ENABLING TRANSFER OF INTERMEDIATE TECHNOLOGIES IN A RURAL COLOMBIA: ALTPEZ CASE

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SUMMARY

The present paper explores technology transfer of pisciculture (fish farming) intermediate technologies in rural recipients in developing economies and assesses enablers of the technology transfer identified in the literature.

Using a qualitative research approach, technology transfer processes are analyzed in the context of a new product development project that involves small-scale rural enterprises, universities, non-governmental organizations and governmental organizations in the Cauca region of Colombia.

The paper builds on prior literature pertaining enablers for the technology transfer, specifically the paper studies the importance of technology transfer enablers such as i) Absorptive capacity, ii) Understanding of the technology source and market maturity, iii) Cultural and geographic distance between transferor and recipient, iv) Recipient's comprehension of the financial implications of the technology transfer, v) Intermediaries connecting transferor and recipient, vi) Institutional network adapting the technology to the local needs and vii) Prior experience in technology transfer projects.

The main findings are the aspects of analysis to describe enablers for technology transfer processes and the relationship between enablers in the testing of enablers in a case study in the pisciculture sector of a rural context of developing economies.

Key words: technology transfer enablers, developing economies, technology transfer, intermediate technology

1. INTRODUCTION

Rural sector in developing nations is often characterized by high levels of ethnic, cultural diversity, a broad variety of products (fruits, vegetables, wood, cosmetics, meat, milk, cheese, tourist services, handcrafts, mining, construction, etc.) and low levels of specialization due to the use low technologies and production of several different types of products. Aside from a limited number of large-scale operations with international focus, the primary sector in these countries tends to consist of many small and medium sized family or community run ventures (Khan, 2001). The success of these rural industries determines the incomes of the rural population of developing countries (Dahlman, 2015).

The challenges of the rural industry in this context is to find solutions for the lack of development caused by for example poor management capabilities (the ability to manage production, sales and distribution), limited access to production technology, limited information about market opportunities for differentiated products (Plazas, Pemberthy, Sánchez-Preciado, 2008) resulting low added values in the products.

Generally, in order to support the productivity and innovation in the rural industry, technology transfer has been used to i) provide and improve basic needs, such as: energy generation, water pumps, house building (e.g. Barnes, 2012; Acker and Kammen, 1996); ii) reduce strains on the environment through the implementation of renewable energies and systems to reduce the use of water or other resources such as chemical fertilizers or natural resources (e.g. Eakin and Lemos, 2006) and iii) solve production problems like the use of inefficient technology or new methods to develop the processes (e.g. Dark, 1987). In this way, technology transfer has seen as a key process to improve the well-being of the rural population, largely through improving the performance of rural enterprises (e.g. Lilleør and Lund-Sørensen, 2013).

Traditionally, the technology transfer involves transferors from the governmental agencies or universities and recipients as members of the rural enterprises (e.g. Metz, 2000). It is possible to identify different activities, of these called "extension services" (Leeuwis, 2013), oriented to technical assistance that includes technology transfer of methods, knowledge and solutions (equipment, infrastructure or techniques). The sophistication of the solutions could be connected to the level of research and development (R&D) invested.

Different levels of technology may not always provide an accurate picture of the real level of the transferred technology or the nature of the transferor or the recipient. For example, while the technology for agriculture/food production is generally classified as low-tech, the state-of-the-art expertise and practice found in genetically enhanced plant material (seeds, seedlings or cutting), equipment and processes could hardly be considered low-technology. Consequentially, it may at times be challenging to accurately distinguish between the levels and the enablers for successful transfer of high, intermediate or low-technology solutions.

Technology transfer experiences in rural regional contexts are mainly documented for the agricultural sector (e.g. Ruttan and Hayami, 1973). However, the rural context could also include activities such as tourism or handicraft, mining, construction which can be important sectors in socio-economic terms. The learning processes involve in technology transfer are not fully described and the ways that the participants (transferors, recipients and intermediaries) operate to

develop their own knowledge remains partially studied (e.g. Hay and Pearce, 2014).

The involvement of the recipient in the process depends of the basic common knowledge (absorptive capacity) existent on the specific technology to transfer (Leeuwis, 2013) and how the indigenous technological capability (Burch, 1987) could be deployed and contribute in the creation of a helpful environment to adapt the new technology and make it easier to assimilate, in this regard, intermediate technologies have more relevance due to their transfer could show the progressive enhancement in the learning of producers in rural industries.

