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Acceptance of innovation diffusion in rural areas - a Romanian Case Study

***Abstract:** In our paper we tried to investigate the organisation and functioning of the Agricultural Knowledge System in Romania. On the basis of system analysis approaches, we critically examined the set of public and private organisations dedicated to research, education and extension, and their interaction with knowledge users (traditional farmers) and the main system failures and strengths in the innovation process in agriculture were identified. The empirical research in this study had a heuristic value.*

***Keywords:** innovation, agricultural knowledge system, Romania*

In Romania, the processes related to the innovation production and knowledge transfer to agriculture and rural areas is still tributary to the traditional model based on a strong confidence in scientific progress and in the role of the State as a driver of modernization. Research, education and extension bodies are seen as strong public institutions, and the approach to ‘innovation adoption’ and ‘transfer of technology’ is used, as a top-down linear process, from research to farming and rural development.

In this paper we propose an analysis of the effectiveness of this approach to the knowledge transfer and highlight its strengths and weaknesses in the Romanian context. Our analyses are based on the concrete results in the implementation in Romania of the FP 7 project (SIRIUS)¹ that is implemented in 11 pilot areas across the globe; one of these areas is Terasa Nord Braila from Romania. The main objective of the SIRIUS project is to implement, in the pilot areas, a computer system for efficient management of water resources (for irrigation) - so, implementation of a technological innovation. Our paper aims at measuring the degree of acceptance of innovation diffusion at the main actors involved in the transfer and implementation of new knowledge through this initiative.

Methodology

The proposed methodology is specific to the qualitative analysis because it is considered most appropriate for studying this phenomenon. We use 2 types of methods for data collecting and for data handling and processing.

a. Methods for observation/collecting data:

- *The participatory observation* is a method in which an observer participates in the activities of the people being studied. A participatory observer in innovation projects attends the meetings of the project team, of the project participants and of the network meetings in a brother sense.
- *In-depth interviews* are a good method to study the assumptions, values and experiences of the project team members, project participants or external parties; at the same time, these are also a good modality to encourage reflection. Within this research method, the monitor can provide the stimulus for the interviewee to examine things in greater depth, such as the barriers in the existing system or the interrelationships. The processing of these interviews was performed using the ATLAS program.
- *Collective reflection meeting (Focus group)* with the interviewees after the interviews. According to this method, the monitor presents the conclusions after the interviews and the interviewees give their feedback on these results.

¹ Sustainable Irrigation water management and River-basin governance: Implementing User-driven Services – SIRIUS – (2010-2013) funded through 7 Framework Programme of the EU

b. Methods used for data handling and processing:

- *SWOT matrix* reflects the strengths, weaknesses, opportunities and threats in the innovation system functionality
- *Innovation System Performance matrix* (ISP matrix) that detailing the main enablers and barriers in the process of knowledge and innovation transfer.

In the recent specialty literature, the innovative processes are systematically approached and more and more frequent concepts such as “systems of innovation are used.” The process of technological innovation involves interactions among a wide range of actors in society, who form a system of mutually reinforcing learning activities. These interactions and the associated components represent dynamic “innovation systems” (Fagerberg, 2005). The concept of a system offers a suitable framework for conveying the notion of parts, their interconnectedness, and their interaction, evolution over time, and emergence of novel structures. Within countries the innovation system can vary across localities. Local variations in innovation levels, technology adoption and diffusion, and the institutional mix are significant features for all countries.

The ISP matrix systematically categorizes some typical institutional characteristics of an innovation system, its main actors and their interactions with each other. As an system analysis, ISP matrix, making the distinction between *actors* and the *rules* which are most related to the system failures: i) *actors*, i.e. customers, firms, policy departments, research institutes, consultants etc. that act and thereby co-create not only products and technologies but also the institutional framework in which they function; ii) *rules/system failures*, i.e. the conditions that are either specifically created by the actors, or have spontaneously evolved, which influence not only the functioning of individual actors, but also the system as a whole. Because of this distinction between actors and failures, it also becomes possible to make a clearer distinction between cause and effect in terms of system functioning and outcomes (Woolthuis et al., 2005; Hermans et al., 2011). According to these theoretical approaches, the main components of the ISP matrix for our study case area were defined (see table 1).

The columns of this matrix contain some of the most important actors that make up the agricultural knowledge system and the lines reflects the different categories of failures depicted in the ISP matrix: the infrastructure, the institutional context like laws, rules and regulations, values, norms and culture, the interactions and networks and the capabilities of actors.

A main data source is represented by the monitoring of SIRIUS project implementation in Romania, SIRIUS project pilot area.

Table 1. Innovation System Performance matrix component for analysing the acceptance of knowledge transfer through SIRIUS project in Romania

Actors	Direct beneficiaries	Indirect beneficiaries	Research Institutes and Universities	Extension and advice
	<i>(final users of the innovation and knowledge transfer)</i>	<i>(public and private organizations for which the implementation of innovations in agriculture and rural development contributes indirectly to the fulfilment of their objectives: reducing pressure on natural resources, their sustainable management, conservation of bio-geodiversity, sustainable social and economic development)</i>		
Rules (system failures)				
Infrastructural failures	Being the physical infrastructure that actors need to function (such as IT, telecom, and roads) and the science and technology infrastructure.			
Institutional failures	Laws, rules and regulations	'Hard institutional failure' refers to laws, regulations and any other formalized rules, or the lack of them, hampering innovation. For example, the absence of organizational regulations generates an institutional vacuum and may slow down certain developments. Incentive mechanisms for researchers which make them more or less inclined to work with farmers		
	Values, norms and culture	'Soft institutional failure' refers to unwritten rules, norms, values, culture, or 'the way business is done'. They affect how actors interact, but also relate to their (in)ability to change their norms and values to enable innovation to take place. For example, different worldviews of researchers and farmers on what constitutes 'good irrigation practices' may affect how they cooperate in innovation processes.		
Interactions and networks failures	'Strong network failures' being the 'blindness' that evolves if actors have close links and as a result miss out on new outside developments. 'Weak network failures' being the lack of linkages between actors as a result of which insufficient use is made of complementarities, interactive learning, and creating new ideas.			
Capabilities failures	The lack of technical and organizational capacity of the system to adapt to and manage new technology and organizational innovations (such as a certain level of entrepreneurship, adequately educated persons, time to dedicate to innovation, networking skills, also referred to as 'absorptive capacity')			

Source: according with Woolthuis et al. 2005: 610-611; & Hermans et al. 2011: 11-21

Background/Context

Knowledge and innovation creation and transfer in Romania

The formal agricultural knowledge system (AKS), defined as the 'triangle' of agricultural research, education and extension (advisory service) establishments (Rivera and Sulaiman, 2009), and their interaction with knowledge users, traditionally farmers. In Europe, these organisations traditionally have been linked in a linear way because AKS was created in coherence with the idea of a strong confidence in scientific progress and in the role of the State as a driver of modernization. Research, education and extension bodies were seen as strong public institutions, and the approach to 'innovation adoption' and 'transfer of technology' was used as a top-down linear process, from research to farming (Knickel, Brunori et al., 2009; Röling, 2009; Leeuwis and Aarts, 2011), in line with the common goal of increasing agricultural production (Hermans et al., 2011).

