Carpathian Journal of Earth and Environmental Sciences, August 2015, Vol. 10, No 3, p. 91 - 100

# FARM STRUCTURE ADJUSTMENTS UNDER THE IRRIGATION SYSTEMS REHABILITATION IN THE SOUTHERN PLAIN OF ROMANIA: A FIRST STEP TOWARDS SUSTAINABLE DEVELOPMENT

**Marioara RUSU[1] & Gabriel SIMION[2]**

[1]*Institute of Agricultural Economics, Romanian Academy, Bucharest, rusu.marioara@gmail.com*
[2]*Faculty of Geography, University of Bucharest, gabriel.simion@umec.geo.unibuc.ro*

**Abstract:** During the socialist period, Romania has made significant investments in irrigation that extended the land with irrigation facilities to 3.2 million hectares, which represent over 20% of the agricultural land and one third of the arable land. After the collapse of the socialist regime, in 1989, large components of the irrigation infrastructure have been destroyed. As a consequence, today, only 15.3% of the land areas equipped with irrigation facilities are occupied by the economically viable systems. In the southern part of Romania, in the Romanian Plain, there is a need for irrigations, as drought, which is quite a frequent phenomenon here, has resulted in losses for the agricultural sector. Land reform led to the emergence of a very large number of small-sized farms. The irrigation systems that were mainly developed in the 1970s, meant to serve the large-sized farms, proved to be oversized and impossibly to be operated in the new conditions. This paper investigates the main results on the agriculture following the rehabilitation of the five irrigation systems: Sadova–Corabia, Nicoreşti–Tecuci, Viziru Terrace, Brăila Terrace and Covurlui Plain. The main conclusions reveal that the irrigation systems rehabilitation was positive for development of competitive/intensive agriculture: land consolidation, growth of cultivated areas, increasing share of crops with high economic value and high agricultural productivity.

**Keywords:** Climate change, irrigation systems, rehabilitation, farm structure, sustainable development, Romanian Plain

## 1. INTRODUCTION

Using irrigation systems in order to improve agricultural outputs represents a demand in the context of climate change registered over the last decades (Cook et al., 2015; Mishra et al., 2011; Zhu et al., 2015).

During the socialist period, Romania has invested constantly in the irrigation systems as a part of agricultural infrastructure. The area equipped for irrigation has expanded from 42 400 hectares in 1950 to 3.2 million hectares in 1989. Romania is ranked first among the European countries, having the largest area equipped for irrigation (Popescu, 2001).

The large irrigation systems were built to serve the large-sized farms – the cooperative farms and the state farms. These forms of organization of production were dominant and characterized by a high concentration of land: in 1989, the average size of a farm state was of 5 012 ha and a cooperative farm was of 2 557 ha in surface. These two types of farms cultivated 91.4% of the agricultural area of the country. The private sector was represented by the individual farms which cultivated merely 8.6% of the agricultural land, especially prevalent in the hill and mountain areas (Rusu, 2000). Irrigation systems that have served these farms were excessive energy consumers, water was pumped from downstream to upstream, but in the socialist period, low attention was paid to energy costs. In 1989, Romania had 375 large hydrotechnical systems for the irrigation of crops, which covered an area of about 3.2 million hectares (MAA, 1998).

After the collapse of the socialist regime, in 1989, large components of the irrigation systems infrastructure have been destroyed. Moreover, the irrigation sector has been over a continuous transition and adaptive processes, in the context where Romanian agriculture made the transition from the socialist planned economy to the market-oriented economy and

EU integration (Sabates-Wheeler, 2001). Since 1989, large farms from the communist period were sprayed by the constitution and reconstitution of land property rights. According to the Farm structure survey, conducted by the National Institute of Statistics, over 3.6 million farms operated 13.06 million hectares of utilized agricultural area, in 2013.

Today, the agriculture sector is characterized by a significant share of individual farms (99.23%) operating more than half of the utilized agricultural area (55.69%). The average size of these farms is very small (2.02 ha). Elderly farmers, deprived of agricultural training, run most of these small and very small farms. In this case, the application of modern production technologies (including irrigation) and efficient management practices are an elusive goal. However, in order to mitigate the difficulties caused by the small size farms and plots, land lease is practiced, especially in the plain area. Thus, from the total of utilized agricultural land, 27.35% is represented by rented land. This mode of operation is a convenient alternative for owners who cannot work the land (owners who do not live in rural areas or elderly people). In this way it is favored the organization and operation of large farms.

In the context of the presence of a significant number of small farms, the existing irrigation systems tend to be oversized and very difficult – if not impossible – to be operated efficiently. Their use became incompatible with the small landowners, which replaced the former large farms with an optimal land area for irrigation. For instance, while before 1989, at an irrigation plot of 750 ha there were two beneficiaries at most, after the enforcement of the land laws, the number of beneficiaries increased to three hundred, making the relation between the water supplier and farmers almost impossible to achieve. As a result, 584 projects under implementation before 1989 were abandoned (206 objectives were definitively stopped and 378 objectives were temporarily stopped) and it led to massive deterioration and even thefts throughout the years (MAA, 1998).