Intermediate technology, also known as appropriate technology, refers to technology that is "labour-intensive and will lend itself to use in small-scale establishments" (Schumacher, 1973). Specifically, in relation to the rural context, Wood (1984: 320) describes both concepts as "a level of technology better than the simple methods used in the rural hinterland, more productive than the traditional tools, but far simpler and less capital-intensive than the modern technology imported from the West".

Despite the recognition of the importance of intermediate technologies in rural environments to improve the production in rural context, technology transfer process of intermediate technologies still has not been much studied (e.g. Cimoli, Ferraz and Primi, 2005; Saad and Zawdie, 2011). This paper explores the transfer of intermediate technologies recipients in rural developing economies and assesses enablers previously identified in the literature, establishing the connection between them.

The understanding of how the context gives conditions (constrains and opportunities) as contextual factors that could be transformed in potential enablers of the technology transfer, in this setting, comes across as fully appropriate. The reason for this is twofold. First, the recipients (such as small holders or craftsmen) are oftentimes incapable of understanding, managing, or investing in the higher technologies covered by patents and licenses. Second, the vast majority of the recipients are incapable of generating the outputs that are traditionally used to measure the success of the technology transfer that is used in the literature (research and development investment, number of new products, market impact, number of contracts or agreements, etc.).

In this paper, enablers could be considered as necessary conditions that in a positive way affect the development of the technology transfer process. The literature on technology transfer has identified: factors that affect the technology transfer (e.g. Lloyd and Milstien, 1999; Kedia and Bhagat, 1988; Gopalakrishnan and Santoro, 2004), aspects for impact measurement (e.g. Chen and Sun, 2000; Lee, Kim, Oh, Kim, 2012), components (e.g. Rabino, 1989), role of participants (e.g. Tsang, 1994; Theodorakopoulos et al., 2012, 2014) and key reasons for success (e.g. Buono (1997; Kissell, 2000; Sung, 2005). It is not fully described, the action of the participants operating in rural context of developing nations and implementing different ways to achieve the goals of the technology transfer process, despite of the adverse conditions such as: low education of the producers, limited offer of affordable solutions, poverty that dismiss the possibility of investment in new technologies, etc.

The contribution of this paper to the literature on technology transfer is the empirical analysis of a theoretical framework of enablers in rural developing countries. From the practitioners' point of

view, the paper shows aspects that could be analyzed in order to identify influential enablers in the transfer of intermediate technologies in rural context of developing economies.

The paper is structured as follows: first, a theoretical framework of enablers is presented. Secondly, the research design and methods is explained. Thirdly, the enablers are identified in a project. Finally, it explains the implications and conclusions of the findings.

2. FRAMEWORK OF REFERENCE

Technology transfer refers to the process of moving established technologies, including tools, facts, skills and routines from providers to recipients (Smith and Sharif, 2007). Successful technology transfer contributes positively to the achievements of the goals of the technology recipients (Cooke and Mayes, 1996; Tisdell, 1990). The process is facilitated by a range of mechanisms, e.g. the market for technology, government authorities, human resources and training, or the technological abilities of providers and recipients, amongst others (Arora and Gambardella, 2010; Kaushik et al., 2014).

There are several contexts to study technology transfer, from Multinational Companies to Subsidiaries in developing economies (e.g. Zhao, 2013), technology transfer from university to industry (e.g. Ustundag, 2011), from the development of the technology in collaborative way between transferor and recipient to the transfer when the technology is included in a package and ready to be sell it (Ramanathan, 1994), from the Government to the industry (Lilleør and Lund-Sørensen, 2013).

Many aspects of technology transfers are discussed in the literature (Lee, 1997; Chatterji, 1990, Hess and Siegwart, 2013) but the mainstream of this literature relates mostly to technology transfer between countries or organizations in established economies (e.g. Festel, 2013; Parry, 1984). Specifically, emphasizing high-tech environments, technology transfer research in the mainstream literature focuses on the inputs and deliverables of the transfer process, whereas the relatively limited literature in lower-tech contexts centres on the dynamics of the process and the interactions between participants (e.g. Theodorakopoulos et al., 2014). Technology transfers in rural contexts are mainly documented for the agricultural sector (e.g. Campbell, 1990; Jedlicka, 1977).

