

IMPRESA WP3: Case Study Report (D3.2)

Final version

Transition towards organic farming in the Camargue (France)

Sylvain Quiédeville
Dominique Barjolle
Matthias Stolze
Otto Schmid

October 2016

Disclaimer:

This publication has been funded by the European Union.

The contents of this publication are the sole responsibility of the implementing partner of the **impresa** project and can in no way be taken to reflect the views of the European Union.



Table of Contents

I. Introduction.....	3
II. Methodology.....	4
III. Overview of the case study	7
1. Contextual elements and description of the innovation being studied.....	7
2. Research programme under review.....	8
3. The actor network.....	9
IV. Impact pathway from research activities to impacts.....	11
1. Impact pathway story and role of actors in the theory of change of the programme under review	11
2. Measurement of the impacts.....	18
3. Role and influence of the research	19
V. Conclusion.....	22
VI. Discussion.....	23
VII. Bibliography	26
Appendix 1: Methodology.....	28
1. Collection of publicly available information on the project.....	28
2. Sampling and face-to-face interviews	28
3. Workshops.....	29
4. Measurement of the impacts.....	29
5. Evaluating the contribution of the research	31
Appendix 2: Actors short description / Maps of actors (according to time evolution)	33
1. Description of the actors.....	33
2. Network and map of actors regarding the conversion to organic farming in the Camargue.....	36
Appendix 3: Comprehensive Impact Pathway of the transition to organic farming in the Camargue .	42
Appendix 4: Table of links of the innovation pathway.....	44
Appendix 5: To take a step back on the methodology followed.....	52

I. Introduction

The aim of the case study in the IMPRESA Project (in WP3) is to elaborate and test a methodological framework for the assessment and monitoring of the impacts of Scientific Research on Agriculture (SRA). The rationale of following a case study approach was to analyse the innovations and research programmes in-depth by shedding light on the complex processes that occur along the related impact pathways.

The present case study, focusing on conversion to organic farming in the Camargue in France, is one of the six cases in the IMPRESA project, which have been conducted with a view of identifying the main points that could support the improvement of efficiency in agronomic research and discussing the opportunity of taking new indicators into an enlarged European Monitoring of Research Impact Assessment. The conversion to organic farming, which can be considered as a radical innovation, has implied several incremental innovations to be developed and adopted. Our goal in that report is to assess in particular what the role of the agronomic research was in Camargue by tracking the pathway the research has followed in interaction with various enabling and disabling factors.

This case study was primarily chosen given the focus of the study on a particular and limited territory (the Camargue), the availability of numerous publicly documents on the research programme (equivalent to a set of projects) under review as well as the presence of a key informant from INRA (Jean-Claude Mouret) who agreed to share information and knowledge with us. In addition to this, the research programme conducted by INRA and its partners was relatively huge in accordance with the number of research projects in it. A limit was the absence of significant exchanges among farmers. But this aspect gives a certain particularity to the case study and therefore offer a counterfactual situation for the final cross-case comparison in the IMPRESA project.

This case-study report proceeds as follows: In the first section we briefly present the methodology followed; an overview of the case is then provided in highlighting the main contextual elements, the innovation studied and the boundaries of the research programme under review as well as the key actors. This is followed by a fourth section depicting the story of the Impact Pathway of the innovation & research programme. A discussion and conclusion are then made with the goal of emphasising the main results of the case-study as well as issues related to the methodology and the measurement of impacts.

II. Methodology

The general methodology (step by step approach) is described in the IMPRESA case study manual (Stigler, Quiédeville, and Barjolle 2014). We slightly adapted the methodology for the Camargue case-study. We briefly explain below how we collected and analysed the information.

We conducted in-depth interviews (**step 1** of the manual) with respondents from INRA, the CFR, the Natural Park of Camargue, private traders (the SARL Thomas, the Comptoir Agricole du Languedoc and BioCamargue) as well as with 15 Camargue farmers (4 organic, 7 partially-organic, and 4 conventional). Researchers (INRA and CFR) were interviewed with the aim to (a) identify the outputs produced by research activities; and (b) to gather understandings as to the role of the research for supporting farmers' transition to organic rice production. The traders were interviewed for collecting overall views and shedding light on changes related to scaling-up of the value chain. As to the producers, they were interviewed to identify general factors (not necessarily linked to research) that facilitated or hindered the farmers' transition, and also to collect the likely impacts of the innovation pathway. The list of potential impacts was then completed thanks to projects' expected impacts (from programme's documentations). Furthermore, a Social Network Analysis (SNA) was done by interviewing all the stakeholders mentioned above (during the same round of interviews).

We have drawn the "researcher's pathway" (**step 2** in the manual) by taking into account the links which were the most raised by stakeholders. The links output-outcome, outcome-outcome, and external factor-outcome were "activated" when a majority of farmers raised them. Regarding the activities-outputs links, we took account of statements from researchers working at INRA, CIRAD and CFR, and for the institutionalisation of the organic rice value chain, we considered the opinions of the organic traders. We therefore attempted to consider the opinion of the actors who were most concerned by the different pathway's components.

We then conducted two workshops (11¹ and 20² persons attended). The objective of these workshops (**step 3** in the manual) was to reconstruct the theory of change and draw the impact pathway. The first workshop was on general factors influencing the innovation process while the second was rather focused on the pathway and impacts of the research programme as such. In the second workshop, the stakeholders were intended to identify changes (outcomes³) related to the transition to organic production (new techniques adopted, relationships and behavioural changes) before defining how they have occurred (activities, outputs, milestones, respective role of the main actors). Finally, the stakeholders have drawn

¹ Present: 6 farmers, 2 researchers from INRA, 1 speaker, and two researchers from the case study team.

² Present: 2 researchers from INRA, 3 researchers from the CFR, 2 participants working at the SARL Thomas, 1 contributor from BIO Camargue, 1 moderator, 1 speaker, 7 farmers, and two assistants.

³ The likely or achieved short-term and medium-term effects of an intervention's outputs (OECD 2002).

the ISRIP pathway by themselves in linking cards representing the different pathway's events, i.e. the activities, outputs, and so on. The identification of the changes was conducted in a plenary session while the completion of the subsequent steps was undertaken through discussions within three diversified groups. At the end of the workshop, we presented the draft of the ISRIP pathway built at the preceding step (the "researcher's pathway"). However, we were unable to reflect the ISRIP pathways with each other because of limitation of time.

A second round (**step 4 and 5** in the manual) of face-to-face interviews was then done with 12 partially-organic (only one part of the farm is organic) and organic farmers (out of a total of 35) as well as with 1 researcher from INRA. All of the interviewees were asked to (1) assess the validity⁴ of the links (except those relying on relationships issues) for which the necessary conditions (including the identification of a relevant underlying mechanism) were not satisfied on the basis of the information collected so far; (2) assess how important the links are in the pathway (use of a 1 to 3 scale); and (3) identify the crucial events through reflexions in terms of counterfactual situations. Note that the links related to research activities were studied with INRA and the others thanks to farmers. Another task, but only done with the interviewed farmers, was to measure the impact pathway indicators (the indicators were previously defined by the case study team on the basis of the list of impacts). Moreover, we must emphasize that the SNA helped us to evaluate the accuracy of links related to relationships issues.

Finally, a feedback round (9⁵ persons attended) was done (**step 6** in the manual) for presenting findings and securing the agreement from stakeholders.

⁴ This was done by checking whether the necessary conditions were satisfied as well as by the identification and evaluation of the accurateness of plausible alternative explanations to the underlying mechanisms.

⁵ Attendance: The president of the rice farmers, two researchers from INRA, one organic farmer, and two researchers from the case study team.

Table 1: Methodological steps for the case study

Common methodological steps	Sources of information	Data collection methods	Data processing methods & tools
1.Initial screening	<ul style="list-style-type: none"> - In-depth interviews with 5 respondents from public and private entities; and with 15 farmers. - Publicly available documents (to be more aware on the programme's objectives, the research activities...). 	<ul style="list-style-type: none"> - SNA matrix filled: The stakeholders were asked to estimate the intensity of their relationships with the other actors involved in the network. - Farmers were asked to quote what the impacts are from their perspective. 	<ul style="list-style-type: none"> - Qualitative analysis of the face-to-face interviews and publicly available documents. - Social network analysis with the Ucinet software.
2.Impact pathway building (1)	<ul style="list-style-type: none"> - In-depth interviews with 5 respondents from public and private entities; and with 15 farmers. - Publicly available documents (to be more aware on the programme's objectives, the research activities...). - First workshop (11⁶ persons attended). 	<ul style="list-style-type: none"> - Qualitative analysis of the face-to-face interviews. - The general factors being raised by the majority of the concerned stakeholders were taken up in the first impact pathway diagram. - Guided workshop discussion. 	Qualitative analysis of the face-to-face interviews.
3.Impact pathway building (2)	<ul style="list-style-type: none"> - Second workshop (20 persons attended⁷). 	Guided workshop discussion: Identifying changes (outcomes) related to transition to organic production before defining how they have occurred, the role of the main actors, and then to draw the impact pathway.	All the opinions expressed were considered.
4.Data collection	<ul style="list-style-type: none"> - Second round of face-to-face interviews with 12 partially-organic and organic farmers (out of a total of 35) as well as with 1 researcher from INRA. - Theories on innovation were also taken into account in order to help identify the alternative explanations. - Results of the Social Network Analysis, in order to suggest and verify pathway's links on relationships issues. 		
5.Evaluation & attribution of the Impact			
6.Feedback round		Feedback round. 9 ⁸ persons attended.	
7.Discussions/ conclusions/ lessons learned	All sources.	All collected data.	

⁶ Present: 6 farmers, 2 researchers from INRA, 1 speaker, and two researchers from the case study team.

⁷ Present: 2 researchers from INRA, 3 researchers from the CFR, 2 participants working at the SARL Thomas, 1 contributor from BIO Camargue, 1 moderator, 1 speaker, 7 farmers, and two assistants.

⁸ Attendance: The president of the rice farmers, two researchers from INRA, one organic farmer, and two researchers from the case study team.

III. Overview of the case study

1. Contextual elements and description of the innovation being studied

The Camargue territory, located in the south-east of France and extending to 145,300 ha, was the scope of this study. We mainly focused on rice production for three main reasons: (1) until 2015, at least, rice was the main crop production in the Camargue; (2) the flooding of the paddy fields results in the pollution of the Rhône (river) since the chemical molecules of the pesticides applied tend to go in the Rhône when emptying the paddy fields; and (3) rice helps to reduce the salt concentration in lands (the paddy fields are flooded).

From a broad perspective, we should specify that organic rice production has increased in the 1980's through the initiative of pioneer producers. In 2014, it accounted for 10% of the total rice farming area and for 16% of the rice producers in Camargue (35 out of total of 215). The main rice trader is the SARL Thomas, which processes around 5000 t of organic rice per annum. Other rice traders in the Camargue are mainly the Comptoir Agricole du Languedoc (also called "Madar"), BioCamargue that commenced trading in 2005, as well as the cooperative "Sud Céréales" that maintains strong relationships with the SARL Thomas through the intermediary of BIOSUD. The latter, specialized in marketing all organic rice from both Sud Céréales and the SARL Thomas, was created in 2003 with a view to improving the organization and thus the performance of the organic rice value chain. In addition to these operators, some others institutions and private companies operate within the organic supply chain (see part 3 on the Actor Network).

The actors have emphasized 5 important incremental innovations (technical and organizational) for organic rice production during the second workshop on reconstructing the impact pathway. They are as follows:

- **Technical innovations:**

- **The development of crop rotation systems:** It consists in cultivating several and different crop productions as well as extending the crop rotations. It is intended to reduce risks linked to pests, diseases and weeds (interruption of their life-cycle). In Camargue, this technique brings some specific challenges: The hot climate does not allow producing successfully many spring crops and the salinization of lands makes cultivating deep-rooted crops (rape, sunflower, etc.) difficult.
- **False-seed bed techniques (mechanical):** This incremental innovation lies in working the soil to allow the germination of weeds seeds, followed by further cultivations to remove and control weeds. In the Camargue, the presence of Cyperaceous raises particular challenges given the difficulty to eradicate their bulbs, with many re-growing.
- **Seeding and flooding the paddy fields at a later period:** The seeding and flooding are interrelated as the flooding precedes or just follows the seeding depending on how the

rice is sowed (by broadcasting afloat or in row). The interest of deferring the sowing date is to increase the window of opportunity to control weeds (before seeding) and facilitate a rapid growth of the rice thanks to higher temperatures (later period in the season) which encourages the smothering of weeds.

- **Increasing the crop-seeding rate:** The objective of increasing the crop seeding rate is to smother weeds as soon as they emerge.

- **Organizational innovation:**

- **Organization of the organic value chain:** Creation of the firm BIOSUD in 2003. BIOSUD is owned 33% by SARL Thomas as well as for SudCéréales, and is their unique direct outlet for organic products.