In the agricultural and rural innovation literature, as elsewhere, the linear view of innovation (i.e., agricultural R&D generates technologies that agricultural extension transfers to agricultural producers for subsequent adoption) is being criticised as the thinking about innovation processes has become broadened from processes of knowledge diffusion and knowledge transfer to processes of knowledge co-creation and social learning (Leeuwis and Van den Ban, 2004; Smits and Kuhlmann, 2004; Knickel, Brunori et al., 2009).

A recent Review of the Research, Development & Innovation (RD&I) sector in Romania² concludes that *Romania's RD&I sector is in a silent crisis, with seriously negative implications for the country's longer term competitiveness and growth prospects*. This crisis is related to three key factors:

- I. research, development, and innovation are not recognized as a linked system to promote private sector innovation and economic growth. Consequently, it is not governed as a sector, but rather split among various ministries and stakeholders who together lack a unified vision or even minimal coordination;
- II. the focus of spending has been on basic research and maintaining a legacy superstructure of institutes and universities at variance with the applied research required by the country's changed economic structure or the development of its areas of comparative advantage. The opportunity cost of years of marginally productive research spending cannot be recaptured, but they must not continue;
- III. the skills of Romanian entrepreneurs and researchers are not being properly mobilized, and too often are frittered away. The Romanian scientific Diaspora is one of the world's largest, the level of domestic scientific output lags far behind the country's competitors, and the Romanian high tech private sector (that group which is sparking growth in neighbouring countries as well as in global leaders) is an abandoned orphan.

Investment in research and innovation is at the heart of the Europe 2020 strategy, which is aimed at a smarter, greener and more inclusive economy delivering high levels of employment, productivity and social cohesion. Private sector R&D investment plays a particularly important role in this strategy. Unfortunately, in Romania, investments in research and innovation (0.47% from GDP) are still based mostly on the public contribution, the private R&D investments account for only 38.3% (the EU average is 61.5%)³. In both public and private sector in Romania, the level of R&D expenditure is lower than the EU average (38% and 15% respectively of the EU27 average)⁴ and these investments are mostly oriented according to the principles of an efficiency-based economy (low cost resources), as compared to innovation-based economies in advanced countries. Because of the realities described above, in 2011, Romania was classified as “modest innovator”, ranked the 24th of the 27 EU countries according to the summary aggregated innovation index⁵.

² World Bank (2012). “Functional Review of the Research, Development & Innovation Sector”, <http://www.sgg.ro/docs/File/UPP/doc/rapoarte-finale-bm/etapa-II: 7>

³ National Authority for Scientific Research (2012). “Evolution of Romania's R&D and Innovation System”, National Conference of Innovation and Research, November, 7-9, 2012, Bucharest, http://nci.ancs.ro/downloads/raport_conferinta.pdf

⁴ Idem

⁵ European Commission (2012) “Innovation Union Scoreboard 2011”, Research and Innovation Union scoreboard, http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011_en.pdf.

SIRIUS project (in brief)

This study is based on data collected on ongoing FP7 Project called SIRIUS – „Sustainable Irrigation water management and River-basin governance: Implementing User-driven Services”. SIRIUS is a trans-national research project involving 18 partners from 13 countries around the world, aiming to develop innovative and new Global Monitoring for Environment and Security (GMES) service capacities for the user community of irrigation water management and sustainable food production, in accordance with the vision of bridging and integrating sustainable development and economic competitiveness (figure 1).

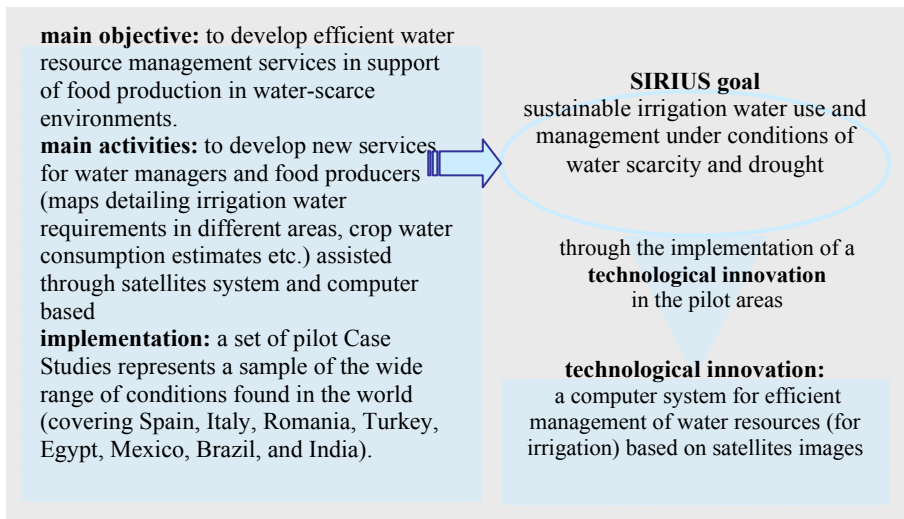


Figure 1. FP 7 SIRIUS project (2010-2013) Sustainable Irrigation water management and River-basin governance: Implementing User-driven Services

The SIRIUS project, has the following main objectives: to prepare the service environment by strengthening the participatory process which is necessary for efficient and affective irrigation water resources management and by jointly developing users' requirements portfolios that lead to sustainable future community agreements for irrigation farming practices assisted by GMES services in each pilot area, based on cooperation of all stakeholders; to strengthen the current version (global, local, portable modes) of the System of Participatory Information, Decision-support and Expert knowledge in River-basin management (SPIDER, developed in PLEIADeS) in two ways: placing it robustly within the overall framework of the GMES SDI, while ensuring it is operational on the ground with the network of local ppgis communities; to further develop, validate and consolidate the product generation algorithms for the SIRIUS portfolio and to operationalize them as far as possible while maintaining user control procedures where needed; to set up and implement SIRIUS portfolio production line, including purpose – oriented quality control, merging data streams from EO (virtual constellation concept), non EO (in – situ,survey) and models;

to generate products for participatory service assessment with users during one growing season; to develop and deploy a framework of business strategies to stimulate operative and sustainable SIRIUS service activities capable of providing benefits to the user community of water resources management; to guide the local user community in a participatory multi – stakeholder process through the set up, test-implementation, training, and evaluation of the SIRIUS services in representative pilot case; to evaluate the social, cultural and economic environment for the sustainable implementation of the SIRIUS Service.

