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SOCIAL DESIGN FOR TECHNOLOGY TRANSFER: AN EXPERIENCE IN RURAL COLOMBIA

In Colombia, more than 70.000 families in rural areas depend economically on the cultivation, transformation, distribution, and production of fique (Furcraea spp) and fique-based products (Peinado et al., 2006). Historically, this crop has been cultivated in regions affected by Colombia's conflict, including extensive areas in the departments of Nariño and Cauca, where fique producers have suffered from violence, displacement, and economic lag. Additionally, the process to extract the fibers from the fique leaves—which are used for most of the fique-based products—is extremely inefficient and dangerous for workers (upper-limb amputations are common among this population). The fibers that are recovered through this process represent just 4% of the leaves, while 96% of the plant is discarded despite its potential uses for various industries. To address these challenges, since 2014 a group of researchers from a private university and a governmental research institution in Colombia partnered to study and develop solutions to enhance the production and transformation of fique and improve the situation of rural families. An important outcome of this collaboration is the design of a semi-automatic system to separate the fibers, juice, and bagasse of fique leaves (España & Barbosa, 2017). This paper presents the methodology intended to transfer this technology to rural communities so that they adopt it, contribute to refine it and involve it in their practices. The methodology has been developed from a social design approach focused on involving rural communities as co-designers of the system and as adopters of this technology.

Keywords: technology transfer, rural, social design, vegetal fibers, *Furcraea* spp

INTRODUCTION

Technology transfer processes refer to transforming inventions created in academia into commercial applications, which is a critical factor for innovation and for creating value for society and organizations (Apax, 2005). This paper presents the methodology developed by the researchers intended to transfer a technological innovation to rural communities in Colombia. The methodology herein presented, was developed from a social design approach focused on involving rural communities as co-designers of the system and as adopters of this technology.

The technological innovation that is in the process of being transferred to rural communities is a semi-automatic system to separate the fibers, juice, and bagasse of fique leaves (*Furcraea* spp). Fique is a type of Agave native of the Andean region that is widely cultivated in Colombia and Ecuador since it adapts well to different climates and different heights, ranging from 0 to 3000 meters above sea level. It has been found that prehispanic cultures used fibers obtained from fique leaves to make everyday products such as footwear, clothing, packaging, ropes, and containers. This tradition persisted in Colombia until the 1950s when industrial products made of plastic and other synthetic materials entered into the mass market. Currently, fique fibers are still used for making coffee sacks and, in some regions, handcrafts. In Colombia, the livelihood of more than 70,000 rural families depends on fique, especially in areas that have been historically affected by the country's violent conflict such as Nariño and Cauca.

Given the cultural, historical, social, and economic importance of fique, there are multiple actors, such as producers, producers associations, governmental agencies, and NGOs, interested in increasing the production and consumption of fique fibers and fique-made products. It is against this background that in

Figure 1. Fique plants cultivated in the Colombian Andean region (Image: Authors).

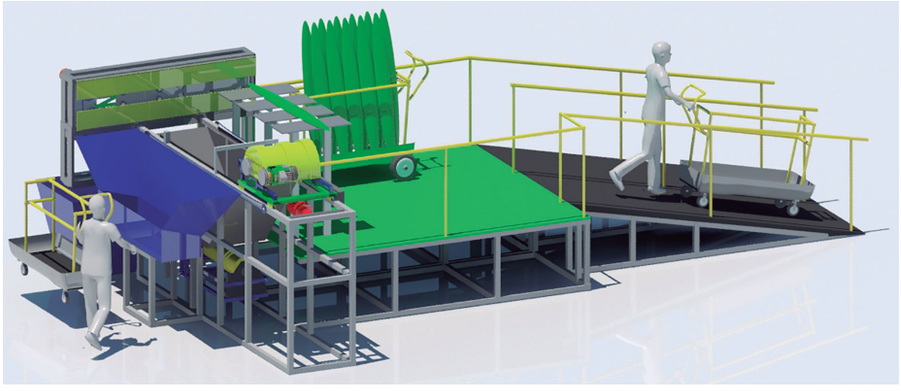

Figure 2. Render of the fique separation system designed and developed by the researchers (Image: Authors).

2014 researchers from Universidad Jorge Tadeo Lozano —a Colombian private university—and Agrosavia—a Colombian governmental organization that conducts agricultural research—partnered to identify and address the most pressing issues facing fique producers and the communities involved with fique transformation, especially those regarding the development of technologies for this sector and the integral use of the fique plant.