2. [Research programme under review](#)

In the year 2000, a research programme made for organic rice production was launched by the French National Institute of Agronomic Research (INRA) together with its boundary partners (CIRAD, CFR, FranceAgriMer), with a view to creating new technical orientations adapted to organic production but also to foster the development of the organic production in Camargue. The related sub-objectives were to give a consistent place to organic production and marketing, make a strong link with training, create new training modules on organic rice production and related issues, and implement an international symposium to develop knowledge on relevant techniques for controlling weeds and discovering potential interactions between worldwide stakeholders. Six projects, which were identified as relevant to help foster organic production in the Camargue territory, have been taken into account.

The six projects under review are as follows:

- **The CE BIOCA project (2000-2004):** The CE BIOCA project (Mouret et al. 2005) has been conducted over the years 2000-2004. CE BIOCA stands for “céréaliculture biologique en Camargue” (organic cereals in the Camargue). This project attempted to explore the conditions of developing organic cereals and to highlight the yield variability factors. INRA and its partners saw the organic production development as being a response to depressed prices and poor economic returns. The project followed a multi-disciplinary approach by involving geneticists, agronomists, economists, and sociologists, with a view to producing references linked to the production requirements of organic farming and developing crop management techniques as well as adapted quality signs.

- **Experimentations in farming plots (2005-2006):** Experimentations in farming plots were running over the years 2005-2006. The purpose of these experimentations was to develop new crop management techniques, that is, techniques for fighting weeds and improving the fertilisation management, in response to issues resulting from the CE BIOCA project.

The trials were conducted on agricultural holdings of partner's farmers with the support of INRA's allies, namely the CFR and the CIRAD.

- **The ORPESA “Table” (2008):** The ORPESA project (Bayot et al. 2009) was conducted in the year 2008. It stands for “Organic Rice Production in Environmentally Sensitive Areas” and was part of the Leonardo Da Vinci programme funded by the European Union. The project was executed with the goal of developing organic rice production in environmentally sensitive areas. INRA established a professional training (called “ORPESA table”) to support farmers’ conversion to organic rice production, mainly by sharing knowledge on weeds management and fertilization with organic and conventional farmers.
- **Experimentation of crop management techniques (2011):** New technical experimentations were conducted by INRA and its partners. These experimentations were mainly focused on weeds management. They were also conducted on agricultural holdings of partner's farmers.
- **International conference on rice (2011):** An international conference on organic rice was conducted and held in Montpellier in 2011. The event's intent was to facilitate exchanges between rice producers, researchers and other actors operating at the different stages of organic rice value chains throughout the world. The related main sub-objectives were to make a state of the art of current knowledge on organic rice production systems, as well as identifying innovations being carried out and the barriers that are restricting their development.
- **CIRAD's Experimentations (since 2012):** They are focused on the technicality of the following machines: Harrows, hoes and rotavators. Chain and Flat harrows (type Z) are tested with the goal of encouraging the weed seed germination (first pass), followed by a second pass to control them. These two runs are made before bringing ducks in lands with a view to fighting weeds as well.

3. [The actor network](#)

The main involved actors in the research programme and innovation under review are two researchers from INRA, one scientist from CIRAD, the cooperative SudCéréales, the private trader SARL Thomas, and 35 partially-organic and organic farmers. FranceAgriMer (National Institute) is also important even though it does not show up in the middle of the actors’ map⁹ (farmers are not directly connected to this institution). FranceAgriMer has financed many experimentations and projects (around 150,000 euros invested between 2000 and 2015) implemented by the INRA, the CIRAD, and their partners. Note that the CFR, the Rice-Farmers Union and the Park of the Camargue are not core elements in the actors’ map. The fact of providing supports to farmers in order to ease the transition towards organic farming is not

⁹ The maps of actors are shown in appendix 2.

considered as a strategy to be followed by both the CFR and the Rice Farmers Union. In fact, the CFR is very linked to the Rice-Farmers Union (the director is the same) and is therefore under pressure from conventional rice producers committed to the Rice-Farmers Union and throwing organic agriculture into some disrepute. Moreover, no organic farming organisations appear to have influenced the actor network. When collecting information on actors' relationships, it was asked whether they were part of farming organizations or linked to some of them, but they answered negatively.

Table 2: Role of the main actors within the network

Main actors	Important role played in the innovation story
SudCéréales (cooperative)	It has been involved in the creation of the firm BIOSUD in the year 2003.
SARL Thomas (private trader)	It has been involved in the creation of the firm BIOSUD in the year 2003.
BIOSUD (private trader)	It was founded in 2003 with a view to selling organic products on market. It offered more outlets for the producers.
INRA (French National Institute of Agronomic Research); Jean-Claude Mouret being a key scientist	INRA was the main implementer of the research programme under review.

The network has substantially evolved since the year 1999, when INRA and its partners launched the programme we assess in this report (maps of actors are in appendix 2). INRA, BIOSUD and CIRAD are today the most important actors in the network, but it has not always been the case. INRA and CIRAD were becoming more and more important, mainly due to their increasingly closed relationships with farmers (exchange of information). As to BIOSUD, its influence has steadily increased since 2003 when it was founded as a response to the growing numbers of organic farmers and to the favourable development of the overall organic market. We should specify that BIOSUD was created by the SARL Thomas and the Cooperative, making the latter two important players in the Impact Pathway story (in 2003 in particular) even though they should not be considered as main key actors anymore.

the CFR attempted to support INRA which was the coordinator of the project. From INRA researchers' views, this project had functioned well, permitting a deepened knowledge on organic production systems. It highlighted yield variability factors, the other main agronomic problems encountered by farmers as well as the constraints that were being faced in accordance with the different types of farms. It was found that the density of weeds is the main factor explaining yields variability. In addition, the weeds management was recognized as the main problem encountered by farmers, all the more due to the presence of Cyperaceous for which the bulbs are difficult to eradicate. This learning phase has allowed the discovery of new technical systems and innovative cultural practices within farms that were not referenced by INRA up to that time. Furthermore, experimentations in farming plots (in 2005-2006), of which the investment is estimated between 50,000 and 90,000 euros (INRA and FranceAgriMer), would not have happened without the CEBIOCA project and related results. Indeed, the INRA would not have set up suitable experimentations without being aware of organic production systems and the main issues to be studied. These experimentations, which were implemented by the INRA, CIRAD, FranceAgriMer and CFR, have developed new crop management techniques, that is, techniques for controlling weeds and improving the fertilisation management, in response to issues resulting from the CEBIOCA project.

The ORPESA "Table" and experimentations set by farmers: Sources of knowledge for implementing advanced experimentations

The ORPESA training scheme (2006-2007), funded by the European Union with around 60,000 euros (total cost of between 140,000 and 180,000 euros), was completed thanks to experimentations in farming plots, "trials" set by farmers (refinement and optimization of the production system) annually, but also to the decision made by the European Union to involve INRA in the ORPESA project. In effect, the ORPESA project was first initiated by the European Union. INRA was contacted afterwards to ask for their participation. Then, the decision to focus on organic Camargue rice was taken both by the coordinator of the project ORPESA (EU) and Jean-Claude Mouret from INRA.

The knowledge exchange platform (Bayot et al. 2009), implemented by INRA, allowed the latter and some farmers to develop their knowledge as all of the participants had a keen interest to share experiences and technical practices with each other. However, if several sessions took place, only few farmers participated, and some of them only for one or two sessions. Some of the farmers who decided not to participate or in a limited extent, have argued during individual interviews that the training sessions were not sufficiently linked with concrete results made by scientific experimentations. The main interest areas arising from the training sessions were then embodied into leaflets and circulated by INRA in placing them at the CFR for free consultation.

There is clear evidence that the ORPESA table would not have occurred if the CEBIOCA project and experimentations in farming plots had not taken place. In fact, INRA would not have been able to participate without being aware on organic rice production systems and issues to be

studied as well as possessing significant knowledge to bring into the exchange platform. In the same context, “trials” conducted by producers annually were needed (crucial) to implementing the ORPESA “Table” as it allowed growers to bring knowledge as well. At the end of the ORPESA project, producers recommended to test the most relevant crop management techniques mentioned during exchanges. Their advice has been followed by INRA in developing new experimental trials in the year 2011. The investment was between 55,000 and 85,000 euros (INRA and FranceAgriMer). These advanced scientific experimentations would not have happened without the ORPESA project which proposed avenues for improvements.

The advanced experimentations: Trigger elements for implementing the first international conference on rice

The new experimentations (2011), implemented by INRA thanks to financial supports from FranceAgriMer, have importantly supported the development of international relationships aiming at exchanging knowledge with foreign researchers and learning of each other’s experiences through high quality interactions. The underlying mechanism is that new issues and challenges were arising from testing and that little responses were available at the national level. It was therefore desirable to extend the scope of the study to an international scale. Then, the development of global relationships greatly assisted the organisation of the first international conference on organic rice which was held in Montpellier in 2011. This conference costed around 90,000 euros and was mainly financed by the Agropolis foundation (30,000 euros), which is a French scientific foundation created in 2007 and aiming at encouraging high level research and education as well as enlarging international research partnerships in agricultural sciences and sustainable development research. The other financial partners were the INRA, SupAgro (National Institute of Further Education in Agricultural Science), the regional political level, and FranceAgriMer. Despite of the substantial content of the conference, none of the stakeholders aside from INRA offered any evidence of a link between the international conference and likely related outcomes (through outputs). The INRA’s opinion was not taken into account to avoid influencing results considering the INRA was the main architect of the international conference being held.

The CIRAD’s experimentations: Disappointing results

Other experimentations, focusing on the technicality of different machines such as chain harrows and attempting to test the interest of bringing ducks in lands to fight weeds, have been conducted by the CIRAD since 2012. These experimentations are mainly financed by FranceAgriMer. As surprising as it may sound, the ducks like eating weeds but “consume” the rice to a very limited extent. The experimentations are conducted in collaboration with an organic farmer who made a part of his fields available to CIRAD. In that way, both the grower and the CIRAD take benefit on the experimentations: The CIRAD has land available for trials and the farmer is very interested in hosting experimentations answering issues arising within his production system, which is influenced by specific local conditions. The latter are important in Camargue given the heterogeneity of the texture and structure of the soils as

well as the height of the land compared to the sea level, which influence the salt concentration of the soils. The organic grower is very satisfied with this collaboration and the ensuing results. That said, we have to underscore the very limited scope of these experimentations. At the moment, only one rice producer out of a total of 140 benefits from this research effort. The other farmers are not willing to make use of this production system, mainly because of the time-consuming nature of the technique (soil working, meticulous management of the height of the water, duck feeding). As a consequence, experimentations set up by the CIRAD have not contributed much so far to the development of relevant techniques to fighting weeds, in the sense that they are not perceived very positively by the potential beneficiaries.

The Social Network Analysis: A confirmation of the growing importance of INRA within the network

The CEBIOCA project, the experimentations from INRA and its partners as well as the ORPESA “Table” have led to a rise of the INRA’s influence in the network through establishing relationships with farmers who hosted scientific experimentations or had a keen interest about them, and by doing in-depth discussions with producers during the ORPESA “Table”. Apart from the ORPESA table, the research activities that have increased the influence of INRA also have led to a growing centrality of the CIRAD in the network. Moreover, experimentations conducted by the CIRAD itself, logically have contributed to its increasing influence. The Social Network Analysis (see also graphics in Appendix 2) allows confirming the growing influence of both CIRAD and INRA within the network.

A main indicator (further details in Appendix 2) demonstrating the growing importance of INRA is the Betweenness¹¹ score (degree of intermediation), which has increased about 46% between 1999 and 2014. This increasing centrality of INRA in the network is explained by three elements:

- The increase in relationships between INRA’s neighbours, which is demonstrated by a growth of 60% of the INRA’s Clustering Coefficient¹². The increase in relationships among the INRA’s neighbours is mainly due to stronger relationships between CIRAD and FranceAgriMer and particularly since 2012: Experimentations implemented by CIRAD, since 2012, are financed by FranceAgriMer.
- The increase of around 80% in the Degrees between INRA and farmers since 1999.
- INRA and CIRAD have developed stronger bilateral relationships as a result of the CEBIOCA project.

¹¹ Allows an operator to be deemed to have a privileged position insofar as it is an intermediary between different operators within the network.

¹² Coefficient which can provide information on a “gregariousness trend” within the network.

With respect to the CIRAD (further details in Appendix 2), its Betweenness score increased about 34% since 1999. The growing importance of CIRAD in the network is explained by two elements:

- A growth of 60% of its Clustering Coefficient due to increasing relationships between INRA on the one hand and CFR and FranceAgriMer on the other hand. Those changes were resulting from the first experimentations in farming plots (2005-2006).
- The stronger relationships between CIRAD and farmers that are revealed by an increase in the bilateral Degrees about 45% since 1999.

Moreover, it is interesting to note that some farmers confused CIRAD with INRA: During the second round of in-depth interviews with farmers, we noted that 4 farmers out of a total of 12 made references to CIRAD when talking about researchers from INRA. The role played by CIRAD is therefore diminished compared to the SNA results.

Limited scope of the research's outputs and crucial importance of economic driving factors

Most of the incremental techniques under review (false seed-bed techniques, seeding and flooding at a later period, increase in the level of water in paddy fields, extending crop rotations) are seen as moderately important to support farmers' transition to organic farming. That said, the increase of the plant density was seen as minor, and the development of the crop rotation as very important.