SIRIUS project in Romania

The current situation of the irrigation system in Romania

Romania has a total of 15 million hectares of agricultural land, two thirds of which are arable, giving the agricultural sector considerable potential to produce a commercially viable and diverse mix of temperate crops and livestock products. Irrigation is vital to Romanian agriculture out of several reasons. First, it offsets rain deficits in the country's semi-arid southern and eastern regions. The water demands of crops in July and August are 300-500 mm, leaving a crop water deficit of some 200-350 mm. This makes irrigation necessary for most summer crops such as maize, vegetables, sugar beet, sunflower, potatoes. In the communist period, a total area was equipped with irrigation infrastructure summing up almost 3.1 million hectares (figure 2). These systems were mainly developed for irrigating crops like maize, wheat, sunflower and sugar beet, as well as rice and vegetables; these crops were established on large areas, operated by the state farms. A large part of the irrigated land areas was located on high terraces, above the water source (the Danube for a large part of the irrigation infrastructure). In certain cases, irrigation systems were built for irrigating land areas located at more than 200 m above the respective water source, including up to 10 repumping stations. The specific costs of the under pressure irrigation networks are high, and before 1989 the state used to hide the real value of subsidies (mainly for the power used for water pumping) (WB, 2009).

Currently, in Romania, the price for access to water from the irrigation system is high for farmers and represents around 1/3 of the production cost/ ha (according to the information provided by farmers from our pilot area). This reality is the result of the current situation of the irrigation system:

- *Irrigation system in Romania was built in the communist period - consequently irrigation infrastructure is old, outdated and highly energy-intensive due to the deficit of investments in the modernization of the irrigation system after 1989 (MARD, 2011)*
- *Irrigation infrastructure was designed to serve the large farms from the communist era and, currently is inadequate of today's system of land properties dominated by small dimensions farms*

- *Large consumer of electric power because it is based on extracting water from the river beds (Danube) and pumping it into irrigation channels – consequently the total cost of access to water from the national irrigation system is very high (MARD, 2010) (electric power represent 90% of the price paid by farmers for the irrigation water)*
- *Water running through open channels and physical wear of the irrigation infrastructure generates losses - the loss of water is estimated at around 40% on Braila's Terrace (our pilot area) (MARD, 2007:15)*



Figure 2. Romania – map of irrigations scheme

Source: National Land Reclamation Agency, <http://www.anif.ro/patrimoniu/amenajari-irigatii.htm>

This situation resulted in the irrigated area representing only 9% in the year 2012 of these 3.1 mil. ha that had been equipped with irrigation facilities in the communist period. Furthermore, following the depreciation, physical destruction of the national irrigation system nowadays, only 30% of these areas were classified as "viable" for irrigation (MARD, 2011: 43)

The Romanian Ministry of Agriculture implemented in the period 1994 – 2012 a project for rehabilitation and the reform of irrigation's system for the purpose of: evaluation of the current situation of the national irrigation system functionality and development of a strategy for rehabilitation and reform of irrigation system. The main goals of the national strategy for irrigation are: to reduce the drought risk, to increase the economic efficiency of irrigation, to improve the irrigation management, to improve the energy efficiency of water irrigation systems, to involve the beneficiaries in the management and the rehabilitation of irrigation systems. The strategic priorities were divided according to period of implementation:

- on short term: *improving the access and the efficiency of water consumption for irrigation at farm level* through: supporting a institutional reform of land operation within the irrigation perimeters to increase the access of far-

mers to water; increase the access of farmers at energy saving technologies for irrigation management within interior areas (MARD, 2008: 11-12); more economic use of irrigation resources by changing the farmers' and National Land Reclamation Agency's (NLRA) behaviours (WB, 2012b)

- on long term: *the rehabilitation of irrigation systems* through investments for modernization of the irrigation system infrastructure (MARD, 2007; MARD, 2011).

The SIRIUS innovative solution for Romanian pilot area is in accordance with the short term objective of national strategy for irrigation and consists of: *improving the efficiency of irrigation water use at farm level by*: facilitating the access of farmers to satellite information regarding irrigation water requirements; selecting and processing the satellite information that is relevant to the project's aim; training the farmers for accessing and using the information via computer

SIRIUS pilot area in Romania (in brief)

The SIRIUS pilot area in Romania is located in Brăila County (red circle in figure 1), in a plain zone, with continental climate, with higher temperatures and lower rainfall in recent years, multi-year averages. Under the conditions of climate aridity tendency, in which the soil moisture deficit during the growing season reaches about 350mm/season, irrigation is absolutely necessary (Symposium, 2007).

Over 90% of the agricultural and arable land areas in Brăila county (92.6% and respectively 93.3%) have, according to NIS data, available facilities for irrigation. According to MARD, Brăila is the county in which, by far, irrigations represent an important component of farming, having the largest irrigated area (65% of the actual irrigated area at national level in 2010 – NIS 2012 data base) and the largest quantity of water pumped (46% of water used for irrigation in 2009 at national level – MARD 2011). However, in the same year (2010), the use of the irrigation system in Brăila was very low. Effectively irrigated areas with at least one watering represented only 15% of the total agricultural area equipped for irrigation at the county level, respectively, 16.4% of arable land provided with such facilities (NIS, 2012). Given the records of the irrigation system in the county with the largest area of operation and its use – Brăila: the irrigation system is still functional in much of the area with such type of facilities (in 2009, for 62.4% of the county area with hydro-technical facilities, the irrigation system was classified as “viable”, capable of use and recipient of the investment in system rehabilitation – MARD 2011).

The Romanian SIRIUS pilot area consists of 4 rural communes (namely Cazasu, Silistea, Vadeni and Tudor Vladimirescu) with a total population of 11000 inhabitants. The *demo-social capital* of this area is defined by:

- a balanced structure of genders, the female population share being 50.2%

- critical demographic phenomena: the birth rate in the rural area is 8.5‰ and the death rate is 13.9‰
- the particularity of the occupational pattern consists in the occupational disequilibrium generated by the prevalence of employment in the agricultural sector. The excessive contraction of the job supply supports this pattern, which became specific for the rural area from Brăila county. The excessive high shares of the population employed in agriculture reveal the excessive economic and social dependence on agriculture, also indicating the high risk to which the respective rural communities are subject to. A mono-occupational structure is materialized into the high vulnerability to any natural, social and economic risk. The unemployment phenomenon affects the employed population of the investigated area, the most vulnerable group being the male population.

While at the level of the statistical analysis one can identify problems that emerged as a result of the lack of jobs, the supply is not diversified and multiple, at the social analysis level much more complex problems were established. In the formal leaders' opinion, the vulnerability is based on the lack of funds, poverty, incorrect application of agricultural policies.

