How can international agricultural research better contribute to innovations: Lessons from Impact pathways analysis

Devaux-Spatarakis, Agathe[1], Barret Danielle[2], Bouyer Jérémy[3], Cerdan Claire[1], Dabat Marie-Hélène[4], Faure Guy[1], Ferré Thierry[1], Hainzelin Etienne[5], Medah Ignace[6], Temple Ludovic[1], Triomphe Bernard[1]

1. CIRAD, UMR INNOVATION, F-34398 Montpellier, France
2. Ministère de l'éducation nationale, F-75007 Paris, France
2. CIRAD, DGDRS, F-75116 Paris, France
3. CIRAD, UMR CMAEE, F-34398 Montpellier, France.
4. CIRAD, UMR ART-DEV, F-34398 Montpellier, France
5. CIRAD, DG, F-75126 Paris, France
6. CNRST, Institut de Recherche en Sciences Appliquées et Technologies, 03 Ouagadougou, Burkina Faso

Keywords: Impact pathway, outcome, mechanism, participatory, case-studies cross analysis, capacity development

Abstract

This paper presents an initial cross-analysis of impact pathways identified in 13 cases studies on agricultural innovation in a developing country context. The aim was to understand better how research actually contributes to impact generation. The results were obtained by applying a common impact assessment approach called ImpresS (Impact of research in the South), which was developed by CIRAD over the past few years. ImpresS includes a set of theory driven, participatory and comprehensive evaluation tools and uses contribution analysis to establish causality links between inputs, outputs, outcomes and impacts.

After an overview of the approach used for the cross analysis, we present three case studies, exemplifying different roles researchers play in the generation of impact pathways and especially in that of outputs and outcomes. We then characterize in more generic terms three patterns of impact pathways that are useful for organizing learning.

Two key results are outlined as a result of the cross analysis of impact pathways and stakeholders. (1) Research contributes to impact pathways according to three main patterns (2). knowledge across cases can be structured within each of them enabling different kind of learning to inform future research projects.

Introduction

"When will we ever learn?" This provocative title from a report by the evaluation gap working group in 2006 summarised the common calling from the scientific, political and international organisations to engage in impact evaluation and learning about development interventions (Evaluation Gap Working Group 2006). Soon, the core of the issue became "how should we learn"? What evaluation methods can best assess our intervention? Beyond the passionate "causal war" that went on among the evaluators community about evaluation methods, a more pacified consensus emerged about the need to tailor evaluation methods to the characteristics of the type of intervention being assessed and analyzed (Donaldson, Christie, and Mark 2009).

In this context, Cirad launched an internal reflection on how to use the evaluation of impact of its research to develop an institutional culture of impact (CIRAD 2011). Embedded in CIRAD's five- year strategic plan, an "Innovation & Impact task force" was formed in 2014. It iteratively developed and tested over two years an evaluation approach called ImpresS (IMPact of RESearch in the South) (Barret et al., 2015, Triomphe et al., 2015). ImpresS was specifically designed to allow the participatory *ex post and in itinere* evaluation of innovation processes taking place in developing countries. CIRAD's main objectives were (1) to develop a robust approach that could be used routinely in the future to assess the impact of research and (2) to identify lessons allowing to optimize researchers' contribution to development impact, when working in partnership with other stakeholders.

CIRAD opted for a theory-driven approach, the impact pathway one, complemented by stakeholder mapping and an analysis of learning situations related to capacity development (Douthwaite et al. 2003; Toillier 2012). The aim was to open the "black box" of innovation and better understand how and through which steps and mechanisms research activities eventually contribute to measurable sustainable development on the ground. In a nutshell, the impact pathway maps inputs, outputs, outcomes and impacts produced within a given innovation process and draws causal links among them. While inputs[1], outputs[2] and to a certain extent impacts[3] are usually fairly easy to identify by researchers or by the stakeholders themselves, outcomes present a specific challenge both in terms of their identification and their actual place and role in the impact pathway.

Outcomes are mainly defined as short or medium term effects of an intervention; they are the first changes that occur (Funnell and Rogers 2011, 27). Specific changes may include participants' behaviour, knowledge, skills, status and level functioning (W.K. Kellogg Foundation 2004). For its part, ImpresS defines outcomes as the appropriation of research results (outputs) by first beneficiaries or intermediate stakeholders which leads to technological adaptation, new rules and new organizations. In other words, outcomes are the necessary changes which enable stakeholders to join and amplify the innovation process. The effects of these changes will eventually lead to actual impacts.

Focusing on outcomes is useful because it allows addressing key questions often overlooked, such as how are impacts produced and what the contribution of research to these impacts is. This paper will particularly focus on the influence of research on shaping outcomes within innovation processes.

We first unfold how the cross analysis led us to explore the link between research contribution and impact pathway patterns (part 1). We then present three case studies exemplifying three impact

[1] The resources used by the research team to produce scientific results and products
[2] The results produced by the research team (publications, technical novelty, etc.)
[3] We distinguish primary impacts: impacts of the use of the innovation(s) on the stakeholders directly or indirectly interacting with research; secondary impacts: scaling out or scaling up of this innovation to other territories and audiences; spillovers (Barret et al., 2015)

pathway patterns, and how researchers contributed to outcomes (part 2). Finally, we identify and discuss some preliminary lessons from these results (part 3).

