ASPECTS REGARDING THE ENERGETICALLY EFFICIENCY OF IRRIGATION OF SOME CROPS IN NORTH-EAST ROMANIA

D. Bucur[1], S. Cîmpeanu[2], C. Ailincăi[1], P. Konvalina [3], J. Moudry. [3]
[1] University of Agronomical Sciences and Veterinary Medicine, 3 Mihail Sadoveanu Alley, 700490, Iaşi România,
[2] University of Agronomical Sciences and Veterinary Medicine, Bd. Marasti nr.59, sector 1, Bucharest, Romania
[3] University of South Bohemia in České Budějovice, Czech Republic
E-mail: dbucur@uaiasi.ro

Abstract
On the basis of some registered information in three areas from Moldova, it was calculated the energy balance and the energetically efficiency of the applied irrigation on eight species of plants. The information's obtained proved that the irrigation process is efficient from the energetically point of view for all the field crops which have been seen in south droughty zone and this process is less efficient in central and moderate warm and moist zone. In the cool moist zone from northern, the irrigation process is efficient only in a few cultures. On the slope lands, where the cultures need more water, the energetically efficiency of the irrigation process is greater than on a plat field. The greatest values of the balance and energetically efficiency were obtained in sugar beet, followed by alfalfa, maize for grain or silage, potato, wheat and sunflower, on the last places coming soybean and bean. There reacted favourable to irrigation the sugar beet, followed by maize for grain or silage, sunflower, potato and wheat, in bean and soybean being registered an energy balance very reduced.

Key words: crops irrigations, water efficiency, sloping land

1. INTRODUCTION

Agriculture is a form of management of the countryside; it involves the largest surface and has strong influence on water regime. Irrigation will become the main water consumer in agriculture and one of the most important one on national scale, requiring, on the average, about 35 - 45 % of water resources from Romania. In the same time, the climate change is estimated at the international level, resulting in the increase of water requirements [1, 3]. Water deficiency and drought stress factors are the most important limiting factors of development of agriculture. For covering all these water requirements, it is necessary to use other unconventional resources [2].

2. MATERIAL AND METHODS

Based on our own research activity [1, 3], as well as on other studies [2] there were calculated both the yield gain obtained by irrigating different agricultural crops, expressed in Mcal, and the energy consumption for the irrigation of those crops. Using the obtained data, there were calculated the balance and the energetically efficiency of the irrigation on winter wheat, grain or silage maize, bean, soybean, alfalfa, sun-flower, potato, and sugar beet. The yields of those crops and the irrigation rates were registered during 1995 - 2010 and represent the average got in three climatic zones in Moldova: in the warm-draughty zone at Cosmesti, Galati county, mean warm subhumid at Podu-Iloaiei, Iasi county and chilly-humid at Suceava. The irrigation rates applied in these zones assured 38 - 68 % of the total water consumption of the different crops at Cosmesti, 14 - 30 % at Podu-Iloaiei and 12 - 23 % at Suceava. For calculating the energy consumption in crop irrigation (1 m^3 irrigation water - 0.395 Mcal and 590 Mcal/ha passive energy) and the energy value of the yield there were used data from the cited literature [4].

3. RESULTS AND DISCUSSION

Under climatic conditions in Moldova, the irrigation applied on plain land increased the yield in winter wheat, about 197 - 2156 kg/ha (Table 1). The greatest gain was obtained in Southern Moldova, at Cosmesti - Galati and smallest in Northern Moldova, at Suceava.

The average irrigation rates ranged between 840 - 1060 m^3/ha, being lower in North and higher in South. The energy balance obtained in wheat irrigation was of 2,353 Mcal/ha at Podu-lloaiei, Iasi county and 7209 Mcal/ha at Cosmesti, Galati county. At Suceava there were obtained negative values. The energetically efficiency was of 7.80 in South and 0.90 in North. So, there results that the winter wheat irrigation is not efficient, energetically, in the mean warm humid zone at Podu-lloaiei and highly efficient in the warm draughty zone at Cosmesti. On sloping land, where a part of the water resulted from precipitation's leaking on soil surface and can't be used by plants, the irrigation efficiency is higher. So, at Podu-Iloaiei the yield gain increased from 865 kg/ha on plain land, up to 1690 kg/ha on a sloping land (10 - 12 %) [1]. The energy balance increased from 2,353 Mcal/ha, up to 5735 Mcal/ha and the energetically efficiency increased from 3.44 up to 8.67.