All the farmers emphasized the unfeasibility to switch to organic farming without extending crop rotations. Another crucial incremental innovation, but organizational, is the improved market access due to the packer enterprise BIOSUD. The relationship between farmers' transition and scaling-up of the value chain was bidirectional. The growth in the number of organic farmers has encouraged the private trader SARL Thomas and the cooperative SudCéréales to organize a specific value chain for organic rice by creating the firm BIOSUD in 2003. This institutionalization, in turn, has allowed sustaining farmers' conversion through the increase in storage capacities for organic products and the improvement of the throughput of the storage silos that prevents delays during harvest seasons.

Moreover, the important price difference (around 100%) between organic and conventional rice as well as the CAP subsidies to both convert and maintain organic surfaces have been reported as two crucial economic and external factors. There are clear evidences that without those elements, the innovation would not have taken place.

The CFR: A limiting factor in the pathway

Furthermore, in the workshops and in-depth interviews, the rice farmers pointed out a lack of involvement of the French Centre of Rice (research and extension centre) that is seen as a barrier for them to switch to organic rice (lack of experimentations and very weak knowledge brokering activities). The French Rice Centre's missions are to provide information and advices to farmers, experiment cultivation techniques and implement a breeding programme.

However, the fact that the involvement of organic farming was not recognized as strategic and given the budget constraint, the CFR has not made specific research for organic rice. In fact, the CFR is very linked to the Rice-Farmers Union and is therefore under pressure from conventional rice producers committed to the Rice-Farmers Union and throwing organic agriculture into some disrepute.

Interestingly, growers underscored this lack of supports as an obstacle. Two reasons can explain this. Firstly, the CFR is a specialized research centre that should answer to issues both arising from conventional and organic rice, farmers reported. Secondly, producers think that the CFR should work in specialist areas that INRA currently engages in but the CFR should also be undertaking. This could also explain the limited recognition of the work assumed by INRA, but we did not test this hypothesis.

The Camargue: A conservative mentality

It is interesting to note the absence of peer-to-peer exchanges between farmers. None of the farmers justified their decision to adopt incremental innovations through inspiration from their neighbours' practices. This hypothesis was tested for all the technical incremental innovations that were identified previously. In fact, this result was not surprising for two main reasons: (1) There is no common work nor sharing of material goods between farmers, which is very uncommon within the agricultural sector in France; and (2) all collaborations (CUMA, joint work) between farmers were unsuccessful in the past: Litigations over outstanding accounts, disagreements on the use of the materials, and so on (Quiédeville 2013; Bassenne et al. 2014).

Some impacts attained

The transition to organic farming contributed to attaining some impacts (see part 2 for more details) at the level of the Camargue territory: Increase in the surface dedicated to organic rice production; fall in the use of pesticides, water, fuels and nitrogen; increase in net margins per hectare; and decrease of the total surface devoted to rice in Camargue. Those impacts are arising from the aggregated outcome "Adoption of the organic production mode".

Table 3: Summary¹³ about “critical points” and enabling & disabling factors.

Influence of the research	“Critical points” (the links that would not have been “activated” without the research)	Enabling factors	Disabling factors
Rather direct	The research programme on Camargue organic production systems would probably not have taken place without one key scientist from INRA.	Participatory training sessions (ORPESA project) were useful for participants (ideas shared, new relevant scientific experiments suggested). That said, only a few farmers attended.	Lack of involvement of the French Centre of Rice: Farmers saw this as a barrier to them converting to organic production.
	Experimentations in farming plots (in 2005-2006), would not have happened without the CEBIOCA project and related results. INRA would not have set up suitable experimentations without being aware of organic production systems and the main issues to be studied.		
	The ORPESA table would not have occurred if the CEBIOCA project and experimentations in farming plots had not taken place. INRA would not have been able to participate without being aware on organic rice production systems, issues to be studied, and possessing significant knowledge.		
	The advanced scientific experimentations would not have happened without the ORPESA project which proposed avenues for improvements.	Increasing influence of INRA in the network , due to the ORPESA project and scientific experimentations conducted. Increased relationships with farmers has mainly helped the idea of organic farming to be developed in Camargue.	
Rather indirect		Creation of the firm BIOSUD in 2003 , which has supported farmers’ conversion mainly through increasing the storage capacities for organic products.	
		Extending crop rotations is crucial for switching to organic farming.	
None		CAP subsidies for conversion to and maintenance of organic areas.	Absence of peer-to-peer exchanges between farmers (“close mentality”).
		Price of organic rice; with an important price difference of around 100% with conventional rice.	
		“Trials” conducted by producers annually have allowed them to bring knowledge in the ORPESA sessions.	

¹³ More details in part 3 “Role and influence of the research”.

2. Measurement of the impacts

The research programme conducted by INRA and its partners have been producing impacts, in other words the effects, intended or intended, produced by the outcomes in a long-term perspective (OECD 2002). A very expected impact is the increase in the surface under organic rice, which has steadily increased, from around 1000 ha in 2008 (200 ha in 1980) to 1400 ha in 2014. It is however difficult to establish a correlation between this evolution and the programme's implementation given the lack of data for the period 1999-2003. The other key impacts mainly concern the decline of the resources used (pesticides, water, fuels, nitrogen). The time span covers from 1999 (just before the research programme started) to the year 2014 (when evaluating the research programme).

Table 4: Impacts of the conversion to organic farming.

Impacts	At the level ¹⁴ of the organic/partially-organic farms	At the level ¹⁵ of the Camargue territory
Surface devoted to organic rice	around 200 ha in 1980 ; 1400 ha in 2014	
Use of pesticides	-51%	-8.5%
Use of fuels (excluding harvesting)	-17%	-3%
Use of nitrogen	-24%	-4%
Consumption of water	-45%	-8%
Total surface under rice	-45%	-8%
Net margin (on the rotation) in 2013	+146% in partial organic mode/conventional +111% in organic mode/conventional	

Source: Statistics from the Agence BIO and calculations based on farmers' statements.

More precisely, we noted a decrease in the use of pesticides around 51% at the organic/partially-organic farm level (farmers who have converted at least a part of their surface to organic farming) and 8.5% in the Camargue (conventional and organic farms), which is directly due to the rise of the surface under organic production. The use of pesticides was measured by the treatment frequency index (TFI¹⁶). The consumption of fuels also has diminished (-17% at the organic/partially-organic farm level and -3% in the Camargue), due to the introduction of crops (grasslands and alfalfa) less demanding in terms of soil working. Then, there is a decrease in nitrogen requirements (-24% at the organic/partially-organic farm level and -4% in the Camargue) resulting from the decrease in the yields as well as the

¹⁴ Farmers who have converted at least a part of their surface to organic farming.

¹⁵ Conventional and organic farms.

¹⁶ TFI equals the ratio of the dose applied to the approved dose. Interviews made at the fourth steps of the methodology raised this issue with farmers by asking the products and the dosages applied. The approved dose were found on the official website: e-phy.agriculture.gouv.fr.

cultivation of crop productions requiring few or zero units of nitrogen (grassland and alfalfa). Finally, the water used has diminished about 45% at the organic/partially-organic farm level and 8% within the Camargue region, thus on the same scale as the decline in the total surface under rice caused by the transition to organic rice farming. The consumption of water is directly correlated to the surface of rice sowed as it is the only crop production in Camargue that needs to be “irrigated” (flooded).

The unexpected reduction of the total surface dedicated to rice, about 45% at the organic/partially-organic farm level and 8%¹⁷ within the Camargue (between 1999 and 2014), is explained by the fact that switching towards organic production requires an extended crop rotation to control weeds. This was unexpected in the sense that this was not reflected at the onset, but it was not a surprise when it occurred. We encountered some difficulties to measure the reduction of the total rice surface due to the conversion to organic farming. There was an attribution issue. When looking at the difference in terms of surface of rice between 1999 and 2014, we only see the global decline. There was another important factor contributing to this decline: The reform of the CAP payments (in 2012-2013) which has decoupled the aids attributed to the rice. Farmers are therefore discouraged to produce rice because they get the same CAP payments when cultivating other cereals being less costly to cultivate. To solve this attribution issue, we asked farmers their surface under rice they had before converting and after, so that we could see the difference due to the conversion.

Another important impact is the increase in net margins per hectare about 111% for the organic farmers (on crop production), without taking the single payment entitlements into account. The difference is even more important, about 146%, for the partially-organic farmers. Those dissimilarities seem to be very important, but can be explained by two main elements: (1) Farmers who converted their lands to organic farming usually possess adapted parcels with a relatively low stock of weeds, therefore ensuring good yields when cultivating in an organic way; (2) most of the farmers converted their surface recently and are not faced yet with huge problems in terms of control of weeds. This underscores the need to monitor the impacts over a long time period.

3. Role and influence of the research

As mentioned above, the CEBIOCA project, the different scientific experimentations as well as the ORPESA “Table” have contributed to increasing the knowledge exchange between INRA and CIRAD on the one hand and the farmers on the other. The research activities played an important role in developing the network, and the influence of INRA and CIRAD increased accordingly. In accordance with the results of the Social Network Analysis and the second face-to-face interviews with farmers, the exchanges between farmers and INRA can be qualified as important and the exchanges between farmers and CIRAD as minor. Additionally, the

¹⁷ This number is less important because not all the farms have been converted to organic agriculture, even partially.

discussions with INRA were indicated as “informal” by farmers. The main reason is that the discussions were not based on “evidences”¹⁸ derived from “real”¹⁹ scientific experimentations nor in relation with specific local conditions of each farm. The farmers think that the information provided have remained too vague for immediate up-taking. The “informal discussions”²⁰ were respectively little and moderately important for developing crop rotation systems and switching to organic farming.

Farmers underscored that the adoption of technical incremental innovations was principally derived from the “tests” set by themselves (refinement and optimization of the rice production system) and, in a more limited extent, from leaflets produced by INRA (built on the basis of the experimentations and the ORPESA “Table”²¹). Interestingly, the respondents asserted that the research did not influence at all the decision of increasing plant density whereas this technique was also described in leaflets produced by the INRA. Similarly, all incremental techniques for controlling weeds were the subject of an INRA communication in an oral form (when meeting producers) but farmers did not really recognize this.

These results raise two important social aspects. First is the communication supports (orally, leaflets, documents). Second is the way by which the farmers receive the information (door to door talking; through plenary sessions; by phone, post or mail; etc.). In the present case, the fact that the INRA has not sent leaflets to farmers (but left them at the CFR for free consultation) may explain the lack of acknowledgement from producers. In addition to this, there was a lack of precision in the advice provided in leaflets although the recommendations were more precise, farmers said. The crux of the problem is the very specific and heterogeneous local conditions in the Camargue, which reduce the effectiveness of generalised information to all the farms. Moreover INRA is more acknowledged by farmers who hosted a part of its scientific experimentations (they rated a double score of relationships with INRA when asking information for SNA). They recognized more the relevance of the techniques developed and their appropriateness to local conditions.

We identified several “critical points” in the Impact Pathway, that is, the links that would not have been “activated” without the research:

- The whole research programme would probably not have taken place without one key researcher from INRA: Jean-Claude Mouret. Indeed, he decided (mainly with one colleague) to develop this programme somehow against the INRA’s will.
- The first experimentations in farming plots (2005-2006) would not have happened without the CEBIOCA project (identification of the problems) and related results.

¹⁸ Farmers reported that INRA and CIRAD did not communicate orally precise results regarding experimentations. In addition, farmers were not able to quote any precise advice they have received orally from INRA and CIRAD.

¹⁹ Experimentations conducted by INRA were not very scientific, farmers said.

²⁰ Farmers formulated this expression during the second focus group that attempted to reconstruct the Impact Pathway.

²¹ Within the second focus group, farmers highlighted that the ORPESA table was linked to farmer’s transition to organic production. However, only two farmers out of a total of 12 confirmed during the second round of face-to-face interviews. In addition, if they have confirmed it, they stressed its low importance.

- The ORPESA “Table” (training sessions) would not have occurred without the first experimentations made (2005-2006), and therefore without the CE BIOCA project and related results. Likewise, this exchange platform owes its existence to the influence exerted by the coordinator of the ORPESA project who contacted and trusted researchers from INRA and especially Jean-Claude Mouret.
- The ORPESA leaflets and the international conference on organic rice systems in Montpellier would respectively not have been produced and held without the ORPESA “Table” and thus without the CE BIOCA project, its results, and the first experimentations.
- The advanced experimentations (2011) on crop management techniques would not have been conducted without the ORPESA “Table” where a deepened diagnosis was made on current farming systems. By extension, they would not have been done in absence of the CE BIOCA project and its results as well as the first experimentations in farming plots (2005-2006).
- The growing influence of INRA and CIRAD in the network would not have occurred without the CE BIOCA project and the first experimentations in farming plots (2005-2006). In fact these two activities were crucial in the chain of events leading to the increasing influence of INRA and CIRAD.
- The increasing volume of interactions in the network (more exchanges and links) would not have happened, or to a very limited extent, without the growing influence of INRA.