In this context, several studies were focused on quantifying the sustainable irrigated areas. A first study had as main result that about 50% of the 3.2 million hectares of land with irrigation systems can be considered economically sustainable, taking account of the complementary character of irrigation, the altitude were there are located the majority of the systems and the low level of irrigation use in agriculture.

A second study, from 2009, conducted for the Ministry of Agriculture, Forests and Rural Development and the World Bank (Report: Irrigation Rehabilitation and Reform Project), argued that from the entire area with irrigation systems, only 451 549 hectares (15.3%) can be considered viable; 12.3% represent irrigated systems and subsystems by pumping, which are marginally viable; and 72.4% are economically unsustainable irrigated systems and subsystems by pumping.

Some papers about the Romanian irrigation sector underlined its extensive character, unrelated with the available financial and material resources. Although, primarily, the construction of the irrigation system has modern concepts, its execution and operation have suffered a series of qualitative shortcomings (Grumeza & Kleps, 2005).

During 2007 and 2013, both total area and agricultural area equipped with irrigation systems had relatively constant values, but the effectively irrigated agricultural area had extremely low shares compared to the agricultural area with irrigation facilities: a minimum of 2.7% in 2010 and a maximum of 10.5% in 2007. Compared to 2007, the effectively irrigated area was down with 56.5% in 2013 (Table 1). A number of legislative, institutional, technical and economic factors determined a significant decreasing of irrigated areas, among which the most important are: 1) dismantling of large-sized farms structures due to land reform implementation; 2) infrastructure damage by destruction, theft, wear-and-tear and obsolescence, abandon, lack of interest of the local authorities and land owners; 3) the increase of water fees and lack of access to funding made millions of farmers to be in the impossibility to irrigate; 4) lack of knowledge of small farmers about the economic advantages of irrigated agriculture; 5) presence of a significant deficit of specific watering equipment to the small-sized farms; 6) lack of correlation between irrigation rehabilitation activities and real water demand at hydrotechnical system level; 7) delay in establishing water users' associations (MAFRD & World Bank, 2009, Report: Irrigation System Rehabilitation and Reform Project).

Romania was not an isolated case; a similar decreasing in irrigated areas took place in most Central and Eastern European Countries (CEEC). For example, before 1989, in Bulgaria, there was an irrigated area of 1.25 million ha but after the implementation of land reform it decreased to 40 000 ha; while in Poland, from 3.2 million hectares to 83 000 hectares (Zhovtonog et al., 2005).

The main causes that have contributed to decreasing the use of irrigation systems in CEEC, were mainly related to inadequate implementation of land laws. Changes in land ownership led to a significant decrease of irrigated areas due to the low interest of farmers for land improvements, caused by the lack of own funds and lack of stimulating policies for funding such actions.

Table 1. Evolution of areas equipped with irrigation facilities and the effectively irrigated area, 2007–2013

| | Units | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|
| Total area equipped for irrigation | ha | 3 155 883 | 3 157 041 | 3 157 041 | 3 153 644 | 3 148 882 | 3 148 882 | 3 149 111 |
| Agricultural area equipped for irrigation | ha | 3 057 047 | 3 058 136 | 3 056 877 | 3 052 865 | 3 047 460 | 3 046 341 | 3 045 966 |
| % of agricultural area in total area equipped for irrigation | % | 96.9 | 96.9 | 96.9 | 96.7 | 97.0 | 96.8 | 96.7 |
| Agricultural area equipped for irrigation actually irrigated | ha | 320 243 | 257 666 | 296 750 | 83 322 | 103.295 | 165 355 | 180 931 |
| % of actually irrigated agricultural area in the agricultural area equipped for irrigation | % | 10.5 | 8.4 | 9.7 | 2.7 | 3.4 | 5.4 | 5.9 |

Source: authors' processing of National Institute of Statistics data, Tempo-Online Database, January 2015

In addition, during the dismantling of agricultural production cooperatives there were created many thefts and damages of equipments for irrigation systems. Another cause was favoured by the lower state funds allocated for land improvements (Constantin & Ciobanu, 2011).

Our study was conducted in the Romanian Plain, which lies in the southern part of Romania. This is a fertile plain region where soils are rich in humus prevail. The specific dryness of this plain is a consequence of both low rainfall and high evapotranspiration values. The entire plain suffers from moisture deficit (Marin et al., 2014). The aridity index – as a synthesis indicator that reveals the water deficit level in a given area – is at a high value, which increases the risk of drought and desertification. Furthermore, climate change scenarios show that in Romania an average warming of 2.0-5.0°C is foreseen for the period 2029-2099. For the southern part of the country, the forecast is even more pessimistic: the maximum temperature average in summer time might increase by 5.0-6.0°C, while in the case of the rainfall regime the negative deviations might exceed 20% (IPCC, 2007, Climate change 2007. Synthesis Report).