The identification of problems is tributary to the socio-economic history of the area; the collective mentality, generated several decades ago, according to which the problems are generated only by factors exterior to the community and must be solved by the exogenous factors are materialized into problems identified by the leaders.

The defining *social capital* for the investigated rural communities is characterized by *social relations with positive effects* (information dissemination, knowledge and information exchange, internalization of the interests of the group the rural actors are part of) and *negative effects* (their sticking to the traditionality matrix results in the emergence of an „anti-novatory” behaviour and the low internalization of values referring to natural environment preservation). The first category of social relations is based on the organization of water users into formalized entities (there are 6 irrigation water users' associations in our pilot area) and on the establishment of producers' associations (“Association of sheep and cattle raisers”).

Results

Our paper aims at measuring the degree of acceptance of innovation diffusion at the main actors involved in the new knowledge transfer and implementation of innovations in agriculture. In order to reach this objective, we opted for the systems approach in agricultural innovation from the perspective of which we make the difference between the players involved in innovation production and transfer, on one hand, and the very process of the production and transfer of the new knowledge towards agriculture. Thus, the analytical approach is divided into two parts:

1. *Actors' analysis* - the goal of this review is to investigate the current organisation and functioning of the AKS actors.

In our understanding, AKS consists of *those actors that are purposefully engaged in knowledge development and knowledge intensive service delivery in agriculture and rural development (it is part of their 'core-business')*.

2. *System failures analysis* - in the process of the acceptance of knowledge transfer in Romanian agriculture, using as example the implementation of a high-tech innovation in the water management for irrigation through SIRIUS project in Romania.

The analyses of the innovation system functionality were based on secondary information from the literature review regarding the innovation actors and process in Romanian agriculture and rural development, and on our investigations and data collected through field survey methods such as: participatory observations, in-depth interviews, focus group with the main actors involved in AKS.

Main actors involved in the agricultural knowledge system in Romania (according to our case study)

According to the literature review, we identified the main categories of actors involved in the process of knowledge and innovation creation and transfer in the area of irrigation, namely:

- *Research and education bodies*, responsible with the development of new ideas in water management and with the theoretical and practical training of final beneficiaries.
- *Extension and advice bodies* that manage / mediates the relationships between the innovators and final users of the innovation. They should act as "innovation intermediary".⁶
- *Direct beneficiaries* - final users of the innovation and knowledge transfer (farmers).
- *Indirect beneficiaries* - public and private organizations for which innovation implementation in agriculture and rural development indirectly contributes to the fulfilment of their objectives: lowering the pressure on natural resources, their sustainable management, bio-geodiversity conservation, sustainable social and economic development etc.

The characteristics of these players are defining for their capacity/ability to assume an active, efficient and effective role in a modern innovation transfer process.

⁶ An **innovation intermediary**, according to Howells (2006) is "an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations."

Often innovation systems do not act as systems and display imperfections or system failures that hinder learning and innovation. Creating and fostering effective linkages among heterogeneous sets of actors (i.e. the formation of adequate innovation configurations, public-private partnerships etc) is often hindered by different technological, social, economic and cultural divides (Hall 2006). Such divides may be caused, for example, by different incentive systems for public and private actors, differences between local indigenous knowledge systems and formal scientific knowledge systems, social and cultural differences that cause exclusion of certain actors and ideological differences.

Organisation of the Agricultural Knowledge System for agriculture (particularly for the irrigation sector) in Romania

The links between knowledge creators and users were broken with the downfall of socialist agriculture. Technological innovations, but also innovations regarding farm management in irrigation and produce marketing only reach a small fraction of farms (especially big farmers that operate large areas of land).

Education and research

A few old *agricultural universities* have recently established departments on sustainable agriculture and are also involved in environmental issues: sustainable use of resources (water in our case), conservation of the natural resources. However, they mostly do the same research as before, under a new name. Theoretical education prevails, and links with the sector are sparse. When training is a pre-requisite for receiving subsidies or other financial support, Romanian farmers mostly opt for vocational or continuing training. A lot of private training centres were established in the last few years that offer short courses of training, retraining; these courses are funded mainly from EU structural funds, and are less connected to the rural local labour market needs.

The research in the area of irrigation is funded from different national (public) or international programs. Since the early 90s World Bank developed more projects in Romania for the evaluation, reform and rehabilitation of irrigation system. The main Romanian public institution involved in the research for irrigation is the National Institute of Research and Development for Land Reclamation (ISPIF), which currently experiences great problems in relation to funding its research activities, due to the public budget restrictions.

The agricultural extension systems do not have a lot of political support anymore. The coverage of services was quite good (each commune had one advisor) until 2010, when the National Agency for Agricultural Consultancy was dissolved. The chambers of agriculture also provide advisory services. At present, at national or at county level, there are a lot of free advisors available that provide services in areas with an excessive diversification, without

a strategic coherence and convergence. The quality of the (free) advice is often low because of: excessive thematic specialization of the advisors, lack of connectivity between them and the farmers needs etc.

The beneficiaries of innovation generated and transferred through SIRIUS project were divided into two categories (direct and indirect beneficiaries): according to theirs status in the implementation of the project findings, according to theirs status in the implementation of the project findings and depending on how the SIRIUS project implementation contributes to the achievement of strategic objectives of the various actors, considered as beneficiaries.

Table 2. Main characteristics of actors involved in the innovation transfer in the Romanian pilot area of SIRIUS project

Direct beneficiaries		Indirect beneficiaries		Research	Extension	
<i>Farmers</i>	<i>IWUA</i>	<i>NLRA</i>	<i>Government</i>	<i>Institutes and Universities</i>	<i>and advice</i>	
<i>Small farms < 10 ha</i>	<i>Big farms > 50 ha</i>	<i>(Irrigation Water Users Associations)</i>	<i>(National Land Reclamation Agency)</i>			
-operate 28.4% of the area equipped for irrigation	-operate 60.7% of the area equipped for irrigation	- associations of farmers with access to irrigation facilities (private)	- public institution under the MARD	- responsible for strategically orientation in agriculture and irrigation	- education on agriculture is mostly public	- structural excessive diversification
- in 2007 applied watering only for 1/10 of these areas	- in 2007 applied watering for 1/2 of these areas	- manages the relationship between users (farmers) and suppliers (NLRA)	- manages the primary and secondary irrigation infrastructure	- fund the national research and education programmes	- research is funded from different national (public) or international programmes	- non convergent - lake of connectivity
- subsistence agriculture	- good skills for farming	- provides water for irrigation	- provides water for irrigation system from Danube River	- research and education programmes	- “ISPIF” experienced big problems with the funding of their research activities	- excessive spatial and thematic specialization
- predominantly agricultural incomes: 87%	- good knowledge regarding the irrigation system	- became the owners of tertiary irrigation infrastructure in their territory	- organizational incoherence: rated fluctuations empirically un-adapted	- fund the NLRA activities		
- traditional agricultural model		- recent history: organizational oscillations	- lack of organizational culture, values	- bureaucratic structure		
- deficit of agricultural skills		- organizations dominated by big farms		- functional confusions and incoherence		
- 70% have empirical knowledge regarding the irrigation system						

Source: own assessments according with the literature review, interviews with the main actors representatives, focus group with stakeholders, participatory observation. For more details see Annex 1.