Much less attention is dedicated to the discussion of the transfer of low-tech solutions and intermediate technologies between actors. Intermediate technologies as solutions that keep balance between the cost, performance and potential of recipients' participation were identified as one way to fill the gap created by the disparate knowledge between the participants in developing countries (Schumacher, 1972; Wicklein and Kachmar, 2001, Bennett et al., 2002). "Intermediate technologies were described as relatively small, simple, capital-saving, labour-intensive, and environmentally less-damaging technologies, suitable for local, small-scale application" (Wood, 1984). Despite the lower level of sophistication and complexity of these solutions, the transfer process is often problematic for the context in which the transfer tends to take place, a context that is frequently characterized by similarly low levels of sophistication and development (Theodorakopoulos et al., 2012; 2014).

Recently research in the field of technology transfer has broadened to embrace technology transfers from universities to industry that comprise a wider scope of technologies including new and still unproven solutions (Alessandrini et al., 2013). The focus of technology transfer from universities to industry has predominantly been on innovation (i.e. the introduction of new product/services/processes) rather than on the low-cost manufacture of goods. In both instances however, the recipients of the transferred technologies are assumed to have an understanding of those technologies that matches that of the patrons (Basu, 2010). Yet other research differentiates technology transfer by the location of transferor and recipient (e.g. Siler et al., 2006). Technology transfers studied in these papers includes both international and domestic transfers, although both are related and share similar characteristics (e.g. Mowery and Oxley, 1995). Whereas traditionally the international technology transfer comprised predominantly horizontal technology transfers, vertical technology transfers could also include international and domestic aspects.

The stream of literature considers technology transfer in terms of inputs and outputs. It tends to focus explicitly on the technology itself, considering the patents, licences, creation of technology transfer offices, investments in R&D, number of new products or services created by the technology recipient, the number of collaboration contracts between the actors in the transfer (industries, universities or government, in any possible combination). In the specific context of technology transfer to intermediate technologies recipients in rural developing economies, this is not fully appropriate. The reason for this is twofold. First, the recipients are oftentimes incapable of understanding, managing, or investing in the higher technologies covered by patents and licences. Second, the vast majority of the recipients are incapable of generating the outputs that are traditionally used to measure the success of technology transfer that is used in the literature.

In a recent study on technology transfer in rural areas in developing countries (Sánchez-Preciado et al., Forthcoming) the following enablers were found to be important:

- Absorptive capacity: the ability of a firm to recognize the value of new, external information, assimilate it and to apply it to commercial ends (Cohen and Levinthal, 1990).
- Understanding of the technology source and market maturity: prior experience on the part of the recipient with the technologies available in the regional or national market will prepare them better to collaborate with foreign technology exporters (Chen and Shun, 2000; Vickery, 1986).
- Cultural and geographic distance between transferor and recipient: technology transfer is oftentimes informal and personal, long distances (physical or cultural) inhibit the formation of trust and understanding necessary for the transfer (Kedia and Bhagat, 1988; Cannarella and Piccioni, 2011).
- Recipient's comprehension of the financial implications of technology transfer: the degree to which the technology recipients understand i) the relations between the costs and benefits of the transferred technology at present and in future, and ii) the related financial flows between the transferor and the recipient as well as between the recipient and its other stakeholders partners (Walker and Ellis, 2000; Schneider, Holzer and Hoffmann, 2008).
- Intermediaries connecting transferor and recipient: it is related to an external party (business incubators or R&D centres capable of bridging the gaps between producers, government institutions and universities) who develop collaboration strategies and implement new projects Shiau et al. (2001) and Li-Ying (2012).

Institutional network adapting the technology to the local needs: it is important to have an available network that can support the collaborative arrangement among the parties involved in technology transfer (Ison and Russell, 2000).

Prior experience in technology transfer projects on the part of the participants (transferors and recipients): oftentimes a complex relationship exists between agents of technology supply and demand. It is also important that the involved parties understand that technology transfer should be sought not as a 'short-term fix' for enhancing production and growth possibilities, but rather as part of a long-term strategy to establish a culture of innovation and technological learning (Saad and Zawdie, 2005).