The current climate regime and the forecasted climate changes will have a negative impact on farm production and the economic development of the region, taking account that the current living standard of the of rural population is characterized by a high poverty level. Agricultural employment/dependence on agriculture is considered as one of the most important causes of this situation. In the rural economy, the share of agriculture is 60.5%, while the European Union (EU) share is only 14.1%. This structure of the Romanian rural economy also determines a similar distribution of the employed rural population by activity sectors: the primary sector, 64.2% (agriculture 56.6%); the secondary sector, 18.5%; and the tertiary sector, 17.3%; as stated in the National strategic framework for sustainable development of agri-food sector and rural space during 2014–2020–2030, by the Presidential Commision for public policies for development of agriculture (2013).

The sustainable development of rural economy becomes debatable, as long as the Romanian agriculture performance has low values compared to those in the EU. Moreover, in the EU, the economic crisis led to lower farm incomes, and the rising unemployment in rural areas, factors that negatively influenced the outlook for sustainable rural development. In this context, for the period 2010–2020, the European Commission (2010) proposed the "The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future", which provides the reorientation of policy objectives, such as the European rural sector to become more dynamic, more competitive and more efficient, contributing to economic recovery by stimulating economic growth, social inclusion and sustainable and smart development.

The main objective of this paper is to analyze the changes produced in the agricultural structure – number and size of agricultural holdings; cultivated area; crops structure and agricultural productivity – following the rehabilitation of five irrigation systems (Sadova–Corabia; Nicoreşti–Tecuci; Viziru Terrace; Brăila Terrace; and Covurlui Plain), located in the southern Romania (Fig. 1). The rehabilitation took place between 2007 and 2011 and it followed the international trend of increased interest in the rehabilitation and modernization of irrigation works.

The International Commission on Irrigation and Drainage makes a difference between rehabilitation and modernization, as stated in the FAO report: Modernization of irrigation schemes: past experiences and future options (1997). Modernization assumes the improvement of irrigation facilities in order to obtain higher parameters compared to previous ones, while rehabilitation refers to the works that bring the deteriorated irrigation facilities to the initial parameters. The objectives of rehabilitation and modernization are related with three directions, namely: technical (referring to intensive and efficient use of soil and water resources); economic and financial (profitability of irrigation facilities); and social focus (local and regional development).

## 2. MATERIAL AND METHODS

### 2.1. Study area

The analysis was done both at the rehabilitated area level and at the level of each five irrigation systems. The rehabilitated area is located in the Romanian Plain and, administratively, it covers different areas in the counties of Galaţi, Dolj, Olt and Brăila. The entire area of the five systems is of 166 847 ha, out of which only 61% have been rehabilitated (101 363 ha). The total rehabilitated area of each system has different shares: Covurlui Plain System has the highest share – 100%, while the lowest share is in Brăila Terrace – 40% (Table 2). Large differences are also related to the number of farms. There are 14 105 farms in the region, of which 57.6% are located in the Sadova–Corabia System.

These five systems were the beneficiaries of the main infrastructure rehabilitation actions through the Irrigation Rehabilitation and Reform Project, which had two components: 1) main infrastructure rehabilitation and 2) investment expenses coverage (water supply network rehabilitation, irrigation equipment, soil water measuring devices, transport systems, etc.) of the Irrigation Water Users' Organizations.