1. An overview of the cross analysis approach and main results

The cross-analysis was conducted on 13 case studies (Box 1). Our preliminary findings show that across them, the 13 case studies included a wide diversity of impact pathways and a wide diversity of stakeholders involved in the respective innovation processes. A closer look at outcomes taking place within these impact pathways showed that outcomes did not constitute one single step occurring between output and impact, but represented rather a combination of various changes or activities. In other words, there was not one causal link leading to impact but rather a variety of interacting outcomes connected among them by a variety of causal relationships. Some outcomes contributed jointly to impact and some contributed to other outcomes which themselves led to impacts. By comparing these causalities between outputs and outcomes among the 13 cases, we observed that some impact pathways were more complex than others. For instance some impact pathways had only 2 or 3 outcomes, while others had as many as 9 different outcomes.

Box 1 : Cross analysis methodology

Cross analysis methodology

Cases under study:

The 13 cases studied (See table of cases in annex 1) reflect the diversity of CIRAD's activities. Nine cases were considered as ex post case studies and 4 as ongoing or in itinere (actual impacts still forthcoming as of 2015). They represent 3 continents (8 cases in Africa, 2 in Latin America, 2 in Asia, 1 is Global), and a diversity of research domains: Breeding (3); Pest & animal diseases control (4); Market innovation(1); Post-harvest technology (1); Water-resource management(1); Mixed farming system(1); Residue recycling (1); Data knowledge platform sharing (1), and innovation types: Technical (5), Organisational (2), Technical/Organisational (6). It was often difficult to differentiate among them since most innovations refer simultaneously to “hardware, orgware and software” dimensions (Smits, 2004).

Cross analysis

Data from all 13 case studies were fed into and analysed though an Microsoft Access © database containing 52 interlinked tables related to the various components of the impact pathway (causal links and steps of the innovation process), the timeframe, and the stakeholders involved. Stakeholder tables detailed all individuals or organizations involved in the innovation process and linked them to one or several components of the impact pathway. This enabled us to focus the cross analysis on the contribution of research to the innovation process.

One of the main variable accounting for this diversity lies on stakeholders involved. A diversity of stakeholders, acting either jointly or separately was involved in different outcomes. They included policy actors (local or national), researchers, NGOs, individual farmers, farmers’ organizations, small businesses, or media. The number of stakeholders contributing to outcomes varied greatly from three to more than 10, organized among themselves in complex partnerships or networks.

Linking actors to outcomes (Box 1) also led us to assess the link with capacity development. In effect, outcomes account for changes allowing stakeholders to take part in and enrich the innovation process to produce impact, which often involved the development of new capacity. These new capacities were often technical, or involved collaboration skills, or adaptive skills as well as learning to collaborate or to adapt.

Looking at this diversity, we made two hypotheses. First, following R. Pawson’s insight, we made the hypothesis that impact pathways patterns could be identified across cases. These patterns, could constitute *reusable conceptual platforms*, enabling us to draw lessons from various cases in order to

inform future innovation design (Pawson 2013). Second, we made the hypothesis that these patterns were induced by the type of innovations developed and the role played by the research team. Therefore, we also studied how research was associated to other stakeholders, not only during the production of outputs but also for the generation of outcomes. We found that indeed, how interactions between researchers and the innovation's stakeholders were configured constituted a determining factor in shaping the impact pathways patterns. Another result was that the influence of research teams over outcomes varied greatly across cases.

Scrutinizing the impact pathways of our 13 case studies for recurring patterns, we were able to identify three different patterns of how the generation of outcomes and the corresponding causality paths are configured. These patterns, varying from simple, complicated, or complex, were closely linked to the nature of the innovation (more or less technological or organizational), and how researchers associated with stakeholders (from research exercising a strong control over the innovation process by research to merely accompanying it) and were able to contribute to the generation of outcomes

2. The three patterns of impact pathways induced by different types of contribution by research

The first case presented below about the eradication of tsetse flies in Senegal epitomizes an innovation process strongly driven by research jointly with political actors which led to a fairly simple configuration of outcomes. The second case about the development of a hulling machine for fonio in West Africa illustrates a co-conceived innovation process between research and other stakeholders, inducing more complicated paths to impact. The third case about the development of a geographic indications for the "Vales da uva Goethe" in Southern Brazil reflects an innovation process driven by stakeholders assisted by a research team, and leading to more complex impact pathways.

2.1 Coordinated control over the innovation process between research and public actors

This case study focuses on eradicating tsetse flies in the Niayes region in Senegal through producing sterile insects carried. Tsetse flies are the vector of trypanosomes, a parasite that prevents the intensification of cattle rearing in this area despite suitable climatic conditions.