The direct beneficiaries of SIRIUS project are the farmers and the Irrigation Water Users Associations (IWUA) from the pilot area – Cazasu from Braila County (see red circle in the figure 1).

The farms structure from our pilot area is dominated by farms that operate more than 50 ha, are the main beneficiary of water from the irrigation system, have good farming skills and knowledge about the functionality of the irrigation system. The small farms are more dominated by a subsistence agricultural activity; they rely on a traditional agricultural model, having a deficit of agricultural skills and mostly empirical knowledge regarding the irrigation system.

The Romanian *irrigation infrastructure was designed to serve the large farms from the communist era* and it is inadequate for the post-communist land operation system. Out of this reason, beginning with 1999, the Irrigation Water Users' Associations (IWUA) was set up, as private associations of farmers with access to irrigation facilities. The IWUAs were established on territorial criteria (location in the area served by pumping / repumping water station) in order to facilitate the supply of water to the farms located in the coverage area of the repumping stations and to enable the calculation of the delivered water price to farmers (water price is different from one pumping station to another and depends on the altitude of water pumping from the extraction source). The IWUAs became the owners of tertiary irrigation infrastructure in their territory, and by this the farmers (IWUA members) become responsible for the maintenance and repair of the irrigation infrastructure that belongs to the IWUA. IWUA activity funding is from own sources and it can also apply for investment programs in the irrigation system rehabilitation funded by the Ministry of Agriculture, with 50% co-financing from IWUAs. Unfortunately, the farmers' financial capacity to pay from own funds for the rehabilitation of an irrigation infrastructure in which no investments have been made even before 1989 is low, and the funds made available by the Ministry of Agriculture for this purpose are quite difficult to access.

The farmers, as potential users of water from the irrigation system and the farmers' associations have to bear the consequences of the current situation of the Romanian irrigation infrastructure - old, out-dated, highly energy-intensive, costly and with great water losses. The direct consequence of this situation for the end users consists in a high price of the access to the national irrigation system and a high irrigation water cost (in Romania, the price that a farmer has to pay for 1000 m³ water from the national irrigation system is ten times as high compared to Hungary). SIRIUS Project provides an innovative solution for increasing the efficiency of irrigation water consumption, which can help farmers to lower their costs in the case of this agricultural input. An increased efficiency of irrigation water use at the level of farmers also lowers the costs of their associations.

The main characteristics of direct beneficiaries, described in table 2 reveals that only big farmers are able to implement the innovation provided through SIRIUS project, because they operate and use the majority of irrigation infrastructure, have good farming skills and a good knowledge of the irrigation system.

Because of the aim of our paper, we place *policy makers* in the category of indirect beneficiaries, governmental institutions can interact with other actors in evaluating the innovation developed under SIRIUS project and can include this innovation in their strategic action plans if SIRIUS solutions are considered viable for the entire irrigation system in Romania. Thus, the Ministry of Education and Research could better orient its public policies from its activity field on the sustainable water use and development of research exploring the opportunities to extend and adapt the results of such projects as SIRIUS at national level.

The Ministry of Agriculture succeeded in designing a coherent strategy for the irrigation system only in the year 2011, although the project that targeted its establishment was initiated even in 1997 under the World Bank consultancy. Due to the bureaucratic structure of governmental institutions, there is a risk that the SIRIUS project findings be presented to the decision-makers with great delay, and the funding of satellite data processing necessary for the innovative system operation, after project finalization, be not possible.

Moreover, the SIRIUS innovation consists of a more efficient use of water resources. Thus, SIRIUS contributes to the sustainable use of resources, which is one of the main goals in the Regional Operational Program, managed by the Ministry of Development. The lack of convergence and coordination between different strategies can become a restriction for a mutually agreed strategy on the importance of innovation adoption at national level.

After 1990, the *land reclamation* sector suffered frequent changes as regards its organization, management, responsibilities, financial support. While at the beginning of this period the land reclamation was a public affair in totality, at present this responsibility is split between public and private institutions, but their attributions and relations are still not clear defined and functional. At present, in the irrigation area, the main operator in land reclamation is represented by the National Land Reclamation Agency (NLRA), which was established in 2011 as public institution under the Ministry of Agriculture and Rural Development. NLRA is responsible with management of the primary and secondary irrigation infrastructure, is financed from subsidies from the state budget (for “public utility” investments for land reclamation) and from own revenues (from the price of delivered water for irrigation to IWUAs). The major public investments in the rehabilitation of primary and secondary irrigation infrastructure keep still awaited.

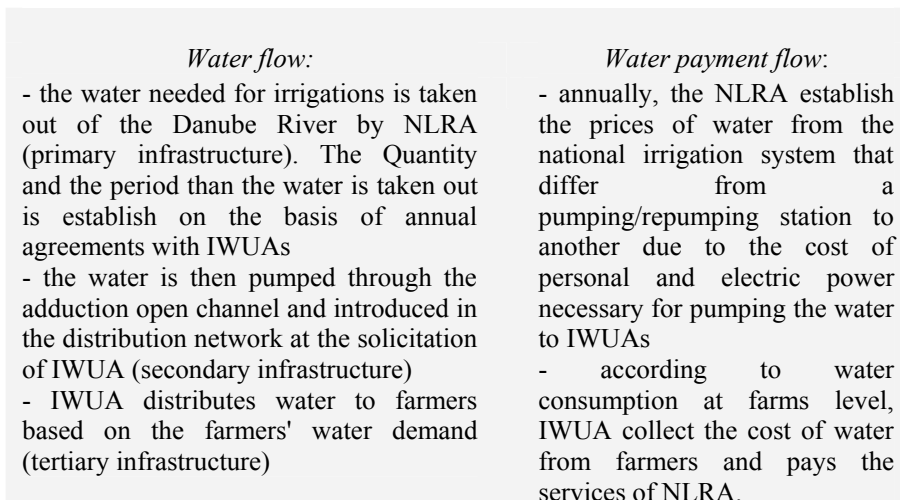


Figure 3. The mechanism of water access for farmers

The mechanism of water access for farmers, described in figure 3, reveals that the farmers support all the costs of delays in reform, modernization and restructuring of the national irrigation system and they have to pay for the economic inefficiency.

