DOI: 10.24850/j-tyca-2019-02-02

Articles

The social adoption of appropriate technologies in Chitejé de Garabato, Querétaro, México; an exploratory study

La adopción social de tecnologías apropiadas en Chitejé de Garabato, Querétaro, México; un estudio exploratorio

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Abstract

This article explores the definition of social adoption of appropriate water and sanitation technologies and the elements that compose it. In order to understand the operation of technology and social organization, a survey was carried out in the municipality of Amealco de Bonfil, Queretaro, specifically in the community of Chitejé de Garabato. The survey was carried out in the context of the attention to marginal localities without water and sanitation services of the Program Agua Cerca de Todos (Water Near All), which included the construction of appropriate technologies. The authors present the findings of the survey and an analysis of the elements that make up the concept of social adoption of appropriate technologies, contrasting some preliminary hypotheses with the results of the methodological exercise in the aforementioned community.

Keywords: Appropriate technologies, water and sanitation, social adoption, technology transfer, Querétaro.

Resumen

El artículo explora la definición de adopción social de tecnologías apropiadas de agua y saneamiento, los elementos que la componen y, para conocer el funcionamiento de la tecnología y la organización social, se llevó a cabo una encuesta en el municipio de Amealco de Bonfil, Querétaro, en específico, en la localidad de Chitejé de Garabato, en el marco de la atención a localidades marginadas sin servicios de agua potable y saneamiento del Programa Agua Cerca de Todos, en el que se incluyó la construcción de tecnologías apropiadas. Se presentan los hallazgos de la encuesta y un análisis de los elementos que componen el concepto de adopción social de tecnologías apropiadas, contrastando algunas hipótesis preliminares con los resultados del ejercicio metodológico en la localidad mencionada.

Palabras clave: tecnologías apropiadas, agua y saneamiento, adopción social, transferencia de tecnologías, Querétaro.

Received: 09/05/2017

Accepted: 11/07/2018

Introduction

Access to drinking water, sewage, and sanitation is still a problem in Mexico. According to INEGI (2010), there is still 9.5 million people without access to water services (they have a complete lack of any hydraulic infrastructure). The number raises to 25 million if we add the people that do not have access to water in their households – that is, the service is available in their community, but they do not have direct access within their homes). To have access to this vital liquid these people must somehow obtain the water and carry it to their homes themselves, often for very long distances.

Regarding sewage, currently 10.7 million people do not have access to these services. There exists an access gap between rural and urban communities. In urban communities there is a coverage of 96.5% for this service, while in rural communities the coverage is of 70.1% (INEGI, 2010). On the other hand, residual water sanitation services are deficient in most communities in the country.

It is important to note that this landscape worsens in rural communities, as they suffer the most: while on average in urban populations 95.5% of people have water service, in rural populations the percentage drops to 80.3% (INEGI, 2010). The reasons for this disparity are diverse – geographical, there are hard to reach zones; social, there exist communities in irregular and precarious living conditions; economical, there are communities with no access to centralized and sanitation services because integrating them to those networks represents technical and financial difficulties to the operators.

To overcome these obstacles and achieve full coverage of drinking water and sanitation services in these communities, implementation strategies of social programs have been launched. The expectation is that the communities will participate in all stages of the projects, with an emphasis on the usage of alternative or appropriate technologies. The success of these type of initiatives – beside the low cost and ease of operation of the technologies – can be seen in the involvement of the communities themselves in the design, construction, operation, and maintenance process of these technologies. There are some citizen organizations that are working in disaffected rural communities and whose goals are to contribute to community development with an environmental sustainability approach. As such, they are implementing *ecotechnology* or alternative technology projects, such as: rain harvest, 'dry' bathrooms, artificial wetlands, amongst others.