A research answer to a defined public issue

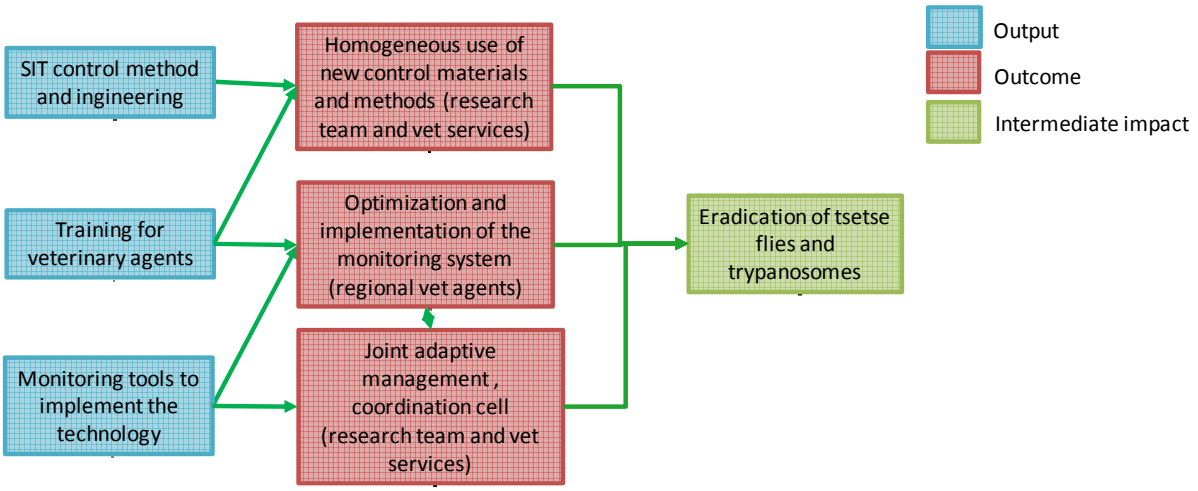
From the beginning of the project in 2005, the research team was involved at the demand of the national vet services of Senegal. It opted to implement a problem solving research approach to find solutions to the eradicate Tsetse flies. The project was conducted jointly by CIRAD, national and regional research institutes, IAEA (International Atomic Energy Agency), the public support services for livestock farmers (Direction des Services Vétérinaires (DSV) and the regional veterinary services. The main research outputs were technical; they consisted of the optimization of the use of a new technology and engineering to eradicate tsetse fly. The involvement of public actors guaranteed a controlled and top-down process of use of the technology and transfer from central vet services to regional vet services or dedicated personnel.

An adaptive top down implementation process

The "novelty" of the tsetse fly eradication process was the adaptation of an existing technique based on an innovative institutional partnership and the daily monitoring of results with a systematic readjustment process. Challenges related to outcomes included first achieving an homogeneous use of the new control materials and methods by the veterinary services, and also developing the capacity to reacting fast to difficulties encountered through the implementation process. To this end, a joint adaptive management coordination cell gathering the research teams and the regional veterinary

services was created: it convened on a monthly basis and allowed to adjust implementation continuously in order to increase impact. This in itself became a central part of the innovation, long with the technical eradication aspects. Figure 1 shows a simplified impact pathway focusing on the outcome chain that contributed to the main intermediary impact, namely: the eradication of tsetse flies, which itself triggered the subsequent impacts such as increase of production or the spread of more productive breeds and intensification (see complete impact pathway in annex 2).

Figure 1: Simplified impact pathway of the eradication of tsetse fly case



The role of the research team

In this case study, possessing a strong technological dimension, the research team played a determining role in producing the main outputs which was grounded on new scientific knowledge and technology management. It also contributed significantly to the outcomes by organizing training of veterinary agents in control and monitoring methods, thus ensuring effective use of the technology. It conveyed a clear vision about expected results and how to attain them. In return, regional veterinary agents suggested optimization of these techniques according to their own experience. This dynamics was reinforced through the formal adaptive management coordination cell, whose members visited similar eradication projects in Central America to acquire a territorial integrated pest management vision. Overall, this innovation achieved organisational change on the way veterinary services operate. The new capacities related to learning, adapting and coordination were later on formalized in a training course to export this technology and its implementation to other African countries.

2.2 Coproduction and co-ownership: the case of the hulling machine for fonio in West Africa

This case study involves the development and dissemination of machinery for hulling and whitening fonio (Digitaria exilis). Fonio is a small traditional cereal mainly produced for auto-consumption across West Africa. Yet due to the small size of fonio grains, hulling and whitening fonio by wood mortar and pestles are considered drudgery by women, and led to a fall in fonio production. Moreover, the cereal was completely neglected by research, as well as by agricultural development projects (Cruz, Béavogui, and Dramé 2011)..