From the above, one can extract three crucial events: (1) The CE BIOCA project; (2) the results of the CE BIOCA project; and (3) the first experimentations conducted in farming plots. By contrast, the incremental technical and institutional innovations (false seed-bed techniques, seeding and flooding at a later period, increase in the level of water in paddy fields, extended crop rotations, and institutionalisation of the supply chain) would probably have occurred in absence of the research, in the same way as the conversion to organic production would have happened.

This conclusion cannot be fully confirmed but we observed that the “critical points²²” are only situated within the research system and between activities and outputs²³. This emphasizes that even though the research produced some outputs, the latter have led to outcomes and impacts to a minor extent. We calculated (according to the method presented in Appendix 1) that the research has importantly contributed to the achievement of the output 1 (typology of farms, farmers’ problems and constraints known) and output 3 (ORPESA leaflets), and satisfactorily for the output 2 (relevant techniques to control weeds, embodied into leaflets). But if the “critical points” would not have been present (counterfactual analysis), the consequences on the impact pathway would have been relatively limited, in the sense that

²² The links that would not have been “activated” without the research

²³ the products, capital goods and services which result from a development intervention; may also include changes resulting from the intervention which are relevant to the achievement of outcomes (OECD 2002).

the outcomes and impacts would still appear. It is however difficult to say if their magnitude (rate of adoption, degree of impacts) would be on the same scale; but we calculated that the research contribution to achieving outcomes was null concerning the increase in plant density, satisfactory regarding the other technical innovations (false seed-bed technique, seeding and flooding at a later period, putting more water in the parcels), and limited for the conversion to organic farming and to achieving impacts.

V. Conclusion

The research has played a limited role to support farmers' transition to organic farming. Three main evidences were identified: (1) Informal testing made by farmers on crop rotation were very important to help them to switch towards organic farming; (2) economic factors were also important and even indispensable; and (3) the institutionalization of the supply chain for organic rice was seen as a crucial factor (the research did not contribute substantially).

Four main links in the impact pathway have been identified:

- The CEBIOCA project and related outputs without which first experimentations in farming plots would not have happened.
- The ORPESA "Table" which owes its existence to the CEBIOCA project and the ensuing initial experimentations.
- The ORPESA "Table" has led to implementing advanced experimentations.
- The growing influence of INRA in the network was due to the CEBIOCA project and the first experimentations in farming plots (2005-2006).

But the research activities and outputs were not acknowledged by the interviewed farmers as being important factors to adopting incremental innovations and switching to organic farming. The perception of the farmers reflected a situation where there was a gap between research outputs and the story telling about their individual decision of adopting new techniques. Producers also underscored that the knowledge exchange flow was not very strong between them and INRA and quasi non-existent among themselves (when excluding the ORPESA "Table").

We may first question the strategy to make the leaflets available at the French Centre of Rice and not to send them to farmers. A second issue is the appropriateness of the advices for each of the farm, which raises the necessity to further link experimentations and particular local conditions. Finally, the role of the institutions, that undertake experimentations, should be further investigated since farmers underlined the CFR should work in specialist areas that INRA currently engages in, but CFR should also be undertaking: The institutional factors influencing the behaviour of the farmers should be studied deeper.

VI. Discussion

Use of impact assessment results and relevance of the impacts measured

The evaluation of the research programme has allowed barriers to adoption of organic agriculture to be identified and studied. This concerns particularly the gap reported by stakeholders between scientific experimentations on the one hand and the specific local conditions encountered on farms on the other. In effect, since the farms are quite heterogeneous within the territory (different altitudes, types of soils, etc), experimentations results appear not to be very suitable for some farmers. Another important point is the very insufficient implication of the CFR in terms of experimentations and advices given about technics for organic rice. The stakeholders suggested the CFR should work in specialist areas around organic rice the INRA currently engages in but CFR should also be undertaking. Furthermore, the experimentations should be designed and conducted more in collaboration with farmers; and on-farm trials should be further developed. The fact of having experimentations more in line with farmers' expectations may strengthen training sessions like ORPESA (in case such training would happen again). Indeed, the farmers may be more convinced to participate, as the discussions may be more relevant for them. Moreover, we think that external experts should regularly assess whether and how outputs, outcomes and impacts are actually achieved in order to bring changes in the way research programmes are executed. In fact the researchers seem to be too optimistic regarding the use of results by potential beneficiaries as well as the achievement of valuable results.

Four environmental and three socio-economic impacts were taken into account in this case study. The table 5 explains why those impacts were relevant to measure or not and what may be improved in the method in that respect.

Table 5: Relevance of research impact measured in the IMPRESA Camargue Case study

Type of impact	Impact	Relevance	Comments
Environmental impacts	Organic surface of rice	It is a good indirect measure of the environmental impacts	Should be measured over time
	Use of pesticides	Not necessarily valuable since the quantity of chemical products sprayed is strongly correlated to the evolution of the surface under organic rice	It would be more interesting to go beyond and assess how the biodiversity evolves for example, as it implies complex dynamics between ecosystem and production practices
	Use of fuels	Relevant given the importance of those inputs and their important impacts	But those tasks are time consuming
	Use of nitrogen		
	Use of water	Not an important issue because it evolves on the same scale as the total surface of rice seeded	Should not be measured over time
Socio-economic impacts	Total surface of rice	Important because the rice helps the reduction of the salt concentration in lands and therefore allows the Camargue to remain an agricultural area	But it is not simple to estimate the decline in surface which is directly due to the transition to organic farming.
	Incomes on crop production	Pertinent given the important differences in terms of economic returns depending on whether farmers cultivate in an organic way or not	This impact should be monitored over many years in order to make sure that the profitability of the organic productions will remain like that.

The method applied

We encountered some difficulties when applying the evaluation methodology, especially on the procedure followed during the second workshop, which attempted to reconstruct the impact pathway. Stakeholders were asked to first define changes (behaviour, relationships, and actions) related to organic farming, before linking them to activities and outputs. The identification of the changes proved difficult, and numerous requests for explanations were posed. It would have been more appropriate to ask changes that occur in personal situations instead of generally, in order to make the exercise more concrete and understandable. The changes could also be collected during face-to-face interviews before the workshop, in order to leave more time for reflecting on the different impact pathways at the end of the stakeholders meeting.

Additionally, one of the workshops for reconstructing the impact pathway was probably too many, whilst some overlaps occurred. This has made the stakeholders less willing to continue participating in the process, especially for the feedback round. Finally, the decision was made to stick to a participatory approach in taking both the primary programme's objectives and the beneficiaries' opinions into account (in that case, the farmers), as basis for the evaluation. This may be viewed as an important bias in the theory of change. Indeed, general impacts such as the ones on the environment were not raised although they probably are important in the eyes of the society. We may bring some modifications in the method we followed by asking experts to complete the list of impacts.

During the second workshop on reconstructing the impact pathway, many various opinions were raised as to the innovation story. Particularly, the farmers expressed a completely different opinion from INRA's researchers at the beginning of the workshop. But this, instead of being a problem, has helped the discussion to really be launched: In fact, the INRA somehow demonstrated that the farmers were wrong, and that some research activities were done and producing results. And the impact pathways have been drawn collectively by finding compromises between different points of views. Nevertheless, since some stakeholders could have dominated the discussions, we decided to validate their statements by following the process tracing method as suggested in the case study manual. We therefore analysed whether all the pathway's events and related links really occurred on the basis of official statistics and information, published articles, the results of the Social Network Analysis, and the majority opinions in face-to-face interviews. We then assessed the strength of the different links. To do so, we did a second round of face-to-face interviews with the stakeholders. The linkages outputs-outcomes were rated by the farmers as they are potential beneficiaries and directly concerned by adoption. It is however questionable: one may argue that the participatory approach loses its substance. We may also say that in-depth interviews would have been sufficient but this would mean forgetting that the workshops really helped to understand the underlying conflicts and issues in the Camargue region. We have learned a lot on the mentality of the actors, their behaviours and beliefs, their different strategies, etc. It seems that people reveal more information when they are "accused" or criticised. Likewise, people react about elements raised by others, which otherwise would have not been taken that much into account. In face-to-face interviews, we may get less information as the interviewer should not influence the answers; there are less interactions and the impact pathway diagram could not be elaborated very well.

VII. Bibliography

- Barbier, J. M., Mouret, J. C., Hammond, R., and Delmotte, S. (2013). "Une plateforme de recherche-développement pour stimuler les apprentissages et accompagner l'agriculture biologique en Camargue (France)". In *Symposium International sur l'Agriculture Biologique Méditerranéenne et les Signes Distinctifs de Qualité liée à l'Origine*. 2013-12-022013-12-04, Agadir, MAR.
- Bassene, J.B., Quiédeville, S., Chabrol, D., Lançon, F., Moustier, P. 2014. "Organisation en réseau et durabilité systémique de deux filières alimentaires (riz biologique et petit épeautre en France)". In : Actes des 8èmes Journées de recherches en sciences sociales, Grenoble, France, 11-12 décembre 2014. INRA, SFER, CIRAD.
- Bayot, M., Mouret, J.C., Hammond, R., and Nougarèdes, B. (2009). "Formation Professionnelle et Recherche Participative. Actions Combinées Pour Développer La Riziculture Biologique En Camargue (France)." *Innovations Agronomiques*.
- Borgatti, SP., Everett, MG., and Freeman, LC. (2013). *Analysing Social Networks*. SAGE Publications Ltd; First Edition.
- Chataigner, J. (1997). "Activités de recherche sur le riz en climat méditerranéen". *Cahiers Options Méditerranéennes*, 24(02).
- Delmotte, S. (2011). "Évaluation Participative de Scénarios : Quelles Perspectives Pour Les Systèmes Agricoles Camarguais ?" Montpellier SupAgro. <http://hal.cirad.fr/tel-00664304/>.
- Delmotte, S., Lacombe, C., Couderc, V., Mailly, F., Mouret, J.C., Lopez-Ridaura, S., et al. (2013). "Obstacles, levers and impacts of organic farming development in Camargue". *Innov Agron*; 32:213–26.
- Delmotte, S., Tittonell, P., Mouret, J-C., Hammond, R., Lopez-Ridaura, S. (2011). "On farm assessment of rice yield variability and productivity gaps between organic and conventional cropping systems under Mediterranean climate". *Eur J Agron*;35(4):223–36.
- France AgriMer. (2011). "Étude Coûts de Production Sur Le Riz Camarguais Récolte 2011" <http://www.franceagrimer.fr/content/download/25632/214156/file/Etude%20co%C3%BBts%20de%20%20production%20sur%20le%20riz%20camarguais%20-%2021%20juin%202013.pdf>
- Mailly, F., Delmotte, S., Mouret, J.C., Ridaura, S., Barbier, J.M. (2011). Submitted. "Décisions d'assolement et changements d'usage des sols en agriculture conventionnelle et biologique : conséquences sur les surfaces en riz dans le delta de la Camargue". *Cahier de l'Agriculture*.
- Mouret, J.C., Dreyfus, F., Desclaux, D., Marnotte, P., Mesleard, P., and Barbier, JM. (2005). "La Construction D'une Démarche Interdisciplinaire À Partir de L'émergence de La Céréaliculture Biologique En Camargue: Le Projet CEBIOCA." In Actes Du Séminaire Sur Les Recherches En Agriculture Biologique- Programme AgriBio de l'INRA, 31–41.

- Mouret, J.C., Hammond, R., Bayot, M., Fabre, D., Thomas, C. (2009). "Production de références pour optimiser la fertilisation organique en riziculture biologique camarguaise (France)". *Carrefours l'Innovation Agron.* INRA; 4:9–13.
- Mouret, J.C., Hammond, R., Dreyfus, F., Desclaux, D., Marnotte, P., Mesléard, F. (2004). "An integrated study of the development of organic rice cultivation in the Camargue (France)". In International Conference on Challenges and Opportunities for Sustainable Rice-Based Production Systems. Torino; 2004.
- Mouret, J-C., Hammond, R., Ridaura, S.L., Delmotte, S. (2012). "Démarches et méthodes pour produire des références techniques et pour accompagner les riziculteurs biologiques camarguais (France)". 1re conférence internationale Les systèmes de production rizicole biologique [Internet]. 2012 [cited 2016 Aug 26]. Available from: <http://www1.montpellier.inra.fr/orp2012/images/communications/mouret.pdf>.
- OECD. (2002). "Glossary of Key Terms in Evaluation and Results Based Management." *OCDE Publication*. Paris.
- Quiédeville, S. (2013). "Durabilité Systémique de La Filière Du Riz Camarguais: Comparatif et Intéraction Entre La Sous-Filière BIO et Conventionnelle." Montpellier SupAgro.
- Quiédeville, S. (2016). Submitted. "Contribution of Social Network Analysis for Evaluating Impacts of Science-Based Research and Innovation Program: The Example of Farmers' Conversion to Organic Crop Production in Camargue". *The Journal of Agricultural Education and Extension*.
- Quiédeville, S., Barjolle, D., Stolze, M., Mouret, J-C. (2016). Submitted. "Ex-Post Evaluation of Impacts of Science-Based Research and Innovation Program: A New Method Applied in the Case of Farmers' Transition to Organic Production in Camargue." *Journal of Innovation Economics and Management*.
- Stigler, M., Quiédeville, S., and Barjolle, D. (2014). "Manual for Case-Studies on Research Impacts' Evaluation." Frick.