They are different from many of the traditional enablers in that they i) emphasize aspects of the transfer process that are much closer to the daily reality of the recipients and the way these recipients interact with the technology; ii) highlight the experiential learning aspect of the transfer process and the degree to which acquired skills from previous and on-going transfers are likely to support actual and future transfers of technology; and iii) focus on aspects of technology transfer process at different organizational levels (ranging from individual to institutional).

3. METHODOLOGY

Using a qualitative approach (Silverman, 2012) based on one in-depth case study, the paper assesses the previously identified enablers in the context of one project of new product development.

In the first step, we have used a qualitative approach based on the study of three in-depth case studies (Silverman, 2012) in which we assessed the previously identified enablers (Sanchez-Preciado et al., Forthcoming 2017), in the context of the pisciculture sector in the Cauca region of Colombia.

The case we selected to gain a deep understanding of the phenomena (Yin, 2003) of technology transfer in rural environments have passed through criteria of theoretical sampling (Eisenhardt and Graebner, 2007). The selection principles for identification of suitable cases were: i) the case includes technology transfer of intermediate technologies in a rural context of a developing economy, ii) the case shows involvement of a network of stakeholders from different types of organizations such as: universities, rural industries, non – governmental organizations, etc. and iii) the case is sufficiently rich to cover the variety of enablers. It is not necessary that the case used all the enablers actively.

3.1 Data Collection

The focus for the data collection was the process to develop a pellet in which the raw material are subproducts of trout and tilapia fish.

With the identified enablers, the next step was to analyze them in the project to know how the mechanisms there were related to them. Organizations that participated in the project were used to gain a deep understanding of the complex phenomena of technology transfer in rural environments (Yin, 2003). The duration of the study was three and a half years. Empirical data was gathered via interviews with producers, technical and administrative staff and support

institutions (universities, non-governmental organisations, Chambers of Commerce, governmental organisations, etc.), and through multiple workshops, four tours to visit 79 farms, participant observation, systematization of experience from 2013 to 2016, and document analysis on projects between 2013 – 2016.

Producers, members of the technical team responsible for the execution of the project were used to gain a deep understanding of the complex phenomena of technology transfer in rural environments (Yin, 2003).

These actors identified how the project activities showed relationships between the enablers using the following system:

1 point was given for highly related enablers, e.g. enabler A has incidence in enabler B
0.5 points was given for enabler's correlation, e.g. enabler A and B influences each other in the same level.
0 points: No related, e.g. there is not any connection between enablers A and B.

The clarification of the arguments to give the points were explain and contrast with other source information like workshops and visits.