Successive incentives and co-conception of the technology

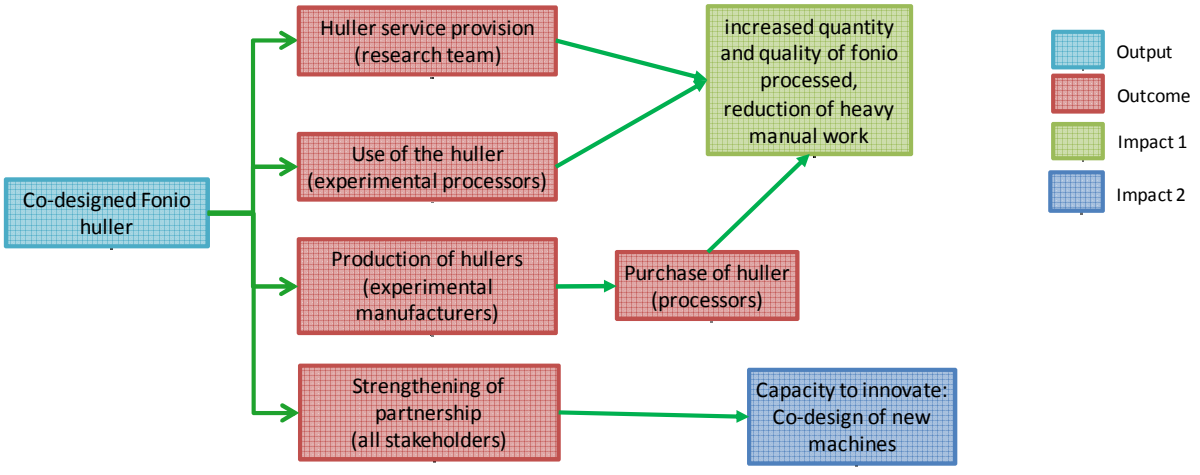
In 1993, women managers of small cereal processing businesses in Mali and Burkina Faso presented the difficulties they encountered in their fonio processing activities to the PROCELOS programme (Regional programme for the promotion of local cereals in the Sahel), and to researchers from West Africa and CIRAD. According to them, the only way to avoid the decline of fonio was to find a way to mechanize hulling and whitening processes.

Following this call for innovation, the CIRAD research team convinced their southern fellow researchers to set up a research project about fonio post-harvest technology. The resulting regional project, entitled "*Improving post-harvest technologies for fonio*", involves CIRAD, institute for agricultural research or applied sciences in Guinea (IRAG), Mali (IER/LTA), and Burkina Faso (IRSAT), was funded by the CFC (Common Fund for Commodities) and supervised by the FAO.
From 1999 to 2004, researchers work together with women processing fonio, and local manufacturers to co-conceive a huller prototype. The participation as stakeholders of future users of the machine allowed for the validation of technical choices and for better adjustment of design specifications to the needs of fonio processors. Many prototypes were tested until the production of the final commercial version of huller in 2003 by IMAF manufacturer in Bamako. Hence, a group of actors composed of researchers, manufacturers and experimental women processors made up the first circle of direct stakeholders in the co-design of the machine.

A bottom up development through co-ownership
Once the conception of the huller finalized, the challenge consisted of developing use and demand for the huller. Each category of stakeholder associated to the co-construction took part in this process. One huller was set up in the premises of the IER/LTA laboratory in Bamako to be used for service provision, as well as for training the many women processors present in Bamako. This allowed to get the word out about the huller in Mali. In 2003, the firm SIPS created by two former manufacturers involved in the co-conception started producing fonio hullers, while some IMAF employees sometimes informally assist other manufacturers to produce the huller. After this, yet another huller manufacturer set up in San in the Segou region which is an important fonio producer. Another diffusion channel was organised by fonio processing women who took part in the co-construction and were the first to invest in a commercial huller and use it also for service provisions to other processors.

By simplifying this innovation process, we can identify the co-designed fonio huller as the main output (Figure 2). There are parallel causality links stemming from this output and resulting in several outcomes.

Figure 2: Simplified impact pathway of the Fonio huller case



The main lesson here lies in the involvement from the beginning of stakeholders from the main categories of actors on which the technology appropriation depends. This participatory process of co-design allowed coming up with a technology fitting both the capacity of manufacturers and the needs of women processors of fonio. Additionally, this first circle of stakeholders became champions of the innovation diffusion through different channels, following their economic interest, but also acting as living examples of the potential impacts produced by using the technology. For instance, rapidly

women processors from the experimenting team increased their incomes improving the quality and quantity of fonio hulled, as the experimenting manufacturers were the first to increase their revenues from selling the technology.

The role of the research team

In this case, the technological dimension was also important and the research team played an important role in the conception of the output, but this role was shared with other stakeholders who made practical contributions. A first step in the innovation process required to build common competencies and knowledge for participating stakeholders to facilitate interactions and contributions to the co-conception of the technology. To this effect, the research team provided formal and informal training. Many capacities were also developed through learning by doing during the co-production process. Stakeholders (research included) learned how to design a technology and adapt it to a specific demand. Moreover they developed capacity and interest to collaborate with each other. While the research team had a vision about the expected results of the innovation process and contributed to the outcomes through training, information, advice, it did not control the development of outcomes which was driven by other stakeholders. An interesting aspect of this case is that the social (capacity to collaborate) and technical (learning to design machinery) capacities developed through the co-construction process, contributed to build a lasting capacity to innovate among these stakeholders (Leeuwis et al. 2014). These capacities were put to use in the subsequent co-design of new machines such as a fonio sand-remover solving new emerging post harvest related issues.