Appendix 1: Methodology

1. Collection of publicly available information on the project

We gathered information from publicly available documents describing the programme under review and the innovation being studied. These documents included the grey literature, published papers like articles focusing on the ORPESA project, but also the leaflets from INRA. The objective was to be more aware on the outputs produced by the research.

2. Sampling and face-to-face interviews

We conducted two rounds of in-depth interviews with the involved actors. In a first round we interviewed respondents from INRA, the French Centre of Rice (CFR), the Natural Park of Camargue, private traders (the SARL Thomas, the Comptoir Agricole du Languedoc and BioCamargue) and 15 farmers (4 organic, 7 partially-organic, and 4 conventional) out of a total of 140. These stakeholders were interviewed, mainly to understand the general factors that fostered or hindered the innovation pathway.

This first round also aimed at collecting information for Social Network Analysis (SNA). We took account of three dimensions: Information flows, collaboration and financial links (with an average calculated). Intensities of relationships (clustering coefficient²⁴, “betweenness”²⁵, “degrees”, distance) were defined by stakeholders in accordance with a rating from 0 to 3. Note that we did not consider the direction of the relationships as this information was not collected in both directions for all the potential relations: The CIRAD and the Union-Farmers Rice were not interviewed at their decision. In those cases, the score stated for one direction has been duplicated in the other direction. In addition to the current relationships, we asked stakeholders to reconstruct the actor network at 6 periods (1999, 2001, 2003, 2005, 2006, and 2010). We made the assumption that the innovation process is derived from changes in the system actors and thus correlated to the “SNA trend”. In fact, the SNA survey asked stakeholders for relevant relationships around organic farming issues. Actors were also asked to detail what has changed, when, why and how.

In a second round, we asked 12 organic and partially-organic farmers²⁶ (the beneficiaries of the innovation) to estimate the importance of the different factors (outputs, external factors, etc) in achieving outcomes. The scale used was: null (0), low (1), moderately important (2), and important (3). However, events focusing on relationships among actors were studied by

²⁴Coefficient which can provide information on a “gregariousness trend” within the network.

²⁵Allows an operator to be deemed to have a privileged position insofar as it is an intermediary between different operators within the network.

²⁶ 8 farmers were the same as those interviewed at the first step.

SNA, attributing the scores in relative terms, and for the other links we asked key researchers from INRA.

3. Workshops

Three workshops were organized: Two workshops aiming at reconstructing the theory of change of the programme, and a feedback round.

The first workshop (11 persons attended²⁷) was organized after conducting first in-depth interviews in order to undertake a review concerning general factors that positively or negatively influenced the farmers' transition to organic production. This workshop has allowed to finalize the initial pathway.

The second workshop (20 persons attended²⁸) aimed at describing and drawing the impact pathway from research activities to outcomes, on the basis of stakeholders' standpoint.

As to the final feedback round (9 persons attended²⁹), we invited all the interviewed stakeholders to present and validate findings, as well as acknowledging their contribution to the study. Note that farmers were very reluctant to participate insofar as they already had contributed through 2 meetings and 2 rounds of in-depth interviews.

4. Measurement of the impacts

- Total surface under rice: During the second round of face-to-face interviews, we asked 12 organic and partially-organic farmers what their current (in 2014) and previous (before converting) crop rotation is and was. The difference equals the decline in the lands under rice, and was expressed in percentage. Knowing that the surface of organic rice today accounts for 17% of the total surface under rice in Camargue, we deduced the fraction of the decrease in the rice area related to the transition to organic farming ($45\% \times 17\% = 8\%$).
- The use of pesticides: It was estimated through the treatment frequency index (TFI)³⁰ which equals the ratio of the dose applied to the approved dose. Interviews conducted with organic/partially-organic farmers at the fourth step of the study raised this issue by asking the products sprayed and the dosages applied, in the year 2014 and before having converted to organic agriculture. The approved doses were found on the official website: E-phy.agriculture.gouv.fr. The diminishment (in percentage) in the use of pesticides at the

²⁷ Present: 6 farmers, 2 researchers from INRA, 1 speaker, and two researchers from the case study team.

²⁸ Present: 2 researchers from INRA, 3 researchers from the CFR, 2 participants working at the SARL Thomas, 1 contributor from BIO Camargue, 1 moderator, 1 speaker, 7 farmers, and two assistants.

²⁹ Attendance: The president of the rice farmers, two researchers from INRA, one organic farmer, and two researchers from the case study team.

³⁰ TFI equals the ratio of the dose applied to the approved dose. Interviews made at the fourth steps of the methodology raised this issue with farmers by asking the products and the dosages applied. The approved dose were found on the official website: e-phy.agriculture.gouv.fr.

level of the Camargue was deduced in the same way as for the surface dedicated to rice (see above).

- The use of nitrogen: Given the difficulty to get directly the information from organic/partially-organic farmers, we first asked the yields and the crop rotations before calculating the quantity of nitrogen required, on the basis of the needs per 100kg of product (see table 6). Still, the information was asked for two periods, before the conversion and in 2014. Moreover, we made the assumption that the nitrogen residue in the soils (from the previous crop production) are about 20kg/ha, apart after cultivating alfalfa. After alfalfa, we made the assumption the N residue is about 50kg/ha. The nitrogen required is calculated as follows: $[(\text{yield} * \text{needs}/\text{ha}) - \text{N residue}]$.

Table 6: Needs of nitrogen/ha

Crop production	Needs (kg)/100kg of product/ha
Durum wheat	3.5
Rice	3
Rape	7
Barley	2.2
Soft wheat/Triticale	3
Alfalfa	0

- The use of fuels: It was even more difficult to measure directly the consumption of fuel. We asked organic/partially-organic farmers to report their crop management techniques with the material used (in 2014 and before converting). We then calculated the consumption of fuel on the basis of the “barème d’entraide” (scoring grid) from the French Agricultural Chamber of the Loiret ⁽³¹⁾. We calculated the consumption of fuel per hour and the performance (ha/hour) of the material in order to estimate the consumption per hectare.
- The use of water: We asked organic/partially-organic farmers whether their consumption of water per hectare of organic rice has changed because of the transition to organic farming and to what extent.

³¹<http://www.loiret.chambagri.fr/fileadmin/documents/Machinisme/grandeculturelevage2015sanscouverture.pdf>.

5. Evaluating the contribution of the research

We developed a method to calculate the role of the research. We first estimated the extent to which each impact pathway's event has led to subsequent events. To do so, we estimated the "strength" of the pathway links, which were rated by stakeholders in accordance with a scale from 0 to 3. The score of each pathway link was then put into relation to the aggregated score of all links leading to the same event. For instance, two links having a score of "3" each contribute to 50% in reaching the same event (they both contribute to this event).

Evaluating the research contribution was relatively complicated since we are faced with a domino effect. The role of the research can be estimated as follows:

Role of the research in achieving an event A = (degree of importance of the links leading to the event A)*(role of the research to achieving the events (previous ones) being connected to the event A.

Example through the figure 2 below:

- All the activities (n° 8, 5, and 2) are fully derived from the research (100%);
- The first link is of minor importance (in black) and rated "1", while the others are important (in red) and rated "3";
- The minor link contributed to 14% in achieving the output 2, while the others each contributed to 43%;
- The research fully contributed to the achievement of the output 2 (100%).

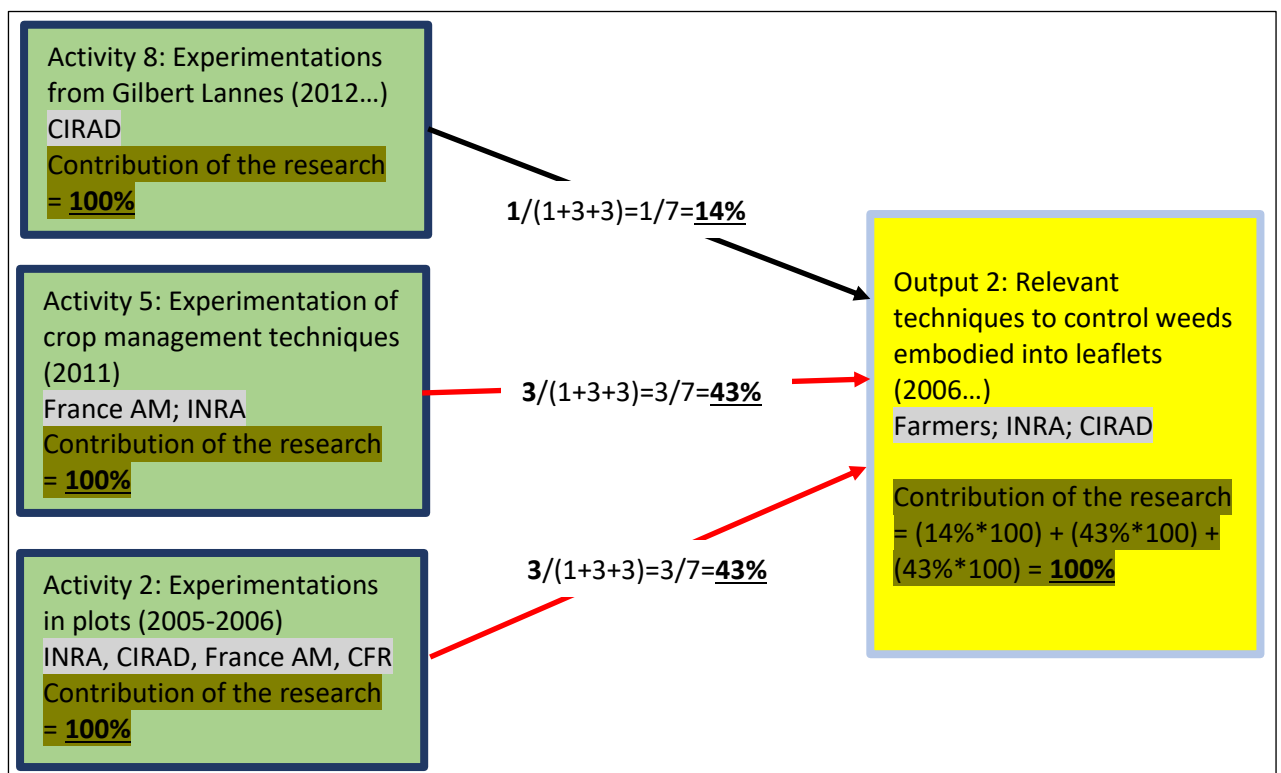


Figure 2: Estimation of the contribution of the research activities (n° 8, 5, and 2) to achieving the output 2.

We then converted the contribution of the research, expressed as a percentage, into words. The table 7 illustrates this:

Table 7: calculation of the research contribution

Contribution of the research in percentage	Conversion into words
<5	Null
]5 to 15]	Very low importance
]15 to 25]	Low importance
]25 to 35]	Limited role
]35 to 50]	Satisfactory
]50 to 65]	Quite important
]65 to 80]	Important
]80 to 100]	Very important

Appendix 2: Actors short description / Maps of actors (according to time evolution)

1. Description of the actors

a) The cooperative and the private traders

- The cooperative SudCéréales: SudCéréales processes both organic and conventional crop productions, including the Camargue rice. In the late 70's, the cooperative was the only trader for rice. Later, in the year 2007, the cooperative has encountered some difficulties. The cooperative had invested in a silo with high capacities, but this strategy was not successful as the other important players in the Camargue followed the same strategy at the same time. There was therefore an excess of storage capacity on the scale of the Camargue, and the cooperative was operating at a loss. The group Soufflet has then taken control of the business. The different parts signed a contract stipulating that Soufflet must be the only outlet of the cooperative. In 2012, SudCéréales collected roughly 60,000T of conventional rice and 0.3t of organic rice.
- The SARL Thomas: The SARL Thomas is a private trader. It was founded in the year 1982 in the Camargue and collected around 6000-7000 t of conventional rice. But the company has taken a turn in 1990. The company switched from conventional to organic production. The rationale of that change is that the SARL Thomas was not able to compete with the cooperative SudCéréales.
- The firm BIOSUD: BIOSUD was created in the year 2003. Both the cooperative and the SARL Thomas took the opportunity to create a specific value chain dedicated to organic production. BIOSUD is specialized in selling organic products, collected by the cooperative and the SARL Thomas, on markets.
- BioCamargue: This company was found in the year 2005. It only processes organic rice. In 2012, BioCamargue collected around 1000 t of organic rice.
- The Comptoir Agricole du Languedoc (MADAR): It collects many different products, including Camargue rice. The company collected respectively 29,000 t and 1,000 t of conventional and organic rice in 2012.

b) The research and extension institutes

- INRA: INRA stands for “National Institute of Agronomic Research”. It launched many research programmes related to conversion to organic rice production. Jean Claude Mouret from INRA Montpellier is specialized on this topic. He possesses consequent knowledge of and experiences on rice management issues. He has been working with rice farmers for more than 30 years.
- CFR: CFR stands for “Centre Français du Riz” (French Centre of Rice). It was founded in 1985. The CFR experiments cultural technics, implements plant breeding programmes, and provides technical supports for rice farmers.
- The CIRAD: It stands for “French Agricultural Research and International Cooperation Organization”. CIRAD creates and provides new knowledge in partnership with developing countries in the South with the aim to support the agricultural development and contribute to debate around major agronomic issues in the world.

c) Other institutions

- The Rice Farmers Union: It was found in 1986. It aims at defending the interest of actors involved in the Camargue rice supply chain. It is funded by rice producers, the traders and processors, FranceAgriMer, the PACA & Languedoc Roussillon region, the General Council of the Bouches-du-Rhône and the European Union through the grant FEADER (European fund for the rural development).
- The Park of the Camargue: It was created in 1970 with the goal to protect the cultural heritage, to ensure control over the land use, to boost the social and economic development, to provide publicly available information on the Camargue, and to conduct research and experimentations.
- FranceAgriMer: It is the National Institute of the Agricultural and Seafood Products. With respect to the markets, its missions are the implementation of a business intelligence, the monitoring of markets, the management of measures on market regulations, and to alert professionals in case of crisis. Then, it endeavours to reinforce the supply chains efficiency and to communicate on risks within value chains.
- The Tour du Valat: It is a Research Centre for the conservation of Mediterranean wetlands. It was founded more than 50 years ago by Luc Hoffman. The centre has since then developed its research activities for the conservation of Mediterranean wetlands with the aim to halt the loss and degradation of Mediterranean wetlands and of their natural resources, and to restore them.