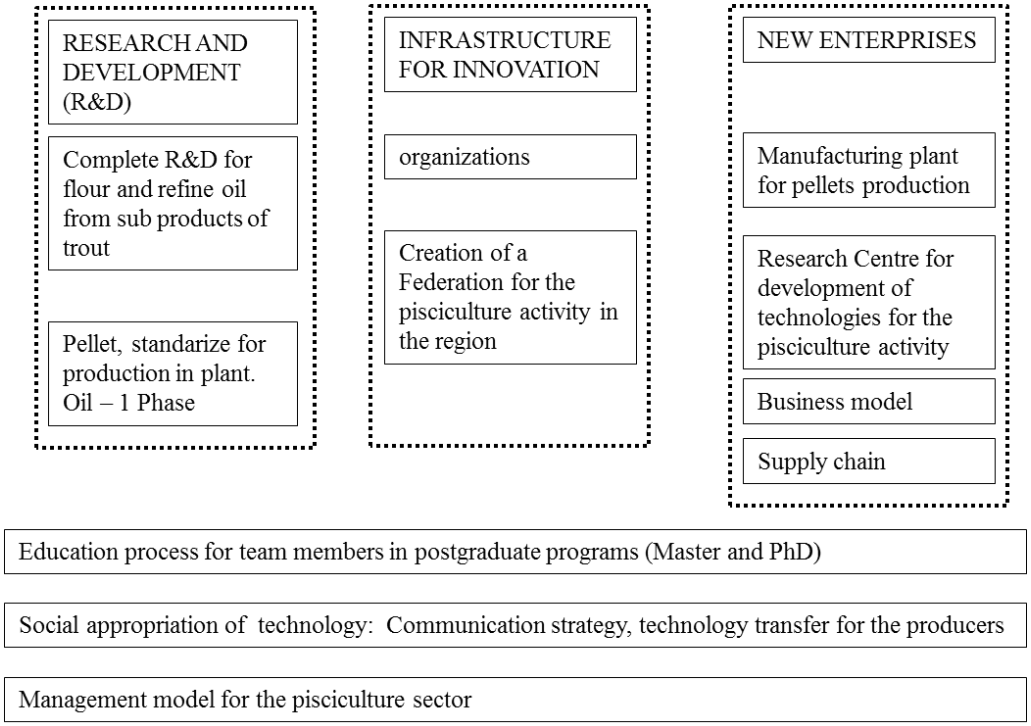
3.2 Data Analysis

To analyze the data collected, first categories of analysis for the producers and other participants in the study were created (their explicit assumptions about each category of analysis (Miles and Huberman, 1994). The coding procedure was discussed with a committee consisting of four producers and one member of the research team. This committee meet every 3 months to discuss the analysis and progress of the study and the information codified by four researchers of different disciplines (engineering, social communication, business administration). This practice helped to the analytical generalization of the data precedent from empirical sources (Yin, 2003).

3.3 ALTPEZ Case

ALTPEZ project had the purpose to find new alternatives for the use of subproducts such as bones, skin and viscera obtained during the production of trout and tilapia. It started on June 2013 and it will be finished on January 2018. During the development of the Project the subproducts were considered the raw material that could be used to produce potential new products like: fish oil (Omega 3), fish flour, probiotic food to feed animals. However, the pellets were the main product identified as the most promising.

Figure 1. Components of ALTPEZ Project



Source: Own elaboration.