As a result of this partnership—and based on the needs expressed by fique producers—a group of researchers from both institutions designed and produced a semi-automatic system to separate the fibers, juice, and bagasse of fique leaves. Currently, some components of the separation system are being patented and the prototype is being tested and improved so that this technology can be transferred to fique producers. As a consequence, the technology transfer methodology presented in this paper was developed by the researchers and is being implemented progressively and rigorously to achieve a successful transfer process.

THE NEED FOR A SEMI-AUTOMATIC FIQUE SEPARATION SYSTEM

One of the motivating factors for designing and developing the fique separation system seen in Figure 2 is that by using traditional separation methods, producers are taking advantage of just 4% of the fique leaf that corresponds to the fibers used for coffee sacks and handcrafts while the remaining 96% of the leaf—which corresponds to juice and bagasse—is currently discarded. Besides representing an environmental issue, discarding this portion of the plant represents a missed opportunity for fique producers since the juice and bagasse have numerous potential applications in several industries (e.g., the fique juice can be used to produce natural soaps, fertilizers, and chemical precursors for the pharmaceutic industry).

Figure 3. Traditional separation methods represent a safety hazards for producers who usually suffer of finger amputations.

Another factor that motivated the development of the semi-automatic separation system is the safety hazards that traditional systems, developed more than 50 years ago, represent for fique producers. The mill that is traditionally used to obtain fique fibers frequently causes finger amputations among workers given its poor safety measures and its high-speed motor. Additionally, this system is heavy and hard to operate, which takes a toll on the health and occupational safety of fique producers.

From a socio-economic perspective, the development of the semi-automatic system represents an opportunity for fique producers to increase their productivity, make a more integral use of the fique plant, and explore the development of new products and applications with higher added value. Additionally, since the separation systems is designed to be used by a community rather than by individuals, the system fosters the creation of new associations that might work under the precepts of a solidarity economy which, in turn, strengthen the position of fique producers when they are negotiating their products with large, corporate buyers.

Given the difficulties that the semi-automatic separation system solves for fique producers, its adoption by this community becomes necessary to improve their socio-economic situation, their work conditions, and the strength of their community.

STATE OF THE PROJECT

Currently, the semi-automatic separation system is being tested and adjusted by the researchers so that it can be deployed in the community. Our intention is that this system becomes the first of a new generation of products that will help rural farmers in making an integral use of fique and many other crops. Once the tests are completed, the prototype will be installed

in a fique-production region to perform new tests under real operational conditions and continue with the technology transfer process. However, we are in front of a crossroads in which the research team needs to decide the best location for the system among three options: Cauca, Guajira, or Antioquia. Cauca is the Colombian department that produces the most fique in the country, it has the largest indigenous population in the country, but it has been critically affected by the its longstanding armed conflict. Guajira is a department that offers ideal geographical conditions to grow fique, for which fique crops are around twice as productive as their counterparts in other parts of the country, but, at the same time, is a department that suffers of extreme political corruption and in which many rural communities live in extreme poverty. Antioquia is a department in which producers have been pioneers in the use of fique juice and bagasse for new applications with higher added value; however, compared to other departments, Antioquia has less areas cultivated with fique, for which its production volumes are relatively low. This decision will determine at what extent the local community of fique producers will adopt the separation system, for which a rigorous and robust strategy for technology transfer is necessary. The strategy that we have developed, and we are in the process of implementing with fique producers is described in the next section.

TECHNOLOGY TRANSFER STRATEGY

According to Rodriguez (2012), technology transfer processes require a holistic approach that considers both its social and economic benefits for rural communities. For Rodriguez, these processes should promote not just the economic growth, but also the strengthening of the social fabric among the beneficiary communities, and their cultural and political empowerment. Espinosa et al. (2016) argue that it is fundamental to identify the factors that might influence the adoption—or rejection—of a technological innovation such as the social dynamics within the community and the interactions between stakeholders in the supply chain. Additionally, Espinosa and colleagues argue that the success of technology transfer processes with rural communities also depend on the type of relationship established between the researchers and the community. For the authors, it is key that researchers establish a horizontal and inclusive relationship with the producers (Espinosa et al., 2016) and acknowledge their expertise and contextual knowledge (Clavijo, 2008), which subverts the traditional relationship characterized by being paternalistic and hierarchical.

As a consequence of the recommendations of the cited authors and our prior experience, the transferring of the semi-automatic separation system to the community of fique producers has been gradual and rigorous to avoid the common pitfalls that usually affect this kind of processes. The strategy that we have applied presents the following characteristics:

Continuous communication with the community: Since the project's inception, the voice of the fique producers was heard and taken into consideration to identify the needs of this economic sector. The need for a "machine" that helped fique producers to separate the components of the leaf was communicated by themselves to the researchers and representatives of the Colombian government during a national fique conference. Likewise, throughout the development process, the researchers have been in contact with the producers to consult with them different aspects of the system, present them the progress made in the project, and collect critical information about the context and the fique production process.