- SupAgro: It is a National Institute of Further Education in Agricultural Sciences and offers a full range of courses from Bachelor of Science Degree level vocational qualifications to PhD level, as well as a range of agricultural engineering training curricula. SupAgro also aims at improving sustainable development in Agriculture.
- “Agropolis foundation”: It is a French scientific foundation that was created in 2007 to encourage high level research and education as well as to enlarge international research partnerships in agricultural sciences and sustainable development research. The members of the foundation are the CIRAD, INRA, SupAgro and the IRD. The latter is a research institute for development; it focuses its research on relationships between humans and their environment.

2. Network and map of actors regarding the conversion to organic farming in the Camargue

a. The Social Network Analysis

The Social Network Analysis (Borgatti, Everett, and Freeman 2013) confirmed the growing influence of both CIRAD and INRA within the network.

The Betweenness³² score (degree of intermediation) of the INRA has evolved from 370 in 1999 and 415 in 2006 to 542 in 2014 (+46% and +31%) whereas other players' Betweenness has remained stable or even decreased, apart from the CIRAD. The average Degrees evolvment (intensity of relationships among actors) also illustrates the increasing centrality of INRA. They have increased about 84% over the last 15 years (from 19 in 1999 and 21 in 2005 to 35 in 2014) for INRA compared with 29% (from 4.9 in 1999 to 6.3 in 2014) for the entire network: This difference provides clear evidences as to the growing role played by INRA on the network. However, the INRA has not allowed for reducing distance among actors. It has decreased about 12% (2.5 in 1999 to 2.2 in 2014) whether INRA is taken into account in the analysis or not.

The increasing centrality of INRA in the network is explained by four elements. First is the increase in relationships between the INRA's neighbours, which is demonstrated by a growth of 60% of the INRA's clustering coefficient³³ (from 0.1 in 1999 to 0.16 in 2014). The underlying mechanism is that individuals with high clustering coefficients (central actors) are linked to actors who are well connected together, increasing the importance of relationships between the central actors and their direct neighbours. The increase in relationships among the INRA's neighbours is mainly due to stronger relationships between CIRAD and FranceAgriMer and particularly since 2012: Experimentations implemented by CIRAD, since 2012, are financed by FranceAgriMer. A second factor explaining the increasing centrality of INRA is the increase of around 80% in the Degrees between INRA and farmers (from 15 over the years 1999-2005 to 27 over the years 2010-2014). These bilateral Degrees started increasing from the year 2005, which means that the CEBIOCA project (2000-2004) did not create significant relationships between farmers and INRA although it was crucial to implementing other research activities. The first experimentations in plots and the ORPESA table boosted interactions between INRA and farmers while the advanced trials (2011) allowed maintaining the same level of relationships. Third, the INRA and CIRAD developed stronger relationships as a result of the CEBIOCA project. They did not exchange about organic crop production before this (the bilateral Degrees switched from 0 in 1999 to 1 over the years 2001-2014). Finally, we noted the steadiness of the relationships between INRA and other stakeholders apart from farmers and CIRAD, and the absence of declining relationships among network's actors when excluding

³² Allows an operator to be deemed to have a privileged position insofar as it is an intermediary between different operators within the network.

³³ Coefficient which can provide information on a "gregariousness trend" within the network.

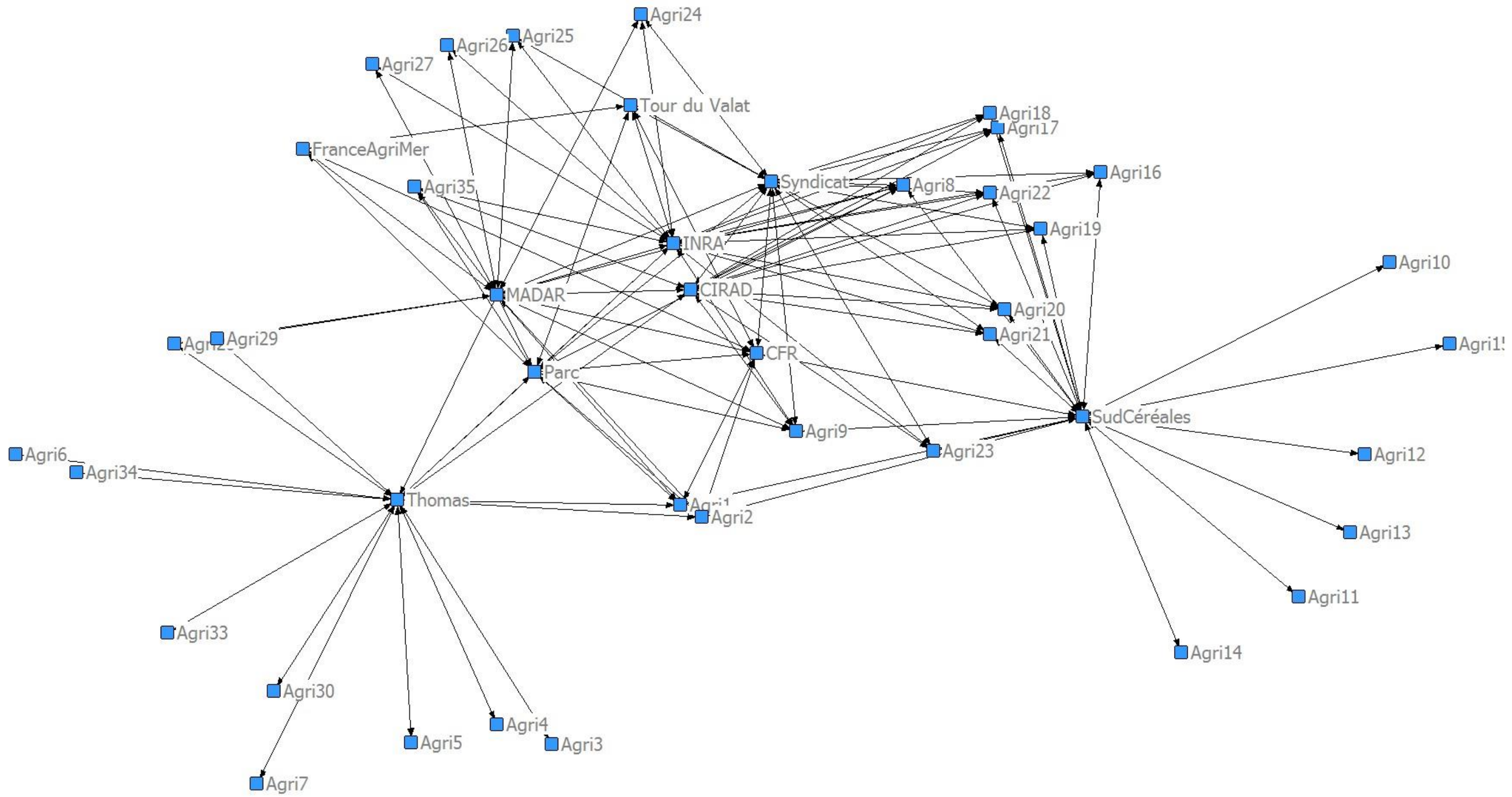
the INRA (the average Degrees among them has even increased from 4.1 in 1999 to 4.8 in 2014).

With respect to the CIRAD, its Betweenness score increased about 34% (from 175 in 1999 to 235 in 2014) and the average “degrees” around 61% (from 14 in 1999 to 22.5 in 2014). The latter increased more than for the entire network (+29%), nonetheless, the CIRAD has not contributed to reducing the distance in the network.

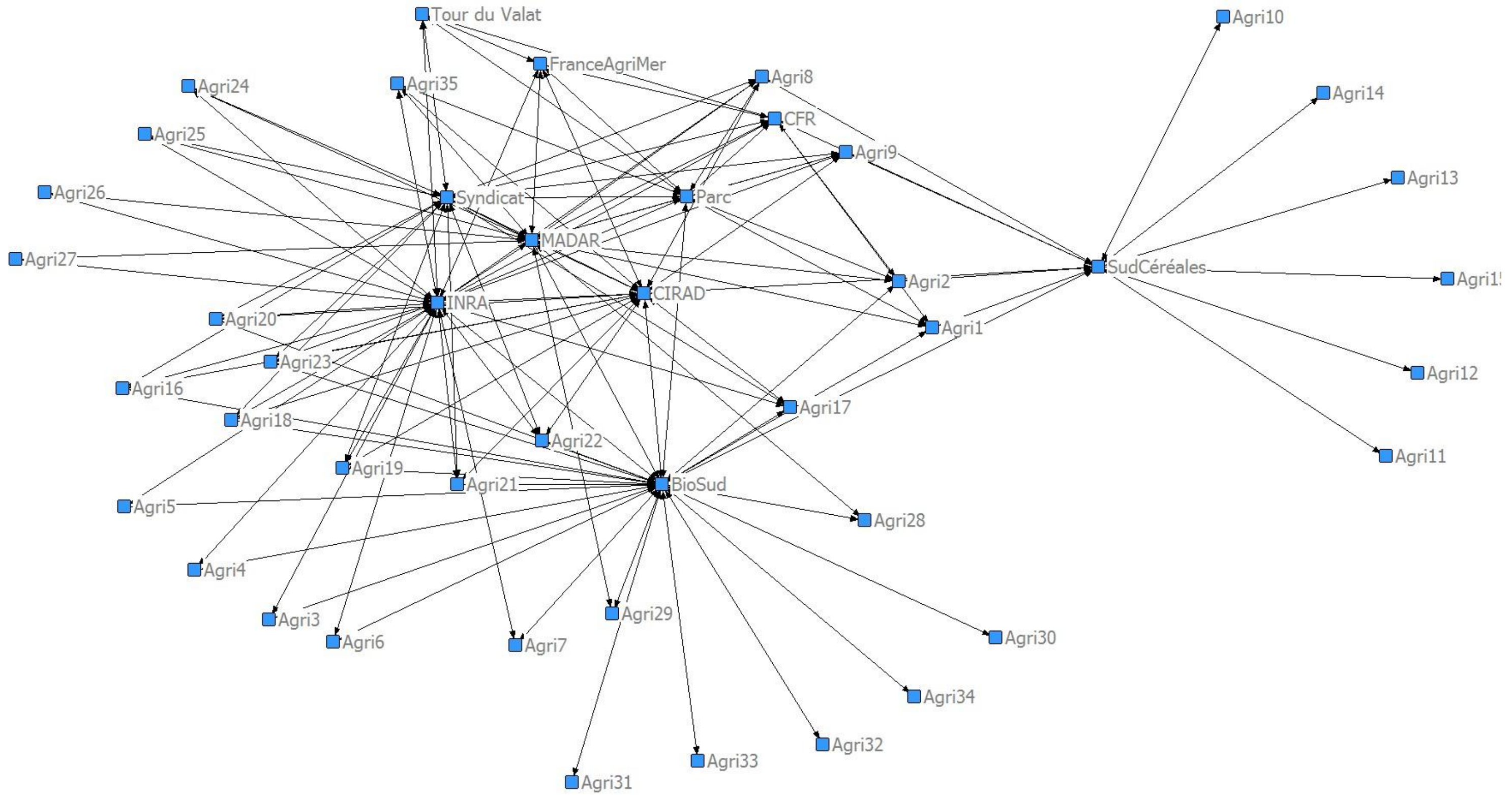
The growing importance of CIRAD in the network is explained by two elements. The first is a growth of 60% of its clustering score (from 0.2 in 1999 to 0.32 in 2014) due to increasing relationships between INRA on the one hand and CFR and FranceAgriMer on the other hand. Those changes were resulting from the first experimentations in farming plots (2005-2006). The second is the stronger relationships between CIRAD and farmers that are revealed by an increase in the bilateral Degrees about 45% (from 11 over the years 1999-2010 to 16 in 2014). By contrast, however, the increase of the bilateral “degrees” between farmers and INRA was approximately 80%.