2.3 Researchers assisting stakeholders through on-going interaction: the case of Geographic indications (GI) of "Vales da uva Goethe"

The project to establish GI in the Urussanga region is part of a political and institutional dynamic that strives for the recognition of the assets and potential of local resources, a revaluation of the links between products and their places of origin and new methods for regional promotion. In 2004, the publication of an article on Goethe wine was the key factor in motivating SEBRAE (a non-profit private national organization with government funding) and producers to launch the process for the recognition of geographical indication in order to improve and promote the quality of the Goethe wine. In 2005, the Goethe wine and grape producers' association "Progoethe" was created. It brought together seven wineries, 12 grape producers, hostels, restaurants and traders in the region. Funding applications were submitted and researchers and technical agricultural services were solicited at that time.

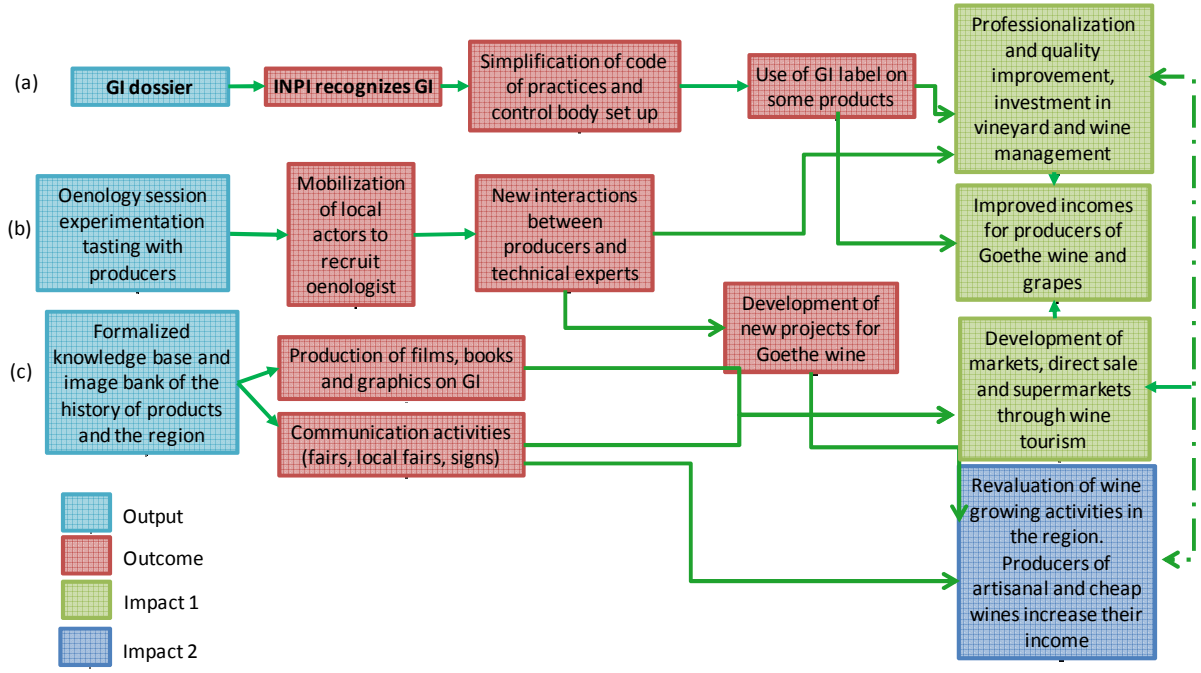
A complex multi-actors' innovation process

Three research projects were implemented between 2005 and 2008 and allowed research to assist stakeholders in the conception of the innovation. A two-pronged approach was adopted in order to improve the quality of the wine through winemaking methods and tasting sessions and to elaborate the technical dossier required for the official registration demand and to assist producers with organizational and marketing support. The projects also provided the opportunity for discussion with technicians and other producers involved in adding value to the products. The geographic name "Vales da Uva Goethe" was recognized by the government of Santa Catarina State in 2010 and by the Brasilian federal state in 2012. From 2009 until 2011, after the application had been submitted, the research institutions continued to interact with producers on a regular basis. Santa Catarina's Federal University and CIRAD withdrew in 2011, while EPAGRI's experimental station in Urussanga continued to support producers. During this period, a group of consultants specialized in product certification (Totum Institute) financed by the Ministry of Agriculture helped producers launch their new GI. For 2 years, producers developed three types of activity: informing consumers about the notion of geographic indication (comic books, information leaflets); defining control methods (control plan, producer contracts); and lastly, an activity that was not planned initially, reviewing the code of practices for GI wine production, which proved difficult to implement.

Innovation process characterized by complex outcomes causalities

Three causality paths between outputs and outcomes ((a), (b) and (c) in Figure 3) were identified within this process.

Figure 3 : Simplified impact pathway of the GI case



For chains (a) (GI dossier) and (b) (oenology session), outcomes were built or implemented step by step. For chain a, the stakeholders assisted by the research team developed the dossier and submitted it to INPI who recognized this GI. To implement their GI, it was necessary to adapt the rules and simplify their code of practices. This made possible the sale of the Goethe wine production with the GI label, which has increased sales and the income of the producers (impact).