Use of participatory design methods: Throughout the development of the separation system, the researchers acknowledged the expertise of fique producers and involved them at crucial times in the design of the system. Initially, researchers involved representatives of the fique producers in the decision-making process in which the characteristics and features of the separation system were determined. Likewise, the participation of producers was crucial to help researchers solve technical difficulties that they found in the initial prototypes of the separation system. Additionally, their participation was instrumental to define the properties and the quality of the fique fibers that were obtained using the separation system.

Consideration of the community's fears and concerns: Due to the continuous communication that the researchers had with the community of fique producers, we became aware of their fears and concerns regarding the project and the deployment of the system. For instance, one of the main concerns that they had was that by introducing a semi-automatic system to the fique separation process, a good number of the workers would lose their jobs which would have a profound negative impact on the community and the project. To address this concern in particular, we adjusted the initial design of the system so that it was less automated, and it would still require human labor but eliminating the hazards and difficulties of the traditional separation process. Another major concern expressed by the community is that younger generations are less interested in producing or transforming fique due to the hazards that the traditional systems entail, the hard labor that is required to operate these systems, and the razor-thin margins of the fique production business. To address these concerns expressed by the community, we designed the semi-automatic system to mitigate at maximum the hazards for the operators,

reduce the labor required to extract the fibers from the leaves, and increase the efficiency of the process to increase the margins and reduce the investment of time and effort. Additionally, once the system is installed in rural areas, we have foreseen the need to communicate these features of the semi-automatic system to younger generations to motivate them in getting involved into the fique production and transformation community and business.

Technology transfer throughout the project's lifecycle: Different from traditional approaches to technology transfer that occur at the end of the development process, in our case, we started the transferring since the beginning of the project. Besides consulting and co-designing with the community, the researchers also shared information and knowledge with them as the project progressed. This approach was motivated by the researchers' intention to include the community as a partner of the project as a result of learning from previous experiences in which other teams developed technological innovations that could be useful for fique producers but that ultimately were not adopted by the community as a result of inadequate or inexistent plans for technology transfer. Likewise, it is projected that the technology transfer process continues after the separation system is implemented and until the community completely appropriates it. Besides involving the community throughout the process, a lifecycle approach to technology transfer might increase the adoption of the system by the community and the long-term viability of the initiative.

Holistic approach to technology transfer: Besides deploying the separation system in the community, the researchers have considered the implications and the potential impacts that the introduction of the system could have on the community, the environment, and the local economy. Based on this analysis, we concluded that we—and other teams of researchers—need to develop new applications that use the fique juice and bagasse to minimize the environmental impact of these by-products and maximize the margins for producers. We calculated that for each ton of fique fiber that the system separates, it produces 19 tons of juice and bagasse. Considering the potential uses of these by-products, the harm that these might cause in the environment, and the potential gains for the community, we proposed a new phase for the project to explore potential uses of fique juice and bagasse. As an example of other applications of these by-products, in the past, the researchers and a group of students developed a collection of soaps and detergents that used fique juice as a significant ingredient since it behaves as a saponin.

CONCLUSIONS

- Traditional fique (*Furcraea* spp) separation methods are inefficient (just 4% of the leaf is used while the juice and the bagasse are discarded) and represent occupational hazards for rural producers. For these reasons, the development and implementation of the semi-automatic separation system is crucial to improve the working and economic conditions of producers and their communities.
- The strategy for transferring the fique separation system to rural areas will depend on the characteristics of the communities, the local conditions, and the region where the system will be implemented. Adjusting the strategy to these conditions—which the research team needs to explore in further detail—is fundamental so that the selected community adopts the new technology and reaps its benefits.
- The use of participatory design methods that involve fique producers in the development of the separation system has been crucial in creating a solution that responds to the needs and conditions of rural communities. In the next steps of the project, the use of this type of methods will be instrumental in reconciling and articulating the diverse approaches brought by governmental researchers who come from the STEM disciplines, and academic researchers who have a design background.
- Keeping a continuous conversation with the community and considering their concerns throughout the development process has created a receptive environment among fique producers towards the semi-automatic separation system. Likewise, it has kept the community engaged and has created realistic expectations for the upcoming introduction of the system into the rural context.
- As part of the technology transfer process that we are conducting, we have understood that it is fundamental to uncover and address the implications of introducing the separation system into the rural context. For this purpose, new solutions that we did not conceive at the beginning of the project are projected to be developed in its future phases to improve the adoption of the system by the community and reducing negative impacts on them and the environment.

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SOMEWHERE, NOWHERE, ANYONE, EVERYONE