Moreover, it is interesting to note that some farmers confused the CIRAD with the INRA: during the second round of in-depth interviews with farmers, we noted that 4 farmers out of a total of 12 made references to CIRAD when talking about researchers from INRA. The role played by CIRAD is therefore diminished compared to SNA results.

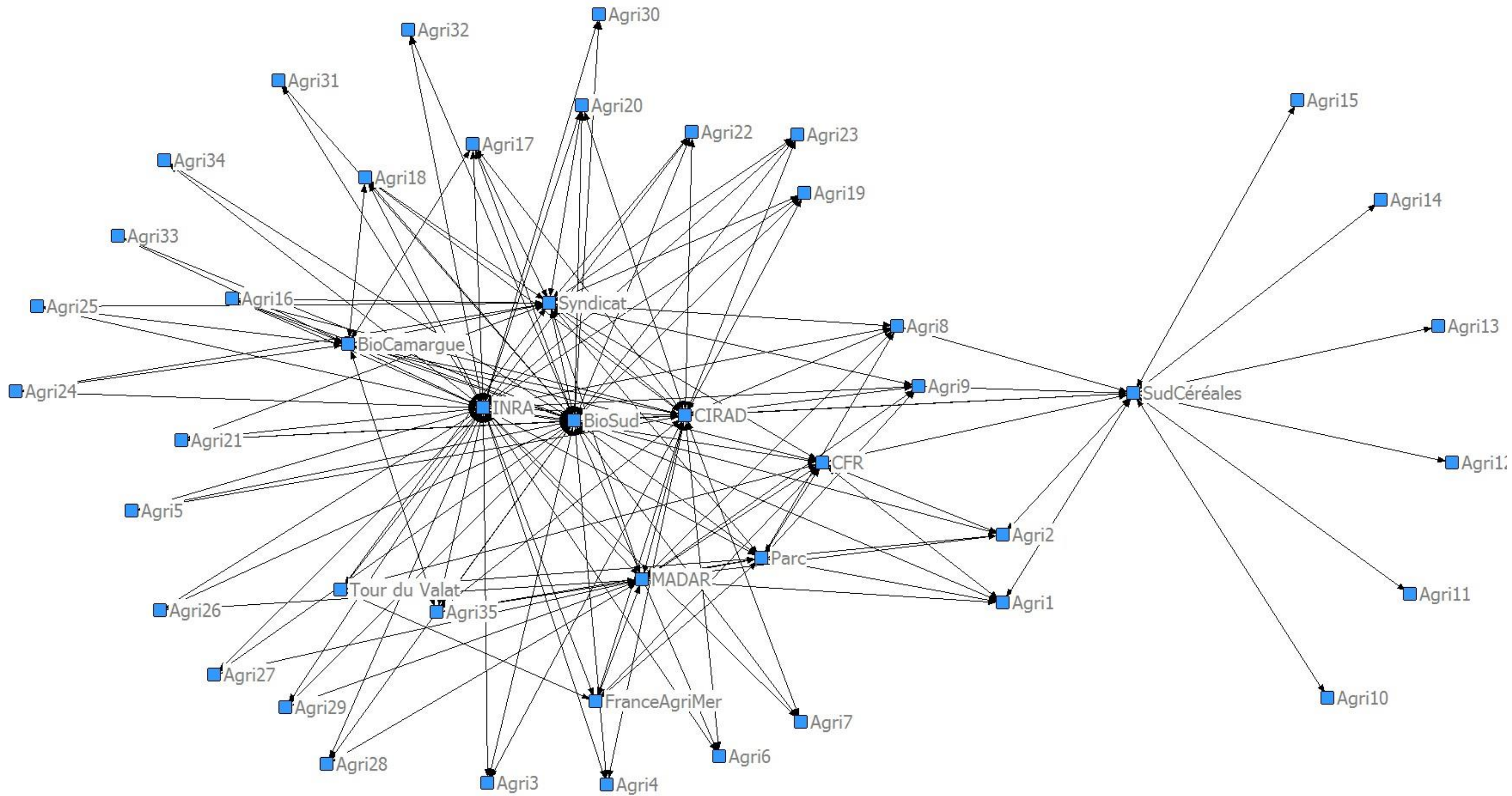
b. *Map of the actors' network in Camargue in 1999*

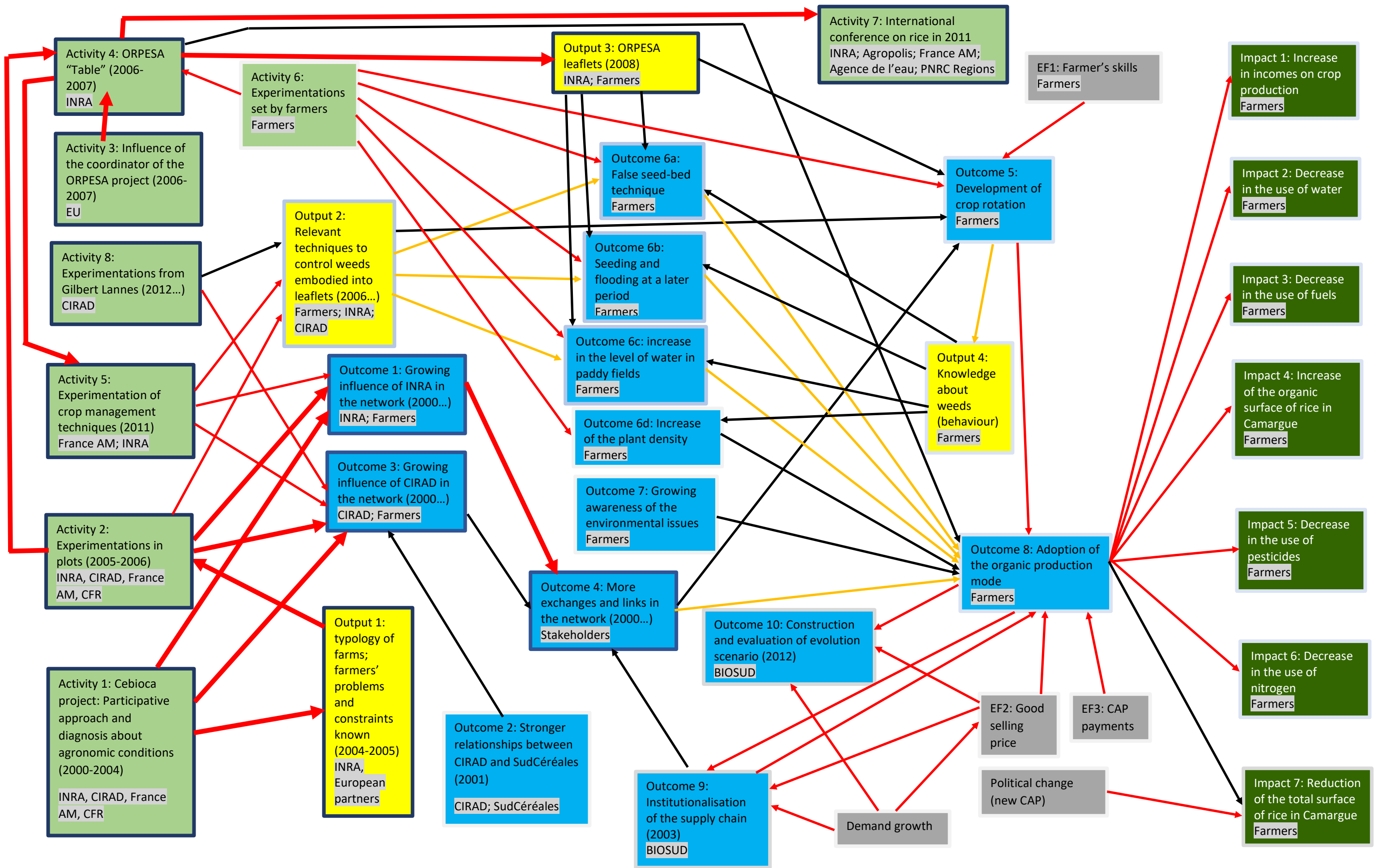


d. *Map of actors' network in Camargue in 2006*





e. *Map of actors' network in Camargue in 2014*





Legende

<u>"Strength" of the links</u>		<u>Contribution of the research</u>			
	Strong and "critical points"		Very important		Limited role
	strong		Important		Low importance
	Moderately strong		quite important		Very low importance
	Weak		Satisfactory		Null

Appendix 4: Table of links of the innovation pathway

N°	Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"
	Variable		Actor		Description of the mechanism	Origin Inf			
	Origin	Destination	Origin	Destination					
1	Activity 1 : Cebioca project: participative approach and diagnosis about agronomic conditions (2000-2004)	Output 1 : typology of farms ; farmers problems and constraints known (2004-2005)	INRA, CIRAD, France"AM" , CFR	INRA, European partners	The CEBIOCA project allowed the INRA to be aware on organic production systems and the main issues to be studied	INRA	No		Very important
2	Activity 1 : Cebioca project: participative approach and diagnosis about agronomic conditions (2000-2004) Activity 2: Experimentation in farming plots (2005-2006) Activity 5 : Experimentation of crop management techniques (2011) Activity 4: ORPESA "Table" (2006-2007)	Outcome 1: Growing influence of INRA in the network (2000...)	INRA, CIRAD, France"AM" , CFR	INRA	Increase of the knowledge transfer from INRA to farmers	"Stak" via in-depth interviews ; SNA	a) Increase in relationships between INRA and others institutes b) Relationships among involved actors in the network decreased, when excluding the INRA	a) No: Relationships between INRA and other institutes did not increase from 1999 to 2014 b) No: The average "degrees" (SNA) in the network increased from 4.1 in 1999 to 4.8 in 2014 (+18%), when excluding the INRA. Similarly, the distance between actors decreased from 2.5 in 1999 to 2.2 in 2014. The second plausible alternative explanation can thus not be confirmed	Important
3	Activity 2: Experimentations in plots (2005-2006) Activity 5 : Experimentation of crop management techniques (2011)	Output 2: Relevant techniques to control weeds embodied into leaflets (2006...)	INRA, CIRAD, France"AM" , CFR	Farmers	The experimentations were mainly focused on weeds management issues	"WS" - "Stak"	These techniques were derived from existing knowledge or/and other research programmes	Not valid	Satisfactory
4	Activity 8: Experimentations from Gilbert Lannes (2012...)		CIRAD	Farmers	The experimentations are focused on weeds management issues. Different machines are tested like harrows. At the same time, bringing ducks in lands for controlling weeds is experimented. This functions well: the ducks eat the weeds. However, this programme is reported as being relatively poor in terms of applicable results	"Stak" via in-depth interviews			

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
5	Activity 2: Experimentations in plots (2005-2006) Activity 6: Experimentations set by farmers	Activity 4 : ORPESA "Table" (2006-2007)	INRA, EU, Farmers	Farmers, INRA	Awareness of the problems/constraints of the farmers Knowledge to bring into discussions on the basis of the experimentations conducted	INRA	The decision was taken both by the coordinator of the project ORPESA (EU) and by Jean-Claude Mouret from INRA. It was not decided yet to take account the Camargue at the design phase of the ORPESA project.	Very important	
6	Activity 3: influence of the coordinator of the ORPESA project (2006-2007)		EU		The coordinator of the ORPESA project (EU) contacted Jean-Claude Mouret from INRA	INRA			
7	Activity 4: ORPESA "Table" (2006-2007)	Output 3: Orpesa leaflets (2008)	INRA	INRA, Farmers	The exchanges between farmers and researchers produced some interesting results. The INRA therefore decided to embody results into leaflets with a view to help farmers in their transition to organic farming	INRA, Farmers (in-depth interviews)	a) The decision to set-up leaflets was decided at the European level b) The technical manuals have not only been written on the basis of the ORPESA results	a) The decision of writing the leaflets was made by INRA b) The technical manuals have been written on the basis of the ORPESA results: 50% from participant's statements, 50% from experimentations in farming plots conducted by INRA (reminder: the results of the experimentations were discussed at the "ORPESA Table".	Very important
8	Activity 6: Experimentations set by farmers	Outcome 6d: Increase of the plant density	Farmers	Farmers	It was found that a higher plant density helps to smother weeds	Farmers (in-depth interviews)	Advices or/and leaflets from INRA or/and other institutes	These alternative explanations are not true, farmers reported	Null
9	Output 1 : typology of farms ; farmers problems and constraints known (2004-2005)	Activity 2: Experimentations in farming plots (2005-2006)	INRA, European partners	INRA, CIRAD, France"AM" , CFR	Awareness of the problems/constraints of the farmers	INRA	No		Very important

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
10	Activity 1 : Cebioca project: participative approach and diagnosis about agronomic conditions (2000-2004) Activity 2: Experimentation in farming plots (2005-2006) Activity 5 : Experimentation of crop management techniques (2011) Activity 8: Experimentations from Gilbert Lannes (2012...)	Outcome 3: Growing influence of CIRAD in the network (2000...)	CIRAD	"Stak"	Knowledge transfer from CIRAD to farmers and stronger relationships between CIRAD and INRA	Researcher (SNA)	a) Increase in relationships between CIRAD and others institutes b) Relationships among involved actors in the network decreased, when excluding the CIRAD	a) Yes: between CIRAD and SudCéréales b) No: The average "degrees" (SNA) in the network increased, when excluding the CIRAD.	Important
11	Outcome 2: Stronger relationships between CIRAD and SudCéréales (2001)				The "degrees" (SNA) between CIRAD and SudCéréales have increased from 0 in 1999 to 2 in 2015 (breeding activities). In fact, few researchers from CIRAD work at the CFR, and the later developed stronger relationships with the cooperative. The cooperative was granted the exclusive right to sell varieties selected by the CFR.				