4. FINDINGS

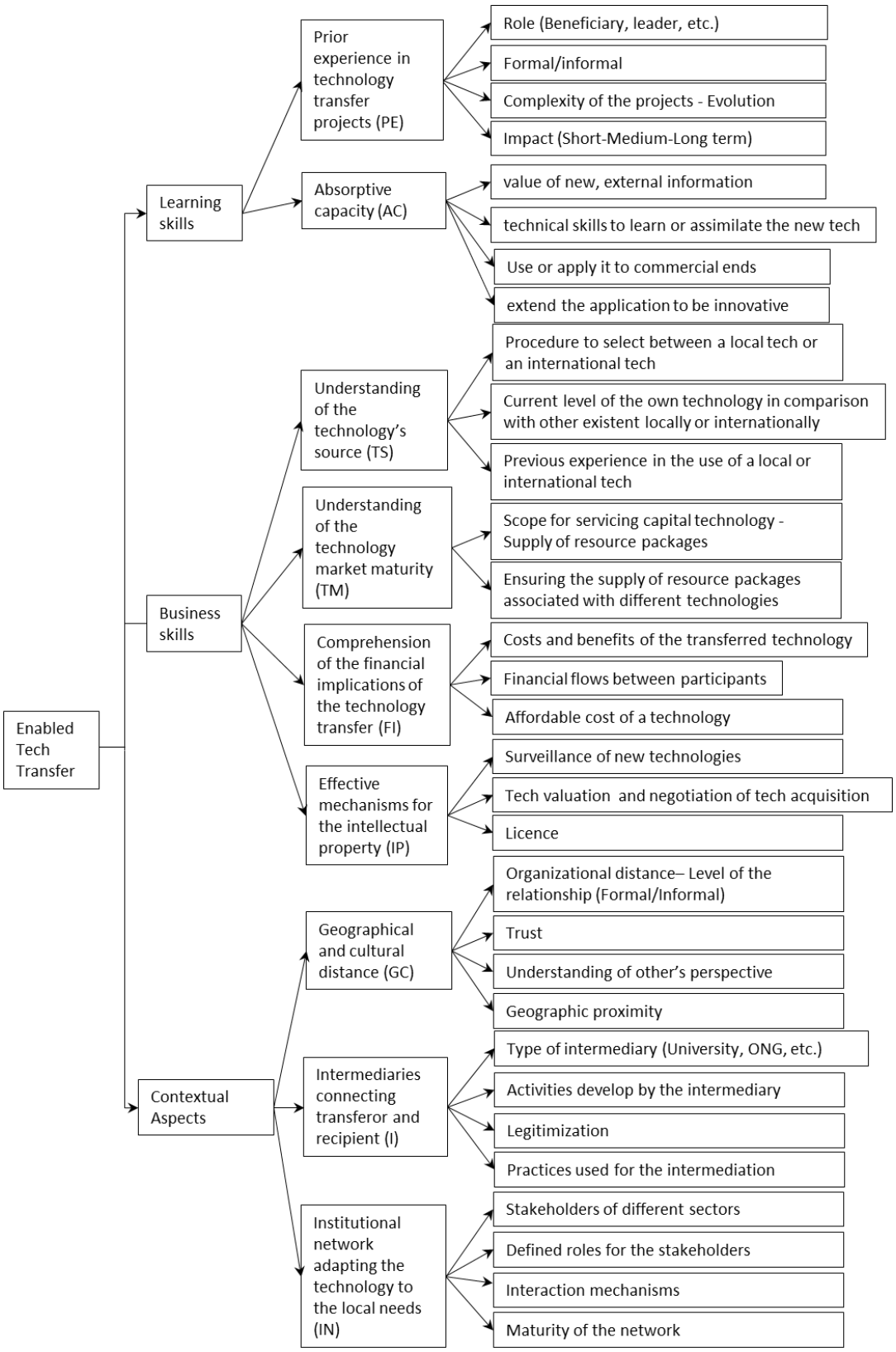
4.1 Aspects Covered in the Enablers

In this rural context of developing economies, transferor and recipient have barriers in the technology transfer like: i) low absorptive capacity in the recipient with limited possibilities to fill the gap easily due to the low education level, ii) related to the previous barrier, difficulties in the recipient to learn through documents and manuals, iii) lack of trust between transferor and recipient to accomplish long term technology transfer projects because of the poor interaction between them, iv) local transferor with difficulties to deploy the technology in a customer-oriented package with potential to be buy it and implemented by the recipient, v) recipient with skills to produce but less knowledge about how to apply technologies and create new business opportunities. These barriers were associated to the collective knowledge and operation in cooperatives in the rural enterprises.

The general framework presented in the section 2 of this paper was analyzed and some additional aspects to understand and describe the enablers were presented in figure 1.

The enablers could be grouped in three categories: learning skills, business skills and contextual aspects. Description of the topics covered in the enablers are appropriate to clarify a way to study each of them in a real situation.

Figure 1. Aspects to describe the identified enablers



Source: Own elaboration.

4.2 Enablers' Relationships

Table 1 presents the summary of the analysis of the relationship between enablers during the execution of ALTPEZ.

Table 1. Relationship Between Enablers

	Learning Skills		Business Skills			Environment				
	AC	**PE**	**TS**	**TM**	**FI**	**GC**	**I**	**IN**	**Total**	**Percentage**
AC		0.5	0.5	0.5	0.5	0.0	0.0	0.0	2.0	7.0
PE	0.5		0.5	0.5	0.5	0.5	0.5	0.5	3.5	**12.3**
TS	0.5	0.5		0.5	0.5	0.0	0.0	0.0	2.0	7.0
TM	0.5	0.5	0.5		0.5	0.0	0.0	0.5	2.5	8.8
FI	0.5	0.5	0.5	0.5		0.0	0.0	0.5	2.5	8.8
GC	1.0	0.5	1.0	1.0	1.0		0.5	0.5	5.5	**19.3**
I	1.0	0.5	1.0	1.0	1.0	0.5		0.5	5.5	**19.3**
IN	1.0	0.5	1.0	1.0	0.5	0.5	0.5		5.0	**17.5**
Total									28.5	100.0

Source: Own elaboration.

Absorptive capacity (AC)
Absorptive capacity was initially developed through the socialization of the practices to feed the fish and implications for the cost production.

Absorptive capacity allows the participants to establish the knowledgeable active members that represent initially the subgroups of participants. The dynamic of the participation in the interaction is based on the communication and technical skills.

Prior experience in technology transfer projects (PE)
Prior experience in technology transfer projects was identified as a progressive way to explain the learning results. The awareness of the participants on the potential risk for new activities or projects help them to create criteria to choose the best alternative.

Understanding of the technology's source (TS) and the technology market maturity (TM)
The interaction supports, the understanding of the technology source was conducted by a research team supported by an intermediary organization (Centro Regional de Productividad e Innovación del Cauca). University of Cauca developed the research and development processes. Sustitutes for the new product were discuss with regular suppliers.

Comprehension of the financial implications of the technology transfer (FI)
Recipient's comprehension of the financial implications of the technology transfer is achieved for few participants of the project.