The observed system failures in the process of knowledge transfer acceptance in agriculture in Romania (particularly for irrigation)

The system analysis through ISP matrix is a tool that provides insights into the actors and factors that are working against the innovation adoption: the inhibitors (the system failures) and, on the other hand, the driving forces, and the system opportunities that actually encourage the acceptance of knowledge transfer.

In the next section we shall proceed to the inventory and analysis of system failures and system opportunities from the perspectives of implementation opportunities in Romania of an innovation of high technological level in agriculture using, as analytical foundation, the experience in the implementation of a computer-assisted efficient irrigation water management service.

Using this framework, we can identify where systemic failures occur, and which actors should be addressed to make innovation possible. Most problems in the innovation system will not be uni-dimensional but will consist of a complex mix of causes and effects, and involved several actors (Woolthuis et al., 2005: 614). By using ISP matrix, it is possible to identify where the major bottlenecks are located in the innovation system, to evaluate where the projects, programs, policy actions focussed on, and, very important, one can evaluate the extent to which the project measures addressed the right systemic failures or actors.

According to ISP matrix methodology, the observed system failures and strengths in the innovation process in the area of sustainable water use for irrigation were synthesized; we identified the main inhibitors/driving forces for each actor involved in the knowledge and innovation creation and transfer (Annex 2).

- Infrastructural failures

The infrastructure consists of the knowledge infrastructure and the physical infrastructure. The arrangement of the infrastructure facilitates or obstructs the access and development of knowledge, but also the actors' accessibility.

The knowledge infrastructure is dominated by factors that rather inhibit the innovation process. Thus, with regard to *public policies*, the research and in-

novation in agriculture is divided into several governmental entities: while the Ministry of Education and Research largely coordinates basic research activities, the Ministry of Agriculture oriented its public policies towards the applied research, and the coordination/convergence between the research policies of the two ministries is rather weak. Due to the rigid bureaucratic structure, the decision making takes a long time and involves several bureaucratic levels, which makes the re-orienting of public policies in research and education be possible only on the medium and long term.

The investments in *research* and innovation in Romania represent only 0.47% of GDP, which means an under-funding of the sector, which determined the migration of the research staff towards other segments of the economy of their emigration to other countries. The financial allocations provided to the land reclamation sector (irrigations included) were modest after 1989, and the main Romanian institution involved in the research for irrigation - National Institute of Research and Development for Land Reclamation (ISPIF) focused its activity on other categories of works, mainly studies on industrial, civil and/or other constructions (Maria, 2008:5-8). The research thematic in agriculture suffered from an excessive segmentation as it is trying to address the numerous problems the sector is facing and it lacks a clear prioritization of the strategic orientations.

As we mentioned above, the extension and advisory services for agriculture suffered from an inefficient segmentation of entities which, although in great number, are not adapted to the final beneficiaries' needs and are established in relation to their chances to obtain finance for their advisory activities from EU or national funds.

The Romanian *physical infrastructure* for irrigation needs massive investments in modernization and technological reshaping in order to increase its efficiency. However, the financing from public budget of the maintenance activity for primary and secondary irrigation infrastructure, operated by NLRA, is considered as state aid and it is not allowed by EU. In their turn, IWUAs also faced difficulties in accessing the funds from the Ministry of Agriculture for investments in the modernization of tertiary irrigation infrastructure because these needed 50% co-financing and the banks provide agricultural loans with great difficulty; in the second place, because these funds did not have the irrigation sector as special destination but rather the rural infrastructure and IWUAs competed against other potential beneficiaries that had greater opportunities to get a better position in the hierarchy of scores.

At the level of small farms, there is a scarcity of irrigation equipment, as this category of farms used irrigations to a lesser extent and the tertiary irrigation infrastructure on their territory rather suffered from physical depreciation. The large-sized farms from the pilot area are generally better equipped with the access facilities to irrigation water and the managers of these farms also

have good technical knowledge in agriculture and IT knowledge and skills that enable them to have access to the innovating solutions for irrigation water management proposed by SIRIUS Project.

As regards the institutional failures, the systemic analysis of the innovation process revealed the existence of both forms with inhibiting effect, as follows.

- Hard institutional failures are manifested under the form of:

Excessive abundance of formalized rules in the application of sectoral public policies which most often are not adapted to the realities. For instance, although MARD designed a strategy for drought control, another strategy for investments in the rehabilitation of the irrigation system, and irrigations are a priority in the National Rural Development Plan 2007-2013, the funds that should be made available to NLRA for the operationalization of these strategic measures (including the investments in innovations for system modernization and effectiveness) were considered a state aid by the EU and the funding of investments in the rehabilitation of the main irrigation infrastructure was constrained.

Both the *absence of regulations* in terms of extension and advice for farmers and the *frequent modifications of the rules* in case of land reclamation generates institutional vacuum, in the first case, the themes of interest for farmers are not the object of extension services (for instance, the deficient operation of the information channels on the new regulations, norms, finance opportunities, etc.); in the second case, the change of the organization form and attributions of land reclamation operators need periods of institutional reconstruction and construction of organizational culture.

Weak incentives for researchers make them less willing to work with farmers.

For direct beneficiaries (farmers), the institutional failures consist of: legislative and institutional ignorance, in the case of small farmers who manage their business in a traditional manner and are not interested to know the new regulations); “legal corruption” phenomenon in the case of larger farmers who have influence upon the decision makers.

- Soft institutional failures (values, norms and culture)

In the segment of policy makers and of the innovation generators for agriculture, Romania experiences an excessive formalization of organizations norms and values that affect their creativity in the interactions with other stakeholders and their ability to promote new ideas in their work. The attempt to impose Western values in the operation of institutions from Romania is confronted with a strong resistance to change of these institutions (which holds true for the most part public institutions) and with a superficial internalization of these values.

In the case of NLRA, the organizational culture is under permanent change, due to the frequent modifications of their status. This contributes to fluctuations in their network relations with other actors from the agricultural knowledge system, thus affecting the cooperation opportunities in the innovation processes.

In the case of farmers, the organizational culture models are different according to the purposes of their business. The small farmers are more traditionalist, their values are specific to the empirical knowledge transfer model (from a farmer to another) and they are rather “prisoners” of the traditional view of “making agriculture”. Unlike small farmers, the larger farmers are more open to innovation, as these have profit increase expectations; however, at the same time, the latter are not so willing to pay for innovation.

The irrigation water users’ associations are a relational “core” benefiting the entire rural community.

The *organizational cohesion* is characteristic for them because: “*We get on well together, we are like a family, we have no problems.*” (IWUA president Petroiu); “*There are no problems, it is the farmer with 440 hectares who pays, then he gets his money back.*” (IWUA member APT Comăneasca, commune Tudor Vladimirescu).