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
12	Output 2: Relevant techniques to control weeds embodied into leaflets (2006...)	Outcome 6a: False seed-bed technique	INRA	Farmers	INRA advised farmers through various documents and leaflets (the discussions did not play a significant role)	"WS" - "Stak"; INRA	a) CIRAD or/and other institutes also provided information to farmers in that respect b) Farmers conducted their own experimentations: learning by doing	a) No b) Yes: It is important c) No d) Yes: but it is of little importance	Satisfactory
13	Output 3 : Orpesa leaflets (2008)	Outcome 6b: seeding and flooding at a later period	INRA, European partners	Farmers	The leaflets derived from the ORPESA "Table" deal with those issues	"WS" - "Stak"	c) Farmers looked at the techniques of their neighbours: peer effect d) More knowledge about weeds (their behaviour)		
14	Activity 6: Experimentations set by farmers	Outcome 6c: Increase in the level of water in paddy fields	Farmers	Farmers	Learning by doing	Farmers (in-depth interviews)			
15	Output 4: Knowledge about weeds (behaviour)		Farmers	Farmers	The weeds management is adapted in accordance with the behaviour of the weeds	"WS" - "Stak"			

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
16	Outcome 6a: False seed-bed technique Outcome 6b: seeding and flooding at a later period Outcome 6c: putting more water in the parcels Outcome 6d: increase of the plant density	Outcome 8: adoption of the organic production mode	Farmers	Farmers	Techniques adapted to organic farming systems	"WS" - "Stak"	1) Other relevant techniques helped the transition towards organic farming 2) The meeting organized by BIOSUD in 2013 at the Park of the Camargue has led some farmers to be convinced	1) Not valid 2) Not valid	Limited role
17	Outcome 7: Growing awareness of the environmental issues		Farmers	Farmers	"Ethical" considerations	Farmers (in-depth interviews)			
18	Outcome 6 : Development of crop rotation		Farmers	Farmers	Techniques adapted to organic farming systems	Farmers; "WS" - "Stak"			
19	EF2: Good selling price EF3: CAP payments		Market	Farmers	Switching towards organic farming is a way to improve earnings	Farmers; "WS" - "Stak"			
20	Outcome 4: more exchanges and links in the network		Stakeholders	Stakeholders	Exchange of information about organic production systems	Farmers; "WS" - "Stak"			
21	Activity 4: ORPESA "Table" (2006-2007)		Farmers, INRA	Farmers	Some arguments provided to switch to organic production	Farmers; "WS" - "Stak"			
22	Outcome 1: Growing influence of INRA in the network (2000...)	Outcome 4: more exchanges and links in the network (2000...)	INRA	"Stak"	INRA has become an important broker in the network	"Stak" via in-depth interviews	Other actors have become important knowledge brokers in the network	Not valid	Important
23	Outcome 3: Growing influence of CIRAD in the network (2000...)		CIRAD	"Stak"	CIRAD has become an "average broker" in the network	Researcher (SNA)			

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
24	EF2: Good selling price EF4: Demand growth	Outcome 9: Institutionalisation of the supply chain (2003)	Market	BIOSUD	BIOSUD was founded as a response to the growing numbers of organic farmers. Opportunity to ameliorate earnings through the demand growth and the good selling price.	BIOSUD	No		Very low importance
25	Outcome 8: Adoption of the organic production mode								
26	Outcome 5: Development of crop rotation	Output 4: Knowledge about weeds (behaviour)	Farmers	Farmers	By their own experimentations and observations as to how to fight the weeds	"WS" - "Stak"	Some institutes provide information in that respect	Not valid	Limited role
27	EF2: Good selling price EF4: Demand growth	Outcome 10 : Construction and evaluation of evolution scenarios (2012)	Market	BIOSUD	BIOSUD tried to convince farmers to switch to organic farming in order to improve its business	BIOSUD	No		Very low importance
28	Outcome 8: Adoption of the organic production mode								
29	Output 2: Relevant techniques to control weeds embodied into leaflets (2006...)	Outcome 6 : Development of crop rotation	INRA	Farmers	Some documents and leaflets were produced by the INRA to explain why and how the crop rotation should be extended and diversified	Farmers (in-depth interviews); INRA	<ol style="list-style-type: none"> 1. ORPESA leaflets (2008) 2. Farmers look at the techniques of their neighbours 3. Farmers set their own experimentations 4. Farmer's skills (not related to the research, either directly or indirectly) 	<ol style="list-style-type: none"> 1. No 2. No 3. Yes: very important 4. Yes: very important 	Limited role
30	Output 3: ORPESA "Table"		INRA	Farmers	Technical elements provided	Farmers (in-depth interviews); INRA			
31	Outcome 4: More exchanges and links in the network (2000...)		INRA	Farmers	Exchange of information about organic production systems	Farmers; "WS" - "Stak"			
32	EF1: Farmer's skills (not related to the research, either directly or indirectly)		Farmers	Farmers	Learning by doing	Researcher			
33	Activity 6: Experimentations set by farmers		Farmers	Farmers					

Link					Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"
N°	Variable		Actor		Description of the mechanism	Origin Inf			
	Origin	Destination	Origin	Destination					
34	Activity 4: ORPESA "Table" (2006-2007)	Activity 7: International conference on rice (2011)	INRA, Farmers	INRA, Agropolis, France AM, Agence de l'eau, PNRC Regions	A list of relevant techniques was made on the basis of the ORPESA "Table". Additionally, some challenges were raised. Both the international conference (2011) and the experimentations (2011) tried to answer those issues.	INRA	No		Very important
		Activity 5 : Experimentation of crop management techniques (2011)	INRA, Farmers	INRA, CIRAD, France "AM", CFR					
35	Outcome 8: adoption of the organic production mode	Impact 1: Increase in incomes on crop productions	Market	Farmers	Due to a higher selling price that compensate more than proportionally the loss of yield	Farmers, INRA	No	Net margin/ha: +146 % for the partial organic farmers Net margin/ha: +111% for the organic farmers	Limited role
36	Outcome 8: adoption of the organic production mode	Impact 2: Decrease in the use of water	Farmers	Farmers	Reduction of the surface devoted to rice	Farmers, INRA	No	The consumption of water has decreased about 45% for the organic and partial organic farmers. At the level of the region Camargue, this consumption has decreased about 8%	Limited role
37	Outcome 8: adoption of the organic production mode	Impact 3: Decrease in the use of fuel	Farmers	Farmers	Due to the introduction of crops (grasslands and alfalfa) less demanding in terms of soil working.	Farmers, INRA	No	The consumption of fuel has decreased about 17% for the organic and partial organic farmers. At the level of the Camargue territory, this consumption has decreased about 3%	Limited role
38	Outcome 8: adoption of the organic production mode	Impact 4: increase of the organic surface of rice in Camargue	Farmers	Farmers	Obvious	Farmers, INRA	No	From around 200 hectares in 1980 to 1400 hectares in 2014	Limited role
39	Outcome 8: adoption of the organic production mode	Impact 5: decrease in the use of pesticides in Camargue (farm level)	Farmers	Farmers	Obvious	Farmers, INRA	No	The use of pesticides has decreased about 51% for the organic and partial organic farmers. At the level of the Camargue region, this consumption has decreased about 8.5%	Limited role
40	Outcome 8: adoption of the organic production mode	Impact 6: decrease in the use of nitrogen	Farmers	Farmers	The needs are less important because the yields are also less important	Farmers, INRA	No	The use of nitrogen has decreased about 24% for the organic and partial organic farmers. At the level of the region Camargue, it's about 4%	Limited role

Link				Mechanism (explanation of the underlying link)		Alternative explanations of the mechanism	Validity of the alternative explanations/Measure of the impacts	Contribution of the research in achieving the "Variable-Destin"	
N°	Variable		Actor		Description of the mechanism				Origin Inf
	Origin	Destination	Origin	Destination					
41	Outcome 8: adoption of the organic production mode	Impact 7: Reduction of the surface of rice in Camargue	Farmers	Farmers	(1) transition to organic production requires lengthening the rotations (for fighting weeds) and this automatically reduces the total surface devoted to rice; (2) as longer rotations reinforces the problem of the salt concentration in the lands; it is not possible anymore to cultivate rice in the lands having a low altitude compared to the sea level. Therefore, this phenomenon also leads to a reduction of the surface devoted to rice.	Farmers, INRA	No	The conversion to organic production has led to a reduction of the surface devoted to rice about 45% for the organic and partial organic farmers. At the level of the Camargue region, the decrease of the surface rice (due to the conversion) is about 8%	Limited role
42	EF5: Political changes (new CAP)		EU	Farmers	Abolishment of aids specifically dedicated to rice, since 2 years	Farmers	No		

Appendix 5: To take a step back on the methodology followed

Items	Problems encountered	Comments
Collection of publicly available information on the project	No specific problem encountered.	No specific comment.
Face-to-face interviews with key informants	No specific problem encountered.	No specific comment.
Face-to-face interviews with farmers	The collection of the SNA data: Farmers had some difficulties to specify what their relationships with the other actors were in the past.	It is probably better to first ask the current relationships before going backwards.
To reunite stakeholders in focus group	To reunite the participants together as many conflicts happened among them in the past. To demonstrate the interest of the meeting to stakeholders. To provide sufficient incentives to stakeholders.	The location of the focus groups has to be chosen very carefully. The location should be as neutral as possible. To provide drinks and foods is not sufficient. It would also be useful to raise issues with a high interest for stakeholders, even if they are not directly related to the study.
Development of the focus group	In the second focus group: Stakeholders were asked to first define changes (behaviour, relationships, and actions) related to organic farming, before linking them to activities and outputs. The identification of the changes proved difficult, and numerous requests for explanations were posed.	It would have been more appropriate to ask changes that occur in personal situations instead of generally, in order to make the exercise more concrete and understandable. The changes could also be collected during face-to-face interviews before the focus group, in order to leave more time for reflecting on the different impact pathways at the end of the stakeholders meeting.
Diversity in group discussion (power, position, status...)	We did not get funders nor “victims” of the programme in focus groups. We got many organic farmers (beneficiaries) in comparison to the number of programme’s designers from INRA and French Centre of Rice (CFR).	Apparently, some stakeholders were not feeling concerned by the topic as they are not “beneficiaries”. The discussion was too much directed from farmers’ perspective, both in plenary session and working groups.
Relevance of the information collected in focus groups	The information collected was too much influenced by farmers given the lack of diversity among stakeholders.	It would have been better to invite less farmers.

Items	Problems encountered	Comments
On the participatory approach in group discussion	Farmers were a bit reluctant to draw the Impact Pathway.	More rooms should be dedicated to the explanation of the meeting's goals to stakeholders
Difficulties in the reconstruction of the theory of change of the programme	Yes, given the large variety of opinions as to both the impact pathway and the usefulness of the outputs	No specific comment.
Reluctance of stakeholders to cooperate with the survey	No specific problem encountered.	No specific comment.
Identification of the indicators of impacts	No specific problem encountered.	No specific comment.
Measurement of the impacts	We encountered some difficulties to measure the reduction of the total rice surface due to the conversion to organic farming. There was an attribution issue. When looking at the difference in terms of surface of rice between 1999 and 2014, we only see the global decline. There was another important factor contributing to this decline: The reform of the CAP payments (in 2012-2013) which has decoupled the aids attributed to the rice.	To solve this attribution issue, we asked farmers their surface under rice they had before converting and after, so that we could see the difference due to the conversion. And during the years after having converted to organic farming, the length of the crop rotations did not evolve.
Social Network Analysis/Stakeholders' Mapping	Farmers faced some difficulties to specify what their relationships with the other actors were in the past. It is tricky to link the "SNA trend" with the "innovation trend".	We made the assumption that the innovation process is derived from changes in the system actors and thus correlated to the "SNA trend". In fact, the SNA survey asked stakeholders for useful relationships around organic farming issues
To draw the first Impact Pathway Diagram based on	No specific problem encountered.	No specific comment.
Interviews with key informants	No specific problem encountered.	No specific comment.
To draw the Impact Pathway Diagram	No specific problem encountered.	No specific comment.
To find alternative explanations (table of links)	No specific problem encountered.	No specific comment.

Items	Problems encountered	Comments
To verify the alternative explanations (table of links)	No specific problem encountered.	No specific comment.
To evaluate the contribution of the research	Yes, given the importance of the external factors which influence results. Many different opinions from stakeholders. Making calculations for evaluating the role of the research: Because all the pathway's events are interrelated.	It is time consuming to make calculations since we are faced a domino effect between pathway's events.
To draw final conclusions	It was a bit difficult given the large variety of opinions as to the impact pathway and the usefulness of the outputs	No specific comment.