The energy balance of irrigation of maize for grains, on plain land, ranged between 3935 and 17286 Mcal/ha. The energetically efficiency ranged between 4.44 and 11.59. The irrigation of maize of grains appears as efficient energetically, mainly in Southern Moldova, in the warm draughty zone and less in the other zones in the Central and Northern part. On a land having a 10 - 12 % slope, at Podu-Iloaiei, the yield gain obtained by irrigation maize reached 3090 kg/ha compared to 1295 kg/ha on plain land. The balance and the energetically efficiency, increased, too, from 3935 Mcal/ha and 4.44 on plain land, respectively, up to 11289 Mcal/ha and 14.65 on sloping land, respectively. The maize of silage, seeded on summer after harvesting the preceding plant at Cosmesti, Galati county and Podu-Iloaiei, Iasi county, reacted favourably to irrigation, registering some mean harvest gain of 17756 kg/ha and 3620 kg/ha, respectively (Table 1). The energetically efficiency was of 5.03 in the central part of Moldova and 15.36 in the Southern part. The silage maize irrigation appears efficient, energetically, both in the warm draughty zone and in the subhumid zone.

Observing the effect of irrigation on soybean crops in the Southern and Mid-Moldova, there was noticed that the yield gain obtained was only of 307 - 1326 kg/ha (Table 2), the irrigation rate being ranged between 1000 and 2450 m^3/ha. The balance and the energetically efficiency were of only 541 - 5032 Mcal/ha and 1.55 - 4.23. Energetically, the soybean crop irrigation is efficient only in the warm draughty zone in Southern Moldova, at Cosmesti-Galati

Table 1. The balance and the energetically efficiency got on irrigation in wheat and maize for grains or silage in some zones of Moldova (1995 - 2010)

Locality	Plain or sloping land	Average yield gain got by irrigation		Average irrigation rate (m^3/ha)	Energy consumption for irrigation Mcal/ha	Energy balance Mcal/ha	Energetically efficiency
		Kg/ha	Mcal/ha				
Winter wheat							
Cosmesti	Plain	2156	8269	1190	1060	7209	7.80
P. Iloaiei	Plain	865	3318	950	965	2353	3.44
	Slope	1690	6483	400	748	5735	8.67
Suceava	Plain	197	756	710	840	-84	0.90
Maize grains							
Cosmesti	Plain	4825	18919	2640	1633	17286	11.59
P. Iloaiei	Slope	1295	5078	1400	1143	3935	4.44
	Slope	3090	12116	600	827	11289	14.65
Suceava	Plain	1968	7717	800	906	6811	8.52
Maize silage							
Cosmesti	Plain	17756	18468	1550	1202	17266	15.36
P. Iloaiei	Plain	3620	3765	400	748	3017	5.03

Table 2. The balance and the energetic efficiency of irrigation of some crops in different zones of Moldova

Locality	Average yield gain got by irrigation		Average irrigation rate (m^3/ha)	Energy consumption for irrigation Mcal/ha	Energy balance Mcal/ha	Energetically efficiency
	Kg/ha	Mcal/ha				
Bean						
Cosmesti	970	3790	1360	1127	2663	3,36
P. Iloaiei	260	1016	400	748	268	1,36
Suceava	205	801	420	756	45	1,06
Soybean						
Cosmesti	1326	6590	2450	1558	5032	4,23
P. Iloaiei	307	1526	1000	985	541	1,55
Alfalfa						
Cosmesti	41600	34112	3600	2012	32100	16,95
P. Iloaiei	8830	7241	1500	1183	6058	6,12
Suceava	8210	6732	1100	1025	5707	6,57
Sunflower						
Cosmesti	1420	8036	2350	1518	6518	5,29
P. Iloaiei	680	3848	1100	1025	2823	3,75
Potato						
Cosmesti	12960	10783	1950	1360	9423	7,93
P. Iloaiei	4100	3411	950	965	2446	3,53
Suceava	3500	2912	600	827	2085	3,52
Sugar beet						
Cosmesti	41200	40376	2950	1755	38621	23,00
P. Iloaiei	8100	7938	1350	1123	6815	7,07
Suceava	5150	5047	900	946	4101	5,34