The outcomes chain (c), about the formalized knowledge of history, is simpler. Local stakeholders worked together with their partners to publish books, comics or leaflets for producers and achieved some significant impact regarding market development (direct sales) and revaluation of wine in the region.

Researchers were only involved in the causality path “b” (see explanations below). For the others causality paths, the involvement of the research team were not necessary. For the production of comics for example, the local stakeholders were able to engage designers and make their own material. Producers also negotiated on their own for several years to obtain the authorization to put an advertising sign on the road. Not working with the research team was sometimes an asset. For instance, it enabled stakeholders to emancipate from the first version of code of practices elaborated with the research team, and simplify its rules in order to foster its use. Producers also recognized that the GI process allowed them to learn and to improve interactions and negotiations with public actors. They also increased their capacity to innovate and create new products (such as sparkling wine). Since 2010, members of the Goethe association are invited to national training courses or to give conferences on their experience, their motivation and the impact. Producers’ organizations and research institutions visit the region periodically and consider the local producers as experts for GI implementation and management.

The role of the research team

In this case, the technological dimension was less important and the research team played mainly a catalyst role in outcome production. It consisted in gathering knowledge on history, geography, wine making culture and bringing stakeholders to work jointly with research. The research team did not hold a precise vision of the results expected or the implementation process necessary to create impacts. Stakeholders defined the innovation as they implemented it, and identified new needs on the ways. Researchers were only involved in the outcome production process, through ongoing interaction based on specific advice and formal or informal discussion. For researchers, it was an opportunity to learn by doing.
One of the main successes is the trust and the common language built between local / state stakeholders and the research team. It helped to implement new research projects and gain new support to implement GI in Santa Catarina region. All researchers capitalized on this experience, became more confident and improved their way to work with the GI approach and support new producer organizations, among others by creating national training courses in this issue.

3. Comparison of the 3 patterns of impact pathways and role of researchers: what can we learn?

3.1 Lessons about the generation of outcomes by researchers within each main pattern

After presenting these three case studies individually, we can sketch their characteristics in more generic terms, so as to enable us to structure lessons gained on what is the contribution of research to innovation processes.
Table 1 presents a comparison of the three case studies presented, according to 6 dimensions linked to characteristics of the outcomes of the innovation process and characteristics related to the research teams' contribution to it:

Table 1: Characteristics of the three outcome patterns in the three case studies

	Tsetse eradication	Fonio Huller	GI
Outcomes characteristics			
Type of outcomes	Use and adaptation of the technology New monitoring organization	Use of the technology, New organization of production of the technology, New partnership, Promotion of the innovation (huller service provision)	New partnership, Means of promotion and communication activities, Development of new projects Implementation and adaptation of the new norm
Causality paths	Few outcomes jointly contributing to one main impact	Many outcomes jointly contributing to few main impacts	Many outcomes contributing to a diversity of impacts
Outcomes stakeholders configuration	Few stakeholders coordinating their action	Many type of stakeholders championing the innovation by different channels	Many stakeholders sometimes assisted or in partnership with other actors
Researchers' contribution to the innovation process			
Outcomes involving research team	All: Use and adaptation of the technology New monitoring organization	Promotion of the innovation (huller service provision), New partnership	New partnerships between producers and technical experts, promotion of the innovation (use of research material)
Research team control over outcomes	High (co-control all outcomes)	Medium (one of many channels)	Low (assist stakeholders on some outcomes)
Research contribution to capacity development	Training and co-monitoring to adapt	Process of Co-construction of technology built technical capacity and new capacity to innovate	Assist in strengthening and structuring technical capacities, ongoing innovation dynamic through lasting partnership with stakeholders

This classification constitutes a first step to organize learning to design research projects more capable of contributing to impact. For instance, when planning their intervention, researchers could strive to identify which kind of impact pathway the innovation they are working on may follow according to its characteristics. They could also anticipate the specific needs in capacities to enable stakeholders to invest in the innovation process according to these patterns. For instance, if we take these three different configurations:

- For the first pattern, challenges in the generation of outcomes and impacts are less dependent on stakeholders' capacities. It represents causality for highly technical innovation, directed to environmental variables. Still it relies on the capacity of technicians to implement homogeneously the new technology, and can lead to some adaptation along the implementation process. Hence, it is important that the research team take part in the implementation process with local stakeholders in order to monitor these local adaptation of the technology

- For the second pattern, challenges in the generation of outcomes rely on ensuring the co-ownership of the innovation and the capacity of stakeholders to champion it. At time, this may require a new organization of production and marketing, or the constitution of new networks that the research team can help to organize. Identifying in advance the need for this new capacity can greatly improve and accelerate the achievement of impacts.
- For the third pattern, challenges in the generation of outcomes rely on ensuring the main stakeholders have the capacity to identify and engage in activities (such as promotion, or creation of new organisations), or seeking funding for new projects necessary in order to reach intended impact. They need to build capacity to innovate, to adapt to changes in context.

3.2 Lessons about the role of researchers in innovation processes

We showed above that researchers can draw different lessons according to the expected pattern of outcome causality in a given innovation process. The type of learning will also depend on the level of control the research team yields over the innovation process. In order to characterize these kinds of learning, we borrow M.C. Patton's metaphors and distinctions between trying to replicate simple, complicated or complex process (Patton 2010, 92).