Theoretical and methodological planning

The underlying idea of this article, as well as its main goal, is to begin to analyze the level or degree of *social adoption* that beneficiaries of rural communities, in which water and sanitation projects have been implemented, have reached through appropriate technologies. Why is the social adoption level reached by the programs or projects built alongside them important? Because while these programs and their respective water and sanitation systems are designed to solve basic problems or rural households, there are many factors that inhibit good operation. There is currently no diligent systematization or documentation of the number of technologies that – as a result of different institutional programs – are still working adequately after having been built in the communities. However, there is empirical evidence that shows that a high percentage of these technologies are not being used, are being used inadequately, or are no longer operating. There are exercises that aim to review the approaches and technologies in Mexico. However, they focus on a general view of appropriate technologies (Ortiz-Moreno, Masera-Cerutti, & Fuentes-Gutiérrez, 2014) and are based on four fundamental items: development, validation, diffusion, and monitoring of the so called *ecotechnologies* (considered appropriate technologies as well). These reviews do not emphasize social adoption. Social adoption goes hand in hand with the sustainability of finished projects.

In a recent project, led by the Mexican Institute for Water Technology (IMTA, its Spanish acronym) in 2013, the authors conclude, amongst other things, that relative to the sustainability verification of projects completed by the Programa para la Sostenibilidad de los Servicios de Agua Potable y Saneamiento en Comunidades Rurales [1] (Prossapys), developed by CONAGUA, "the biggest weakness of these projects is their operation and maintenance" (López-Ramírez & Moya-Fonseca, 2013: 189). Furthermore, the authors add: "Lest the projects become deficient or deteriorate, it's necessary to repair or rehabilitate the projects in such a state urgently. Otherwise, the economical investment, the organization, and the human effort used for them will have been in vain" (López-Ramírez & Moya-Fonseca, 2013: 189-190).

In addition to the aforementioned Prossapys, there are several institutional programs that have buil water and sanitation systems, such as the Programa de Infraestructura Indigena (PII), formerly called Programa de Infraestructura Basica para la Atencon de los Pueblos Indigenas (PIBAI) of

[1] Program for the Construction and Rehabilitation of Drinking Water and Sanitation Systems in Rural Zones.

the Comission for the Development of Indigenous Peoples (CDI); the Programa Habitat of the Secretariat for Agrarian, Territorial, and Urban Development (Sedatu); Programa de Desarrollo de Zonas Prioritarias (PDZP) of the Secretariat for Social Development (Sedesol). These programs do not always build centralized or conventional systems. They do, however, include some appropriate technologies, separately or in conjunction, to create more technologically complex systems. Technologies are designated as appropriate, alternative or *ecotecnia* (ecotechnology), if it meets – at least generally – the following requirements:

a) It requires little investment.

b) It used the materials available in the communities.

c) They require intense manual labor.

d) They are small in scale.

e) They can be assimilated and maintained by the social group which uses them.

f) They are flexible and adaptable to modifications (Murphy, McBean, & Farahbakhsh, 2009).

g) They do not harm the environment (Pérez & Zabala, n/d).

In addition to the above points, some authors have added local water management traditions (Ryan & Vivekananda, 1993), the integration of kinship ties for technological appropriation (Warriner & Moul, 1992), and other authors have emphasized local and cultural knowledge (Grieve, 2004; Driesen & Popp, 2010; Lawal, 2010) and the relation between social dimensions and technological sustainability (Alam, 2013). The concept of social technologies (Thomas, 2011) approaches the issue differently, wherein the creation of skills and a greater interrelation between social, cognitive, and technological systems are incorporated. However, much of this work emphasize the acceptance of the technologies and not what we may call technological adoption. Certainly, alternative technologies can meet their requirements, but their use, maintenance, and proper running are also dependent upon *the ways of usage and the methodological approaches* that were used for their introduction. It is important that the technological framework of introduction for this type of systems in rural communities acknowledges at least the following elements: the importance of the recipients' knowledge, their active participation and environmental sustainability (Pérez & Zabala, n/d). Although, one may add the social sustainability of the technology and the perceived attention to a need that the recipient population might feel. Hence, the concept of "appropriate technologies:" "(…) present a series of problems: conceived as temporary solutions, aimed at users with low education levels, they end up generating top-down dynamics. As such, on the one hand, they favor the employment of outside expertise, foreign to the beneficiaries, and on the other, the under-use the local technological expertise (both tacit and codified) that has been accumulated historically" (Thomas, 2011: 9).