The alfalfa covers significant areas in Moldova, the irrigation of this crop assuring yield gains higher in the Southern part, reaching the average of 34112 kg g.m./ha and lower in the Northern and Central part, where there was only 8210 - 8830 kg/ha (Table 2). The balance and the energetically efficiency of irrigation were very high in South, up to 38621 Mcal/ha and 23.00, respectively and somehow lower in the Central and Northern part, registering values of 5707 - 6058 Mcal/ha and 6.57 - 6.12, respectively.

The irrigation of potato crops influenced favourably the yield of tubercles especially in South Moldova, where there reached a mean yield gain of 10783 kg/ha. In the Central and Northern part, the gains obtained were of 3411 kg/ha and 2912 kg/ha, respectively (Table 2). The average irrigation rate increased from North to South, from 600 m^3/ha to 950 m^3/ha. The balance and the energetic efficiency of irrigation registered relative by high values at Cosmesti - 9423 Mcal/ha and 7.93, respectively and lower values at Podu-Iloaiei and Suceava.

Sugar beet finds conditions favourable for vegetation in Moldova, but its irrigation increased the yield about 38621 kg/ha at Cosmesti, 6815 kg/ha at Podu-Iloaiei and 4101 kg/ha at Suceava (Table 2). The irrigation rate was very low in North - 900 m^3/ha and relatively high in South - 2950 m^3/ha. Like in the above mentioned crops, in sugar beet, the balance and the energetically efficiency of irrigation were higher in the warm draughty zone in South, having mean values of 38621 Mcal/ha and 23.00, respectively and relatively low values, of 4101 - 6815 Mcal/ha and 5.34 - 7.07, respectively, in the chilly humid and mean warm subhumid zones in the Central and North Moldova.

Analysing the energy balance of irrigation applied on different agricultural crops in the three zones of Moldova, there are registered some very evident differences. In the warm draughty zone, at Cosmesti- Galati, there was registered high-energy balance, at most of the studies species. There are remarked the sugar

beet, alfalfa, grain/silage maize, potato, wheat and sun flower crops.
In the mean warm subhumid zone, at Podu-Iloaiei - Iasi, the energy balance got registered lower values. The greatest values being registered in sugar beet, alfalfa, grain/silage maize, sunflower and potato.
The irrigation applied in the chilly humid zone, at Suceava, is efficient energetically only in grain maize, alfalfa, sugar beet and potato.

4. CONCLUSIONS

1. The efficiency of the irrigation of some crop in a certain pedoclimatic zone can be estimated if there are taken into account the balance and the energetically efficiency obtained.

2. In Southern Moldova, at Cosmesti-Galati county, in the warm draughty zone, the irrigation proved to be very efficient energetically for all crops. The greatest values of the balance and energetically efficiency were obtained in sugar beet, followed by alfalfa, maize for grain or silage, potato, wheat and sunflower, on the last places coming soybean and bean.

3. In the mean warm subhumid zone, at Podu-Iloaiei, Iasi county, the irrigation is less efficient energetically. The balance and the energetically efficiency registered here some lower values. There reacted favourable to irrigation the sugar beet, followed by maize for grain or silage, sunflower, potato and wheat, in bean and soybean being registered an energy balance very reduced.

4. On sloping land, due to the higher deficiency of water in soil, the balance and the energetically efficiency got in crop irrigation registered higher values than on plain land.

5. The irrigation of agricultural crops in the chilly humid zone in Northern Moldova, at Suceava, is efficient energetically in maize for grains, alfalfa, potato and sugar beet.

5. REFERENCES

[1] English, M. and Raja, S.N. 1996. Perspectives on deficit irrigation. Agricultural Water Management **32**:1-14.
[2] Geerts, S. and Raes, D. 2009. Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. Agricultural Water Management **96**(11):1652-1658.
[3] Rieul, L. and Ruelle, P. 2003. Irrigation - Guide Pratique. Cemagref.
[4] Teşu I., Baghinschi V., 1983 - Energia şi agricultura, Editura Ceres, Bucureşti