The *organizational solidarity* on IWUA was based on the respect of members’ rights and on helping the members; the legal norms ensured the emergence and development of this type of association and succeeded in implementing a modern economic behaviour: “*The rights are ensured by law*” (IWUA president Siliştea)..... “*Farmers get help, water is paid for the small farmers who became members because they grow vegetables.*”(IWUA member APT Comăneasca, commune Tudor Vladimirescu).

- Interactions and networking failures

The main failures in *interactions and networking* that were identified in the process of knowledge production and transfer to agriculture (irrigation in particular) appears in the segment of coordination, creation and extension of the innovation process.

The policy makers interact more in a formal manner with the other actors from AKS. These interactions are more frequently based on the traditional relation between policy makers, on one hand, and public research and extension institutions, on the other hand. The final beneficiaries’ real needs for innovation reach the public agenda with difficulty if their interests do not get support from strong organizations. In the field of irrigations, the farmers began to get organized as water users only in 1999 and their organizations do not have enough negotiation power yet.

The research in the field of agriculture and irrigations suffers from thematic and methodological isolation due to its funding from national research programs that often are not connected to the final beneficiaries' real needs. In Romania, the research brokerage is not a reality yet, and the results of the innovations resulting from research are often listed in a large research work that remains locked in a drawer.

The extension and advisory services are poorly connected with the research institutions and the innovation dissemination to final users is insufficient. Moreover, the bottom-up approach in research is very difficult to achieve in this context.

In the case of the irrigation water users' associations, the relational system with the other actors form AKS is functional: "*We have very good relations with the Agricultural Directorate, they keep us informed about the modification, each month, help us to draw the documentation and now we also appealed to them.*" (IWUA President Silișteea). "*The relations existed, because there were years when they provided subsidies and had to report to National Association for land irrigation.*" (IWUA member APT Comăneasca, commune Tudor Vladimirescu).

The farmers have close links with each other, they frequently interact due to the physical closeness, and they exchange information and knowledge. The large farmers appeal to the extension and advisory services in the problems they are interested in, but most frequently they received the necessary information from the other farmers or they looked for information on the internet.

- Capabilities failures are important inhibitors for innovation.

The policy makers have only little reflexivity on the AKS functionality because they do not have the ability to request a feedback and to learn from experiences. *Universities* have nearly no practical orientation and the research suffered from inadequate mechanisms for the delivery of research outputs (either as new knowledge or new technologies) to farmers through demonstration or via advisors, trainers and educationalists.

Extension providers are uncoordinated, without basic education in advisory techniques, communication skills, quality management procedures etc.; as a result, their actions may confuse the final beneficiaries. NLRA has a weak technical capacity for innovative actions due to the lack of funds for that activity.

IWUAs suffered for a weak organizational capacity because they do not have the networking skills for this type of activity yet, they do not have specialized staff for this and do not have the ability to mobilize all their members to invest in innovation. In the case of *small farmers*, the capabilities failures consist in:

low level of formal agricultural education, lack of knowledge demand capacity, low professional qualifications in the key-problems. *Large farmers* benefits from specialized university education in the agricultural field; they are IT users, yet with a limited time that can be devoted to innovation. This means that they have limited innovation absorptive capacity.

Conclusions

The innovation and the mechanisms by which it is produced, transmitted and promoted among farmers can be considered the key-factor towards a sustainable development of this economic sector.

In Romania, the processes related with innovation production and knowledge transfer to agriculture and rural areas is still tributary to the traditional model based on a strong confidence in scientific progress and in the role of the State as a driver of modernization. Research, education and extension bodies are seen as strong public institutions, and the approach of 'adoption of innovations' and 'transfer of technology' is used, as a top-down linear process, from research to farming and rural development.

There are strong barriers in the dissemination of information through the top-down channels of the classic system for transfer of knowledge and innovation in Romanian agriculture and rural development. One of the main reasons is the bureaucratic structure of this system and the deficiencies in the qualification and involvement of the leadership and employees from these public institutions.

The dissemination segment of agricultural knowledge system is not capable of transmitting and determining the implementation of innovations to the final beneficiaries in an efficient and effective manner because:

- there is little integration and cooperation regarding the exchange of knowledge and know-how between researchers and extensions actors, on one hand and between extension and advice bodies and the final users on the other hand
- traditional culture and superficial organizational culture - at the level of research, governmental, non-governmental, extension entities – there are strong barriers
- there is no network that integrate all the entities involved in the process of knowledge and innovation transfer.

In figure 4, a short overview is given of the bottlenecks and opportunities as they were experienced by Romanian knowledge and innovation system for agriculture and rural development, with a particular attention for the innovation process in the irrigation area. Using the Innovation System Performance matrix, we plotted these failures and driving forces with circles that represents

the areas in which system barriers (red circles) or opportunities (green circles) are observed and the actors that are related to them. In the same figure, we plotted in blue colour the actors and rules that are addressed on SIRIUS project.

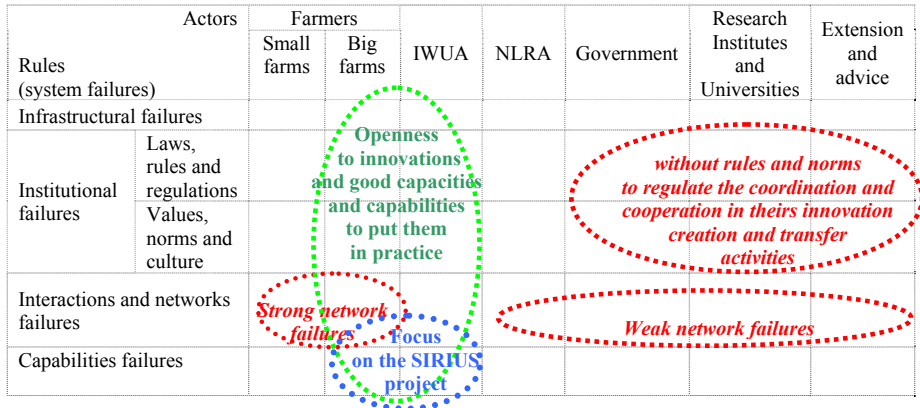


Figure 4. The observed system failures and strengths vs. the actually addressed points in knowledge transfer through SIRIUS project in Romania

The main failures that were identified in Romanian agricultural innovation system functionality and the actors that were affected by them are following:

the policy makers, researchers, educational institutions and extension bodies act without rules and norms to regulate the coordination and cooperation their activities in providing innovation oriented public policies, creating the innovations and transferring them to the final users

because of the lack of linkages between the public actors from AKS (research, extension, advice, policy makers) weak network failures appears due to the fact that the actors mentioned above are not well connected and fruitful cycles of learning and innovation may be prevented because there is no creative recombination of knowledge and resources

the final users from our case study (farmers – irrigation water users) have close links between with each other and acts as closed networks in which the learning process is more related to the confidence in the other members of this small community, this fact causing myopia and blocking new ideas from entering.