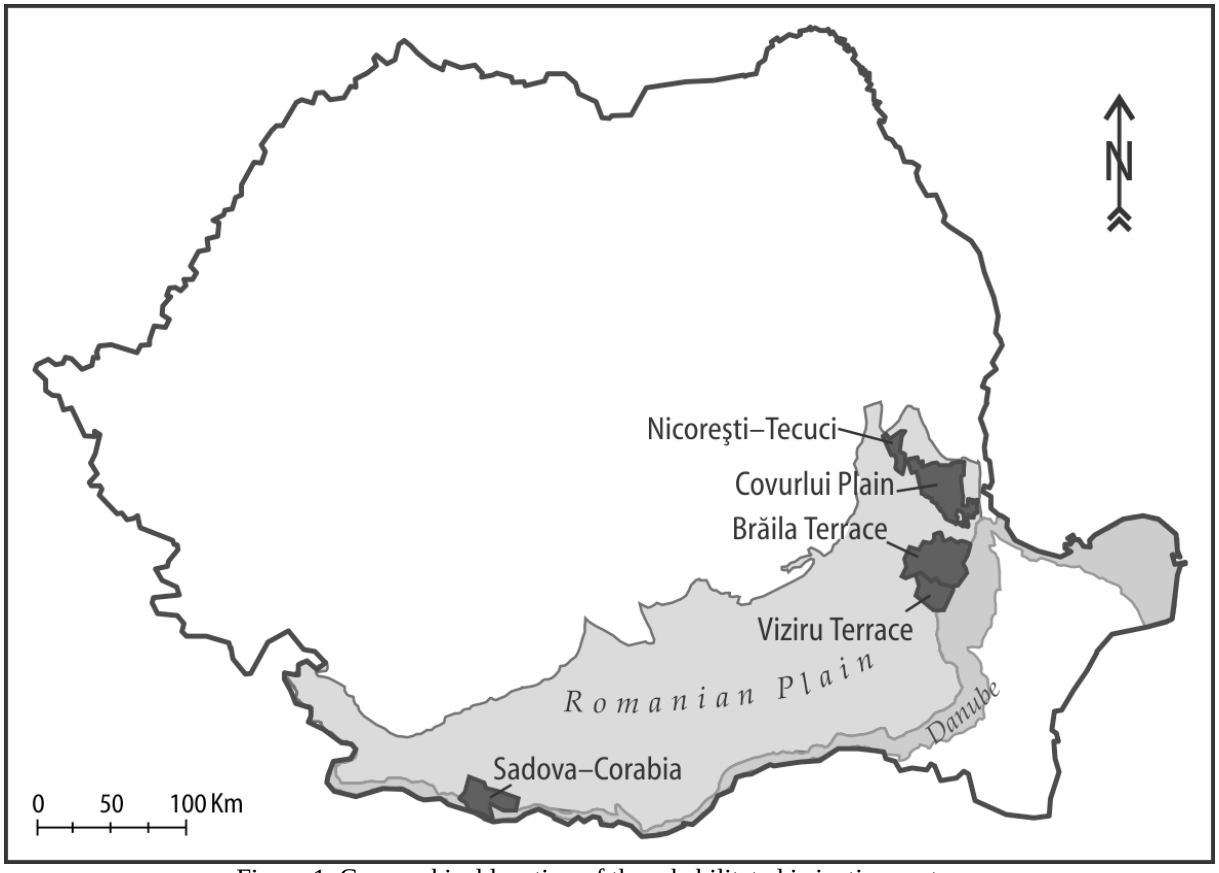

Figure 1. Geographical location of the rehabilitated irrigation systems

Table 2. Rehabilitated area – general information

| Irrigation system | Number of farms | Total area (ha) | Rehabilitated area (ha) | Share of rehabilitated area (%) |
|---|---|---|---|---|
| Sadova Corabia | 8 128 | 74 443 | 40 310 | 54 |
| Nicoreşti Tecuci | 2 090 | 16 596 | 11 149 | 67 |
| Brăila Terrace | 1 363 | 22 300 | 8 865 | 40 |
| Viziru Terrace | 702 | 32 669 | 20 200 | 61 |
| Covurlui Plain | 1 822 | 20 839 | 20 839 | 100 |
| *Rehabilitated area* | *14 105* | *166 847* | *101 363* | *61* |

Source: authors' processing of data from Management Unit of Irrigation Rehabilitation and Reform Project, 2012

### 2.2. Data and methods

The statistical data on which the analysis was based covered the period 2007–2013 and it came mainly from the following sources: 1) National Institute of Statistics (NIS) – for statistical data at national and county level, and 2) statistical data/information from the National Agency for Payments in Agriculture (NAPA) – for the crops structure and farms structure. The lack of official data at national level, which target a series of important aspects related to the irrigation sector – cultivated area, total production, average yields, consumption of inputs, etc., by irrigated and non-irrigated areas separately – represented a main limitation in the structuring of our work.

The following dimensions were analyzed in this paper: the number of farms and the average farm size, the structure of cultivated areas, the share of high value crops (HVC) and the agricultural productivity. At the same time, we must mention that the analyzed period (2007-2011) represents a very short interval for making an accurate evaluation of the impact of the irrigation system rehabilitation on agricultural structures. Moreover, the changes of agricultural structure and productivity are not limited only by the use of irrigations.

The influence of natural factors, mainly weather and soil type cannot be overlooked either. Likewise, the evaluation achieved in this work could present a number of limitations related to: the reduced capacity of farmers to maintain and modernize the irrigation systems; a certain degree of mismatch between the typology of farm irrigation facilities and the requirements of the users; the existence of an insufficient number of farmers who have the required organizational, financial and technical capacity for practicing irrigated agriculture; the adoption of proper crop irrigation structures, etc.

We consider that our analysis reveals only early directions while the results in this sector will be seen in time.

## 3. RESULTS AND DISCUSSION

The analysis uses a series of indicators that shows the positive trends of agricultural structures in the areas with rehabilitated irrigation systems. The significant number of farms (14 105) operating in the rehabilitated area raises administration and management challenges in the irrigation activity. If we consider that the agricultural land of the farms is also divided into several parcels, there are problems of cadaster and identification of land properties, and, while farmers have a low association spirit, we can see the negative implications upon the management of the crop irrigation activities.

In the rehabilitated area, we can notice the decreasing rate of the farms number (Fig. 2). In 2011 compared with 2007 there were by 11.48 % fewer farms. The same tendency ruls in the rehabilitated irrigation systems as well: Viziru Terrace and Covurlui Plain systems experienced a significant decreasing of the number of farms (15%), while the trend is lower (4.40%) in the case of the Nicoreşti–Tecuci system.