- Innovation with a high level of control by the research team over outcomes and the overall process (first type of outcome causality links) due to its central role in knowledge and technology production may be easier to replicate in other contexts. This control works especially well when the purpose of innovation is to act upon the biophysical environment and does not necessarily require strong interactions with stakeholders, or in-depth changes in practices among producers. In that sense, these are *simple* situations. In such cases, what is mostly needed is a good strategy for implementing research, a supporting institutional framework, partnership with a few strategic stakeholders and provision of adequate technical training among users of technologies.
- Innovation with a medium control of the research team over outcomes (second type of outcomes causality links), are more *complicated* to learn from in order to replicate it to other settings. It is like "sending a rocket into space". One can learn from former experiences, know all the stakeholders that should get involved and have a high level of prediction of impacts if everyone plays its part. Yet, it can go wrong in many steps along the way depending on stakeholders' strategies or capacities and external factors. The process depends on many stakeholders.
- Innovation with a low level of control of the research team over outcomes (third type of outcomes causality links), are more *complex* to learn from. It can be compared to "raising a child". One can understand which mechanisms led to success and impacts, but the research team yields little influence on them. It can assist stakeholders with knowledge production, technology, brokering and capacity development but all this may take many different forms and must adapt to a diversity of unexpected challenges according to external and internal factors. Many unexpected outcomes and impact can emerge.

3.3 Acknowledging challenges in cross-analyzing Impact pathways

Building impact pathways was one of the most challenging exercises for members of the ImpresS team not familiar with this approach. It was also a difficult exercise to conduct as it implied organizing participatory workshops with stakeholders unfamiliar with these concepts and the corresponding tools. Mapping the causal steps of an impact pathway can be quite subjective and the same innovation can be represented differently by different participants. Also, precision varied among cases with regard to the level of detail obtained.. Moreover there are specific challenges in mapping impact pathways of innovation processes. First, a diversity of stakeholders can take part in every step of the innovation process, and second, the evaluator must deal with multiple outputs, outcomes and impacts and multiple causality. Also, expected outcomes appear to have rarely been formulated ex ante, and at the beginning of the evaluation researchers had a variable degree of knowledge about them. Many

research teams did not monitor or control these outcomes in real time; therefore, they had to be "harvested" from participatory workshops, and many unexpected outcomes emerged (Wilson-Grau and Britt 2013).

Analyzing outcomes is a difficult task given their diversity across cases. Yet, it seems that identifying patterns of outcomes' causality in the impact pathways allows overcoming some of these challenges related to this diversity. Studying all outcomes in each case study and how they interact in generating impacts enabled us to identify the main challenges of these innovation processes and learn to which extent research teams can act upon them. Our current findings could also be completed by studying similar innovations which have had little impacts in order to understand why outcomes don't happen, or how outcomes can lead to unintended impacts.

Conclusion

This analysis presented the first results from a cross analysis of thirteen diverse case studies evaluated by the ImpresS approach developed by CIRAD. It demonstrated that combining a theory-driven approach and tools (the impact pathway) with a detailed stakeholder analysis and a study of capacity development can greatly help us to progress in understanding how research teams contribute to innovation processes and impact. We identified three different patterns of impact pathways, and linked them to how research contributes to innovation. This classification helped us to identify useful lessons in order to improve the way research teams design their activities. One predominant lesson is that research teams must determine as much as possible in advance what role they want and can play in outcome production in order to anticipate capacity needs of other stakeholders and how they can contribute to fostering it.

As for every attempt to identify patterns, we acknowledge that many innovation situations may consist of hybrids between two sets of characteristics. Further analysis across more cases should enable us to elaborate sub-patterns to specify the nature of such hybrids. Studying innovation on a long timeline, which may sometimes involve different research teams taking part at different phases, can also contribute to identifying different patterns and roles of research according to the phase of the innovation process. Adding more cases to the analysis could allow strengthening and enriching this typology, and maybe coming up with more relevant variables. Eventually, our hope would be to help researchers planning to work on new innovations to easily identify their impact pathway pattern and anticipate the associated challenges. Yet, as R. Pawson underlined, all these lessons will never enable us to control every risk on the way, but at least we can improve our "highway-code" to project building (Pawson and Tilley 2004, 27).

Bibliography:

Barret, D., Clavel, D., Dabat, MH., Faure, G., Mathé, S., Temple, L., Toillier, A., Triomphe, B., 2015: IMPRESS (IMPact des REchercheS au Sud). Guide méthodologique sur l'évaluation des impacts de la recherche agronomique dédiée aux pays du sud. CIRAD, Montpellier, 103 p

CIRAD. 2011. "Vision Stratégique 2012-2022, Faire de La Recherche Un Véritable Outil de Développement." Montpellier, nn p.

Cruz, Jean-François, Famoï Béavogui, and Djibril Dramé. 2011. *Le fonio, une céréale africaine*. Agricultures tropicales en poche. Versailles Cedex: Editions Quæ.