Innovation System Performances analysis for the implementation of SIRIUS project in the Romanian pilot area reveled the existence of a good openness to innovations at the big farmers level and, in the same time, they have good capacities and capabilities to put the innovation that was proposed through SIRIUS in practice. There is a strong direct relationship between the degree

of openness to the innovation of the direct beneficiaries and their professional training. In the same time, the final beneficiaries are not so willing to pay for innovation. The SIRIUS project addresses exactly the actors that are more interested in their innovation through creating a direct link between the researchers and final users.

Establishing a direct link between researchers - generators of innovations - and end-users of their innovations, SIRIUS project bypassing the traditional channels of transfer of innovation and through that, avoid the failures from Romanian innovation system.

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Annex 1. Description of the main actors involved in the innovation transfer in Romanian pilot area of SIRIUS project

Direct beneficiaries		Indirect beneficiaries		Research Institutes and Universities	Extension and advise	
Farmers	IWUA's (Irrigation Water Users Associations)	NLRA (National Land Reclamation Agency)	Government			
1 Small farms (< 10 ha)	2 Big farms (> 50 ha)	3 IWUA's (Irrigation Water Users Associations)	4 NLRA (National Land Reclamation Agency)	5 Government	6 Research Institutes and Universities	7 Extension and advise
<ul style="list-style-type: none"> - operate 28.4% of the area equipped for irrigation - in 2007 these farmers applied watering - only for 1/10 of these areas 	<ul style="list-style-type: none"> - manages the relationship between users (farmers) and suppliers (NLRA) of water for irrigation by annual agreements - the ownership of the tertiary irrigation infrastructure (which was built in the communist period) was transferred to the IWUA (after 1999). - Farmers become responsible in maintaining and repairing the irrigation infrastructure that belongs to the IWUA - in the Romanian pilot area, the big farms represents the majority of the members of IWUA (~80%) 	<ul style="list-style-type: none"> - public institution under the Ministry of Agriculture and Rural Development - financed from own revenues (from the price of delivered water for irrigation) and subsidies from the state budget (for "public utility", investments for land reclamation) - manage the primary and secondary irrigation infrastructure - operate, manage, maintain and repair the investments made for land reclamation that are declared at "public utility" - provide water needed for irrigations to IWUA's on the basis of annual agreements 	<ul style="list-style-type: none"> - 5.1 Ministry of Agriculture and Rural Development <ul style="list-style-type: none"> - provide laws, regulations that govern the good functionality of national irrigation system and the relations between the actors involved in the irrigation process - fund the NLRA activities (<i>but not operational costs for the irrigation system functionality</i>) - is represented in territory by County Department of Agriculture that are responsible for the implementation, at the county level, of the ministry strategy and governance program for agriculture, food production, land reclamation, etc. - 5.2. Ministry of Regional Development and Tourism through the 8 Regional Development Agencies at regional level <ul style="list-style-type: none"> - manage the Regional Operational Programme - the overall objective of the ROP consists of supporting and promoting sustainable local development, both economically and socially, in Romania's regions, by improving the infrastructure conditions and business environment, which support economic growth - 5.3. Ministry of Education and Research <ul style="list-style-type: none"> - responsible for national education and research policy through multiannual programmes 	<ul style="list-style-type: none"> - 6.1. Education on agriculture <ul style="list-style-type: none"> - is mostly public - 6 universities and/or faculties related to agriculture - Chambers of Agriculture, some private NGO's and firms organize training on agriculture for farmers under governmental or EU funded programs or projects - 6.2. Research on irrigation <ul style="list-style-type: none"> - 6.2.a National research system <ul style="list-style-type: none"> - National Institute of Research and Development for Land Reclamation - "ISPIF" (working under the scientific coordination of the Academy of Forestry and Agricultural Sciences, Bucharest) provides technical assistance in construction, operation and maintenance for all kinds of land reclamation works such as irrigation, drainage, soil erosion control, fisheries, environment protection, rural development and applied informatics - 6.2.b. International entities <ul style="list-style-type: none"> - WB programs – for evaluation, reform and rehabilitation of Romanian irrigation system - 6.2.c. EU programmes <ul style="list-style-type: none"> - FP 7 - SIRIUS project 	<ul style="list-style-type: none"> - 7.1 County's Chambers of Agriculture - 7.2. County's Chambers of Commerce, Industry and Agriculture - 7.3. Innovative firms-based on research - 7.4. Associations/groups of agricultural producers - 7.5. Local Action Groups - 7.6. National Rural Development Network-Romania - 7.7. Technical assistance projects/programmes - 7.8. National Romanian Committee for Irrigations and Drainage - 7.9. Association for Land Improvements and Rural Constructions from Romania 	

Annex 2. The observed system failures in the process of the acceptance of knowledge transfer through SIRIUS project in Romania

Rules (system failures)	Actors		IWUA's	NLRA	Government	Research Institutes and Universities	Extension and advice
	Small farms	Big farms					
Infrastructural failures	Dispose of irrigation equipment in a small degree	Good infrastructure including IT knowledge	Difficult access to funds for investments in the modernization of tertiary irrigation infrastructure	Financing the maintenance activity for irrigation infrastructure, operated by NLRA, is considered as state aid- it is not allowed by EU	- Bureaucratic system - Lack of convergence	- Insufficient public investments in research infrastructure - Excessive segmentation of thematic	- Structural void - Inefficient segmentation of entities
Institutional failures	Legislative and institutional ignorance	- Well informed, but not by official channels - "Legal corruption" phenomenon		Frequent modification of duties	- Formal framework - Legislative abundance - Empirical inadaptability of laws	- Weak incentives for researchers	Institutional vacuum
Values, norms and culture	Traditional values specific to empirical knowledge	- Open to new if they benefit from - Not so willing to pay for innovation - Acculturation phenomena: modern values superimposed on traditional ones	- Young organization - Organizational solidarity and cohesion	Lack of organizational culture values	- Excessive formalization of values - Inadequacy of imposed values	- Weak motivation - Good intentions - Segmented formalization of norms - Superficial internalization of modern values	
Interactions and networks failures	Have close links each other	Closed networks	Functional interaction	Bureaucratic formalization of the relations between actors	Weak (formal) linkages with other actors	- Inadequacy of dissemination forms - Thematic, methodological isolation	- Lack of connectivity - Weak coordination and correlation
Capabilities failures	Weak educational capabilities	- Limited time that can be devoted to innovation - Specialized university education, IT users	Weak organizational capacity	Weak technical capacity	Formal, stated interest	Weak technical capacity	Socially inefficient strategies

Source: own determination according to ISP matrix methodology, blue color marks the identified strengths in the process of innovation creation and transfer, red color highlights the system failures