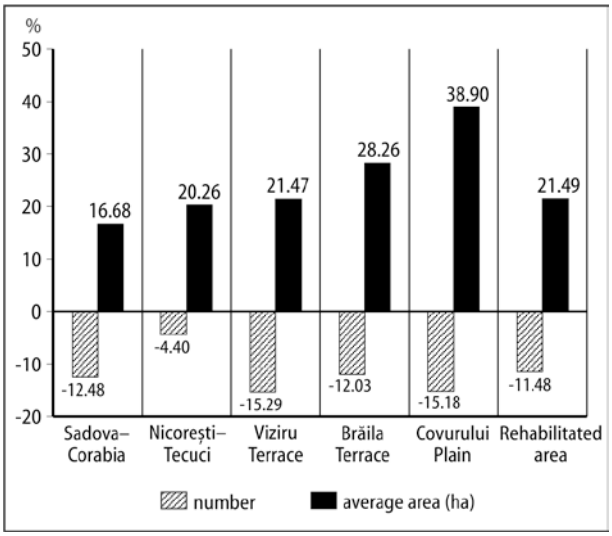


Figure 2. Evolution of the number and average size of farms in the rehabilitated area (2007–2011) (%)
Source: authors' processing of data from NAPA, 2012

The lack of financial resources and technological knowledge determined the closing of

small farms in the detriment of competitive farms. The irrigations represent a valuable input in farming if operational agricultural structures exist. Farm consolidation is well demonstrated through the analysis of the evolution of the average farm size and the farm structure by size categories. In the rehabilitated area, at the end of 2011, the 14 105 farms operated 86 272 ha, with an average farm size of 6.12 ha, having a higher value compared to the national average (3.57 ha). A significant increase of the average farm size was observed both in the rehabilitated area (21.49%) and for each irrigation system. The analysis revealed a polarization among the irrigation systems: there are large-sized farms in Viziru Terrace and Brăila Terrace and small-sized farms in Sadova–Corabia and Nicoresti–Tecuci (Table 3).

The classification of farms by size classes show that the group of consolidated farms are the family farms, with an average size of about 30 hectares, belonging to the group "10–100 ha" which increased by 7.35%.

By irrigation systems, a different situation can be noticed: farms "under 10 ha" are getting consolidated within four systems (while Sadova–Corabia system is an exception); farms "10–100 ha" are getting consolidated in four systems except for Covurlui Plain; farms larger than 100 ha registered a slight decrease in all systems, except for Nicoreşti–Tecuci. This situation could be explained by the fact that the large-sized farms operate as part of the declared areas under the land lease system, process that features a certain degree of volatility.

Farms concentration followed a general ascending trend, which can be found both at rehabilitated area and irrigation systems level. This can be an effect of the irrigation systems rehabilitation – it is possible that the investments made in this sector have influenced the behaviour of many farmers, who adopted different development strategies by the increase of farm size. In the case of large-sized farms, the irrigation of crops can be better managed while costs are dropping.

In the analyzed period, the cultivated area (75 551 ha) was maintained at higher values compared to the nationwide average (Fig. 3).

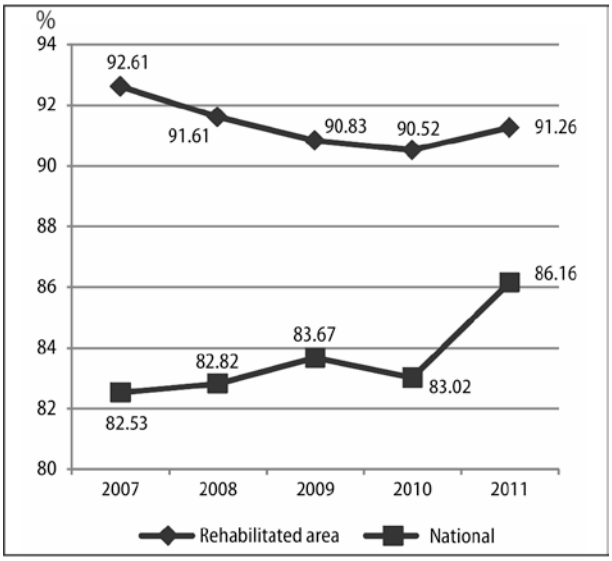


Figure 3. Share of cultivated area in total arable area (2007–2011). Source: authors' processing of data from NAPA, 2012

This trend was maintained by the low share of abandoned/ uncultivated land in the rehabilitated area: the uncultivated land had an yearly variation ranging from a minimum of 5 297 ha in 2007 to a maximum of 8 144 ha in 2010. The value of this indicator is strongly influenced by what happens in Sadova–Corabia system.