Donaldson, Stewart I, Christina A Christie, and Melvin M Mark, eds. 2009. *What Counts as Credible Evidence in Applied Research and Evaluation Practice?* Los Angeles: SAGE.

Douthwaite, Boru, Thomas Kuby, Elske van de Fliert, and Steffen Schultz. 2003. "Impact Pathway Evaluation: An Approach for Achieving and Attributing Impact in Complex Systems." *Agricultural Systems* 78: 243–65.

Evaluation Gap Working Group. 2006. "When Will We Ever Learn? Improving Lives Through Impact Evaluation." Center for Global Development.

Funnell, Sue, and Patricia Rogers. 2011. *Purposeful Program Theory, Effective Use of Theories of Change and Logic Models*. Jossey-bass.

Leeuwis, Cees, Marc Schut, Ann Waters-Bayer, Remco Mur, Kwesi Atta-Krah, and Boru Douthwaite. 2014. "Capacity to Innovate from a System CGIAR Research Program Perspective." Program Brief AAS-2014-29. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural Systems.

Patton, Michael Quinn. 2010. *Developmental Evaluation□: Applying Complexity Concepts to Enhance Innovation and Use*. New York: Guilford Press.

Pawson, Ray. 2010. "Middle Range Theory and Program Theory Evaluation: From Provenance to Practice." In *Mind the Gap: Perspectives on Policy Evaluation and the Social Sciences*, edited by Jos Vaessen and Frans L. Leeuw. Comparative Policy Evaluation, v. 16. New Brunswick, N.J: Transaction Publishers.

Toillier, Aurélie. 2012. "Evaluation de L'impact D'une Innovation Organisationnelle, Le Cef, Sur Le Renforcement de Capacites Des Op et Des Producteurs Au Burkina Faso." Synthèse préliminaire. Cirad.

Triomphe B., Barret D., Clavel D., Dabat M.H., Devaux-Spatarakis A., Faure G., Hainzelin,E., Mathé S., Temple L. , Toillier A. "Towards a generic, comprehensive and participatory approach for assessing the impact of agricultural research in developing countries" working paper presented at the conference: Impacts of agricultural research - towards an approach of societal values, INRA, November 3-4 2015, Paris.

Wilson-Grau, Ricardo, and Heather Britt. 2013. "Outcome Harvesting." Cairo, Egypt: Ford Foundation.

W.K. Kellogg Foundation. 2004. "Logic Model Development Guide." Battle Creek, Michigan: W.K. Kellogg.

Annex 1: Case studies

Case name	Research focus	Impact status	Geographic area	Type of innovation	Type of partnerships
Tsetse eradication program in the Niayes area of Senegal	Animal health & ecological intensification of livestock production	In itinere	Senegal	Technical organisational	Research (PRO-North/South), farmers' organizations
Fonio post-harvest equipment	Innovation in post-harvest technology	Ex-post	**Mali/Burkina-Faso, Guinea**	Technical	Research (PRO-North/South), NGOs
PI@ntNet	Development of a collaborative identification platform dedicated to data and knowledge sharing	In itinere	**Global**--Europe, Indian Ocean, South America	Technical, organisational	Research (PRO-North/South), NGO
Biological control of the white grub *Hoplochelus marginalis* on Réunion Is.	Development of Integrated Pest Management to reduce infestations by a key insect pest of sugarcane	Ex-post	**Réunion Is.**, Madagascar, Comoros, South Africa, Mauritius,	Technical	Research (PRO-France), farmers' organisations, Industrial partners, local government
A participatory approach to residue recycling for a better livelihood	Fertility management and environmental externalities	In itinere	Réunion Is.	Organizational	Research (PRO-France), farmers' organisations, Industrial partners, local government
Groundnut breeding for drought resistance	Groundnut breeding	Ex-post	Senegal	Technical, Organisational	Research (PRO-North/South), farmers' organizations
Participatory sorghum breeding	Breeding, participatory research	Ex-post	Burkina Faso	Organizational, technical	Research (PRO-North/South), farmers' organizations
Fertipartenaires	Design in partnership of innovations in mixed farming systems Burkina Faso	Ex-post	Burkina Faso (Tuy region)	Organizational, technical	Research (PRO-North/South), farmers' organizations
Integrated and Participatory Water Resource Management towards effective agricultural systems	Water resource management	Ex-post	Indonesia, Central Java Province, Kali Pusur watershed	Organizational, technical	Research, industrial partners, farmers' organizations, local governments, NGOs
Genetic improvement of upland rice for high altitude conditions (in Madagascar	Rice breeding and genetics		Madagascar (high altitude areas)	Technical	Research (PRO-North/South), farmers' organizations, local governments, NGOs
Evaluation of animal health surveillance and control systems (REVASIA)	Surveillance and control of animal diseases	In itinere	**Vietnam** (+ Southeast Asia + Egypt)	Organizational	Research, veterinary services, national & local governments, international organizations
Control of the coffee berry borer	Experiments on trapping	Ex-post	**Dominican Republic** (+ other Central America	Technical	Development agency, farmers' organizations
Geographical Indications	Institutional and market innovation	Ex-post	Brazil	Organizational, technical	Research, farmers' organizations, NGOs, national & local governments