Geographical and cultural distance (GC)
Geographical and cultural distance between transferor and recipient were systematically decreased giving opportunity and responsibilities to the producers to participate. Traditionally, indigenous communities have established hierarchies that sometimes create difficulties to listen the opinion and ideas of all the people in places outside their own community. The segmentation of the plan in activities forces everyone to work and have their own opinion explicitly expressed.

Intermediaries connecting transferor and recipient (I)
Organizations operating as intermediaries explore and guide methodologically the producers and the transferors in the customization of the technologies.
The intermediaries connecting transferor and recipient trained ambassadors as individuals.
The action level occurs in the organizations level and individual. Usually the ambassadors have technical knowledge about specific topics such as: marketing, management, production, finance, etc.
Intermediaries become important to organize and legitimize the actions and implement the technologies. New processes like communication protocol, technical assistance, assessment, feedback, etc. and new organizations appeared in the project to configure a specialized actor. This new process or intermediary covers the needs of long term view that allow the participants to share resources and experiences.

Institutional network adapting the technology to the local needs (IN)
Network organisations have close relationship for the implementation of some technologies but there is a recognition of the skills of the other participants.
Network of organisations increase its cohesion and base on trial and error solve practical problems of the interaction. Technical problems are solved with more efficiency.

Enablers are not entirely disconnected, ALTPEZ has shown that there is certain type of relationship between some enablers. Some of them are:

The previous project experience of the participants gave learning opportunities (absortive capacity) for all of them in different aspects of the use and assestment of the new technology introduced.

Absorptive capacity starts to show homogeneous common knowledge in the participants and more skills in some of them that become in the group of experts when some new problems appear. As a result of this, individuals and the organizations they repesent deployed their learnings to being leaders or ambassadors (Intermediaries).

5. CONCLUSIONS

While other studies primarily focus on the input-output elements of technology transfers (ie, resources, commitments on the one hand and the resulting products or patents on the other) this study predominantly seeks to understand the transfer processes and the enablers that make them more effective. In this document enablers were extracted and validated. This study argues that the analyses of technology transfer processes in the light of these seven factors will not only enhance

the understanding of those processes and the role that the actors play in this, it will also increase the likelihood that the transfers are being done successfully.

For the present study, enablers the technology transfer in rural context of developing economies, did not identified the intellectual property aspects fully. The project analyzed did not show evidence on this type of practice. It is possible to argue that this is not a frequent practice in this particular type of projects. Mostly, all the time the use of patents implies the payment for the license and rural enterprises, usually the lack of knowledge on the value, potential and procedure to use them. The financial resources to invest in this kind of technologies could be low. In this case, University of Cauca gave access to the producers of the technologies developed and help CREPIC to transfer them.

In sum, the above three viewpoints respectively emphasize the direction of technology transfer (horizontal or vertical), the type of actors involved in technology transfer (e.g. individuals, organizations), and the location of these actors. However, literature largely fails to distinguish between the enablers that facilitate the transfer of high-technology and the transfer of technologies that takes place at the much more elementary level, comprising mainly low-technologies and intermediate technologies aimed at enhancing the productivity of the rural sector in regional developing economies. This is problematic because building a less-than-comprehensive understanding of the enablers influencing this type of technology transfer may lead to inaccurate conclusions and misplaced recommendations.

Absorptive capacity is used to develop a long term vision of the use of the technology. The participants adopt specific roles based on their expertise and they work together. The level of common knowledge is not very different between participants, but in some principles of the technology, still were identified gaps.

In the literature on technology transfer, absorptive capacity is related to the recipient. However, this study has shown that transferors need to develop capacity to learn how to use and find new applications for the technologies in a collaborative with the users.

Technology transfer participants traditionally are transferor and recipient. Some recent literature considers other participants or intermediaries. In the analyzed case, the participation of external leaders that are not producers in the project have changed the interaction and usually the legitimacy of this actor have helped to across organizational boundaries and use contextual barriers.

The role of the intermediaries gave the other participants the alternative to evolve in their relationships and go further in the expectations for future collaborations.

Geographical and cultural distance between transferor and recipient were dismissed due to the exchange of knowledge about potential alternatives to customize the new technology (financial implications). The understanding of the geographic location, families and communities around each farm and institution has showed a change in the way the members of the project see the other participants.

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