Table 3. Evolution of average farm size by size classes (ha), 2007–2011

| Irrigation system | | Less than 10 ha | 10-100 ha | 100-500 ha | Over 500 ha | Total (ha) |
|---|---|---|---|---|---|---|
| Sadova-Corabia | 2007 | 2.21 | 20.31 | 187.50 | 1 170.00 | 3.24 |
| | 2011 | 2.09 | 25.53 | 180.66 | 1 051.80 | 3.79 |
| Nicoreşti-Tecuci | 2007 | 1.98 | 27.86 | 156.50 | 0.00 | 3.37 |
| | 2011 | 1.98 | 30.29 | 222.50 | 0.00 | 4.06 |
| Viziru Terrace | 2007 | 2.63 | 31.03 | 228.93 | 759.33 | 13.85 |
| | 2011 | 2.74 | 32.88 | 221.73 | 719.60 | 16.82 |
| Brăila Terrace | 2007 | 1.98 | 35.49 | 207.64 | 0.00 | 8.87 |
| | 2011 | 2.20 | 36.59 | 181.83 | 665.00 | 11.37 |
| Covurlui Plain | 2007 | 1.22 | 37.78 | 196.50 | 1 389.25 | 6.37 |
| | 2011 | 1.37 | 31.93 | 191.12 | 1 483.25 | 8.84 |
| Rehabilitated Area | 2007 | 2.07 | 28.83 | 207.25 | 1 047.92 | 5.03 |
| | 2011 | 2.04 | 30.95 | 200.81 | 1 030.33 | 6.12 |

Source: authors' processing of data from NAPA, 2012

The analysis by crop structure and farm types, revealed the high share of grain crops. The typology of the crop structure by the three main crop groups (summing up more than 85% in share) provides a relevant overview of the cropping pattern in the rehabilitated area (Table 4).

Table 4.Cropping patterns in the rehabilitated area

| Farm size class | | | |
|---|---|---|---|
| Under 10 ha | 10–100 ha | 100–500 ha | over 500 ha |
| Grain crops - 63% | Grain crops - 41% | Grain crops - 54% | Grain crops - 56% |
| Industrial crops - 10% | Industrial crops - 29% | Industrial crops - 29% | Industrial crops - 31% |
| Fodder crops - 10% | Pastures and hayfields - 11% | Seed plots - 7% | Pastures and hayfields - 7% |

Source: authors' processing of data from NAPA, 2012

This situation highlights that in order to become economically competitive, irrigated agriculture has to shift from the irrigation of extensive crops to the irrigation of high-value crops (HVC), that bring substantial profits, which are possible to make the best use of the conditions developed by the rehabilitation of irrigation systems.

The high value crops with potential to generate higher incomes under the irrigation conditions were considered the following: seed plots, vegetables, vineyards, orchards, fodder crops in arable land, sugar beet, rice, peas, beans, medicinal and aromatic plants and soybeans.

HVC give farmers the possibility to increase both incomes and farm stability by crop diversification. The increase of areas under HVC might represent an opportunity for the poor rural communities to reduce their dependence on grain crops cultivation and to promote the transition from subsistence farming to market-oriented farming (Del Carpio et al., 2011; Rusu, 2013).

In the rehabilitated area, the average area cultivated with HVC was of 33 295 ha, accounting for 44% of the total cultivated area. During 2007–2011 a slight expansion of 4% (1 598 ha) of the area with HVC was accounted in the rehabilitation area (Table 5). An analysis, by irrigation systems reveals that in four systems – Nicoreşti–Tecuci (+11%), Viziru Terrace (+6%), Brăila Terrace (+22%) and Covurlui Plain (+27%), the area under HVC increased in 2011 compared to 2007; the only system in which a negative trend was noticed being Sadova–Corabia (-17%).

Different trends were registered by crop types: a significant increase was noticed in grain legumes, alfalfa and vegetables (melons in particular), while in maize and seed plots there was only a slight increase. A significant shrinking was noticed in the case of the following crops: soybeans, medicinal and aromatic plants, vineyards and fruit trees.

We must specify that the high share and the increasing trend of areas under HVC can be a first step in the process of rural development. HVCs represent a good opportunity for farmers to increase their incomes through their participation in the food chains, on the condition of an efficient vertical coordination, to ensure equilibrium between demand and supply. The increase of areas under HVC and their production increase implicitly need, as a precondition, the existence of adequate infrastructure: planting stock sources, adequate advisory and extension service and, last but not least, the presence of a cold chain (from harvesting to retail) for the cultivated fruit and vegetables.

The efforts made both worldwide and at national level for the expansion of irrigated agricultural areas and for the increase of yields per hectare are justified if we take into the consideration the current food crisis. The lack of achievement in agriculture is largely generated (too) by the high dependence on the yearly weather conditions (weather-dependence of agricultural production). The diversity of natural, economic and social conditions available in the analyzed irrigation systems determines the existence of various types of crop structures, which make possible/facilitate specific crop rotations for each irrigation system and each farm type.

Table 5. Prevalence and expansion of high-value crops

| Irrigation system | 2007 | 2011 | Difference | |
|---|---|---|---|---|
| | | | ha | % |
| Sadova Corabia | 1 1512 | 9 606 | -1906 | -17 |
| Nicoreşti Tecuci | 5 255 | 5 853 | +599 | 11 |
| Viziru Terrace | 9 981 | 10 555 | +569 | 6 |
| Brăila Terrace | 3 344 | 4 088 | +744 | 22 |
| Covurlui Plain | 5 927 | 7 519 | +1 592 | 27 |
| *Rehabilitated area* | *36 019* | *37 616* | *+1 598* | *4* |

Source: authors' processing of data from NAPA, 2012

Productions are different every year and they are influenced by the soil type, by weather, by the economic and organizational conditions and, last but not least, by farmers' options to use agricultural inputs and irrigations implicitly.

