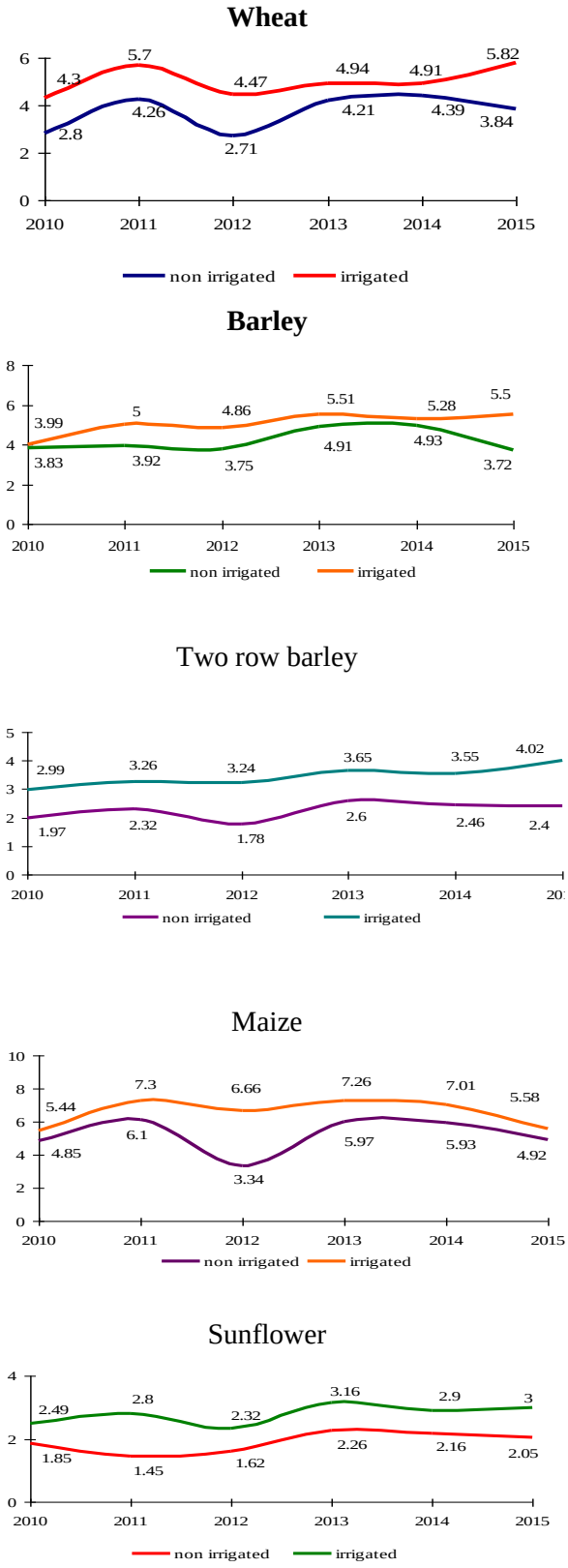

Fig. 3. The average yields obtained under irrigated and non-irrigated system in Braila county (t/ha)
Source: own calculations based on data supplied by ARDD Braila, march 2017

(d)In non-irrigated maize, except for the year 2012, the potential average yield of the area, estimated at 4.8 t/ha, was by far exceeded, in the whole investigated period; in irrigated maize, it is only in the years 2011 and 2012 that average yields per hectare were obtained that were higher than the potential average yield of the area, estimated at 7.2 t/ha;
(e)In non-irrigated sunflower, in three out of the six analyzed years, the obtained average yields were higher than the potential average yield of the area, estimated at 1.92 t/ha; in irrigated sunflower, also in three out of the six analyzed years, the average yields were higher than the potential average yield in the area, estimated at 2.64 t/ha.

CONCLUSIONS

In the period 2006-2015, in Braila county, there were years when the annual rainfall was under the optimum threshold for the development of crops, while the aridity index had values indicating great variations of continental climate degree. The water deficit in soil imposed irrigation utilization, as an absolutely necessary hydro-technical measure under arid and droughty climate conditions specific for Braila county. In the year 2015, over 91% of the county's agricultural area was equipped for irrigations, but the 113 IWUOs had signed contracts to irrigate only 25.6% of the land area equipped with irrgigation facilities.
In the period 2006-2015, the effective utilization of agricultural areas equipped with irrigation systems was maximum 33%, while in the years 2006 and 2010 respectively, the utilization degree was under 15%.
In the investigated period, the grain cereals prevailed in the crop structure, the largest areas being cultivated with wheat, maize, barley and two-row barley; the oil crops followed next, the largest areas being cultivated with sunflower. In all the investigated crops, the average yields per hectare obtained under irrigated system were higher than those obtained under non-irrigated system. It is worth mentioning that in certain crops, namely wheat, barley, maize and sunflower cultivated under non-irrigated system, average yields were obtained in certain years that were higher than the potential yields in the area for the respective crops. At the same time, even under irrigation system, the average yields obtained in wheat, barley. An exception was represented by the average yields obtained in irrigated maize in the years 2011 and 2012, when these exceeded the potential average yield of the area for this crop, as well as the average yields obtained in sunflower, which were higher than the potential average yield of the area for this crop, in the whole analyzed period.

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REFERENCES

[1]Florian, V., et al., 2013), Managementul apei pentru irigaţii, Ed.Academiei Române, Bucureşti
[2]Dumitraşcu, M., 2006, Modificări ale peisajului în Câmpia Olteniei, Ed.Academiei Române, Bucureşti
[3]Păltineanu, C., Mihăilescu, I., Secelanu, I., Dragotă, C., Vasenciuc, F., 2007, Using aridity indices to describe some climate and soil features in Eastern Europe: a Romanian case study, Theoretical and Applied Climatology, 90 (3-4), 263-274
[4]Prăvălie, R., 2013, Climate issues on aridity trends of Southern Oltenia in the last five decades, Geographia Tehnica, 1 70-79
[5]Sima, E., 2013, The Agro-Eco-System of an Area Equiped with Irrigation Facilities – Case Study: Braila Terrace, in Agricultural Economics and Rural Development Journal, Vol. 10(1):121, https://ideas.repec.org/a/iag/reviea/v10y2013i1p103-121.html, Accessed on June 13, 2017
[6]Sima, E., Tudor, M., Chitea, M., 2012, The Irrigation Water Users' Associations – Case Study: North Braila Terrace in Agricultural Economics and Rural Development Journal, Vol.9(2), p.264, https://ideas.repec.org/a/iag/reviea/v9y2012i2p263-278.html, Accessed August 25, 2017
[7]Agency for Environmental Protection Brăila, Annual reports regarding environmental state for Braila county, 2009-2015, www.apm.braila.ro, Accessed on August 5, 2017
[8]ARDD Braila, data provided on request
[9]NIS, data base available at www.tempoonline

[10]MARD, The National Register of Land Improvement Organization, July 2015, http://www.madr.ro/docs/, Accessed July 20, 2017