In the rehabilitated area, it can be noticed that under the irrigation regime, the average yields are higher than the national average for all crops. There are significant differences, ranging from a minimum 51% in potatoes and a maximum 78% in wheat. The analysis of average yields for the irrigated crops was made based on data declared by farmers in a field survey conducted in the region (Table 6).

Table 6. Average yields for the main crops in the rehabilitated area and nationwide (Kg per hectare)

| Crop | Rehabili-tated area | Natio-nal level | Differences rehabilitated area vs national level |
|---|---|---|---|
| Corn | 6 955 | 4 525 | +2 430 |
| Wheat | 4 743 | 3 663 | +1 080 |
| Sunflowers | 2 900 | 1 798 | +1 102 |
| Soybeans | 3 560 | 1 980 | +1 580 |
| Vegetables total: | 24 324 | 15 877 | +8 448 |
| Off wich: *watermelons* | 28 567 | 20 868 | +7 699 |
| *vegetables* | 20 081 | - | - |
| Potatoes | 34 725 | 16 554 | +18 171 |
| Corn seeds | 4 567 | - | - |
| Rape | 2 800 | 1 882 | +918 |

In the context of the climate change scenarios and the strong dependence of rural economy on agriculture, it is very important to reduce the socio-economic vulnerability of rural communities (Niacşu et al., 2015). The national irrigation systems are one of the most efficient tools in the fight against the effects of increasing aridity (Pravalie et al., 2013; Simion, 2010; Tang et al., 2014).

Although, theoretically, the control methods of aridity are known, more than 20 years of technological decline have amplified the gap between theory and practice. The official reports confirm this situation: irrigations are presented as an urgent priority, as well as one of the main tools to the sustainable development of agriculture and rural areas in Romania.

Irrigation systems do not exist on an isolated basis; they are parts of the different large systems – regional systems, rural development systems, ecological systems, national food production systems, etc. (Bastakoti et al., 2010; Mupaso et al., 2014). The sustainability of irrigation systems will be superior as a process of conformity with these great systems exists and non competing objectives are developed (Al-Jayyousi, 1999; Ianoş et al., 2009).

Taking into consideration the context presented above, it can be considering that the rehabilitation of irrigation systems (and the irrigation of crops implicitly) will be a core element in the sustainable development of countryside: both as a climatic risk mitigation tool and for the using of fertile soil at its maximum production capacity.

## 4. CONCLUSIONS

Climate changes caused the emergence and expansion of areas with high desertification risk in the poor rural areas in the southern part of Romania, which require the existence of running irrigation systems. The change in land ownership regime from the beginning of the 1990's led to the emergence of a very large number of small-sized farms as well as to the deterioration of the irrigation systems meant to serve the socialist large-sized farms. In these conditions, the existent irrigation systems proved to be oversized and difficult to operate in an efficient manner.

Romanian government and the World Bank set as main goal of the agricultural policy the modernization and rehabilitation programs of certain irrigation systems. Between 2007 and 2011, five systems located in the southern part of the country were included in such programs: Sadova–Corabia, Nicoreşti–Tecuci, Viziru Terrace, Brăila Terrace and Covurlui Plain.

The main effects/tendencies noticed in the agricultural structures as a result of the irrigation system rehabilitation were positive. Our paper revealed that farms had a general concentration trend (decreasing number of farms and increasing average farm size), that can be found both at the level of the rehabilitated area and for every irrigation systems. Viziru Terrace, Covurlui Plain and Brăila Terrace systems experienced a significant consolidated trend, while the tendency is lower in the case of Nicoreşti–Tecuci and Sadova–Corabia. Likewise, farms classified by size classes show that family farms, with an average size of about 30 hectares recorded the strongest concentration.

The cultivated agricultural area had a high share throughout the investigated period and it was maintained at higher values compared to the national level (except Sadova–Corabia system). The typology of the crop structure by the three main crop groups

(summing up more than 85% in share) shows that the cropping pattern in the rehabilitated area is dominated by the grain crops. During 2007–2011, a slight expansion of the area with HVC was accounted. By irrigation systems, Nicoreşti–Tecuci, Viziru Terrace, Brăila Terrace and Covurlui Plain experienced an increase of the area under HVC while the only system in which a negative trend was noticed was Sadova–Corabia.

The increase of areas under HVC might represent an opportunity for the poor rural communities to reduce their dependence on grain crops. This could lead to the transition from subsistence farming to market-oriented farming, in the condition of the existence of adequate infrastructure: planting stock sources, adequate advisory, extension service and cold chain for cultivated fruits and vegetables, etc.

The efforts made for the irrigation systems rehabilitation are also reflected in the increased agricultural productivity: under the irrigation system, the average yields are higher than the national average for all crops, with differences ranging from 51% for potatoes and 78% for wheat.

Taking into consideration the positive results presented above, it can be considered that the rehabilitation of irrigation systems could be a core element in the sustainable development of poor rural communities in the southern part of Romania. The investments made in the rehabilitation of the five irrigation systems might have influenced many farmers' behaviour, who have adopted strategies to develop their farms.

## REFERENCES


**Al-Jayyousi, O.R.,** 1999. *Rehabilitation of irrigation distribution systems: The case of Jericho City*. Water Resources Management, 13(2),117-132.

**Bastakoti, R.C., Shivakoti, G.P. & Lebel, L.,** 2010. *Local irrigation management institutions mediate changes driven by external policy and market pressures in Nepal and Thailand.* Environmental Management, 46, 411-423.

**Constantin, F. & Ciobanu, L.,** 2011. *Aspects of technical progress in Romanian agriculture compared to some EU countries*. Economia, 14(2), 473-483.

**Cook, B.I., Shukla, S.P., Puma, M.J. & Nazarenko, L.S.,** 2015. *Irrigation as an historical climate forcing*. Climate Dynamics, 44(5-6), 1715-1730.

**Del Carpio, X.V., Loayza, N. & Datar, G.,** 2011. *Is irrigation rehabilitation good for poor farmers? An impact evaluation of a non-experimental irrigation project in Peru.* Journal of Agricultural Economics, 62, 449-473.

**Grumeza, N. & Kleps, C.,** 2005. *Irrigation systems in Romania (In Romanian).* CERES, Bucharest, 418p.

**Ianoş, I., Peptenatu, D. & Zamfir, D.,** 2009. *Respect for environment and sustainable development.* Carpathian Journal of Earth and Environmental Sciences, 10(1), 183-192.

**MAA,** 1998. *Evolution of agri-food sector in Romania: Annual Report 1997 of Ministry of Agriculture and Food (In Romanian)*. Agris, Bucharest, 159 p.

**Marin, L., Birsan, M.V., Bojariu, R., Dumitrescu, A., Micu, D.M. & Manea, A.,** 2014. *An overview of annual climatic changes in Romania: trends in air temperature, precipitation, sunshine hours, cloud cover, relative humidity and wind speed during the 1961–2013 period.* Carpathian Journal of Earth and Environmental Sciences, 9(4), 253-258.

**Mishra, A., Ghosh, S., Nanda, P. & Kumar, A.,** 2011. *Assessing the impact of rehabilitation and irrigation management transfer in minor irrigation projects in Orissa, India: A case study.* Irrigation and Drainage, 60, 42-56.

**Mupaso, N., Manzungu, E., Mutambara, J. & Hanyani-Mlambo, B.**, 2014. *The Impact of Irrigation Technology on the Financial and Economic Performance of Smallholder Irrigation in Zimbabwe.* Irrigation and Drainage, 63, 430-439.

**Niacşu, L., Ioniță, I. & Curea, D.,** 2015. *Optimum agricultural land use in the hilly area of eastern Romania. Case study: Pereschiv catchment.* Carpathian Journal of Earth and Environmental Sciences, 10(1), 183-192.

**Popescu, M.,** 2001. *Transition lessons. Agriculture 1990-2000 (In Romanian)*. Expert, Bucharest, 252 p.

**Pravalie, R., Peptenatu, D. & Sirodoev, I.,** 2013. *The impact of climate change on the dynamics of agricultural systems in South-Western Romania.* Carpathian Journal of Earth and Environmental Sciences, 8(3), 175-186.

**Rusu, M.,** 2000. *Economic typologies in rural space*. In: Gavrilescu, D. & Giurcă D. (coord.), Agri-food economy (In Romanian), Expert, Bucharest, pp. 384-392.

**Rusu, M.,** 2013. *Romania's Irrigation Systems and Cropping Tendencies.* Management Agricol, 15(2), 13-17.

**Sabates-Wheeler, R.,** 2001. *Land reform and farm choice in Romania*. Problems of Post-communism, 48(4), 27-37.

**Simion, G.**, 2010. *The spatial changes of land use in the Bucharest metropolitan area 1970s – 2000s*. Human Geographies - Journal of Studies and Research in Human Geography, 4(2), 115-123.

**Tang, J., Folmer, H., van der Vlist, A. & Xue, J.,** 2014. *The impacts of management reform on irrigation water use efficiency in the Guanzhong plain, China*. Papers in Regional Science, 93(2), 455-475.

**Zhovtonog, O., Dirksen, W. & Roest, K.,** 2005. *Comparative assessment of irrigation sector*

*reforms in Central and Eastern European countries of transition.* Irrigation and Drainage, 54, 5, 487-500.

**Zhu, X., Zhao, A., Li. Y. & Liu, X.,** 2015. *Agricultural irrigation requirements under future climate scenarios in China.* J Arid Land, 7(2), 224-237.

Received at: 16.02.2015
Revised at: 20.04.2015
Accepted for publication at: 02. 06. 2015
Published online at: 03. 06. 2015