One may recognize at least three general approaches (both theoretical and methodological) for the introduction of technologies into rural communities: that of technological transfer, that of appropriation, and that of social adoption. The first two are generally managed by public institutions and development organizations, by Citizen Organizations, and by national and international foundations that support these systems, especially to make up for water and sanitation needs. The last approach, however, is a new one, at least in how it differs from the previous two (Martínez-Ruiz, Murillo-Licea, Starkl, López, & Libeyre; Murillo-Licea & Martínez, 2010). This does not prevent it from having achieved important milestones and from developing experiences made by citizen-led groups, that may be classified within this approach.

The difference between the three aforementioned approaches lies within the different intervening elements in their instrumentation, design, and introduction of appropriate technologies. The first approach is that of *technological transfer*. It is centered on the relation between the technologist and their technology. Its view is that the technologies can be adjusted to the real conditions of the rural communities from the "laboratory." In these cases, the "lab" can be expanded to a place where the diverse technologies are being offered and showcased, generally all integrated into a single technological system. Generally, this type of approach is common in public institutions with little contact to the real-life conditions and context of the rural inhabitants. Alternatively, they might have statistic data that shape this type of approach. Additionally, this type of technological introduction tends to be based on homogeneous systems or on technological packages with no variations. This is due to the view of those who have developed it – a view of efficiency and operation from the point of view of the lab technician.

The second approach is focuses on the relation of the technology itself to the direct recipients of it. We refer to it as *technological appropriation*. This approach represents a step forward, since it considers the beneficiaries. This approach's main goal is not just on ensuring the technology works and building the systems, as is the case for the technological transfer approach. It focuses on the technology being used by the recipients of it. However, the term "appropriation" poses several problems, amongst them the fact that it is a verb that encourages someone to take an object for their personal or direct use. Additionally, it poses the technological system as an object foreign to the community; thus, the need to appropriate it for daily use. Although in many ways it is a step forward on the importance of active social participation of the recipients, there is an element that is not left out in this approach: the social sustainability of the technologies. The literature on this topic would make it seem as though this approach and that of "technology acceptance" or "assimilation" (De Luca, 2012; Viatte, 2001) are synonymous. We do not intend to frame this technological sustainability in the linguistic field of sustainable development (Vega-Encabo, 2004), but rather in a characteristic that allows the union between social dimension and technological dimension.

Thus, the term *social adoption of technologies* is born (Martínez-Ruiz *et al*., 2010; Murillo-Licea & Martínez, 2010). This approach considers the relation of the technological device to its beneficiaries, but from a sustainability perspective. That is to say, it seeks to deal with a specific need considering the device-beneficiary relation and its durability. According to Martínez-Ruiz *et al*. (2010: 131), social adoption faces obstacles when, from the institutional planning and engineering intervention perspectives, organization and participation are favored over aspects such as knowledge of the environment, the target population´s hygienic, and social and economic dimensions. Murillo-Licea and Martínez (2010: 115) add the importance of acknowledging local expertise, active participation, and social and environmental sustainability in relation to the technologies.

As such, the technological adoption approach cannot be measured in the short run, and perhaps it cannot be measured in the mid-term run either, but rather in the long run. Social adoption of technology is based on the active participation of the target population throughout the entire process – from choosing the technology, to its maintenance and it replicability.

Additionally, in opening up to procedures of the target zone, of the culture, and of local social organization or to the expertise and traditions of a place, the technological process is molded to certain local conditions that facilitate its adoption. Carr (2016) talks about the "integration" of a technology, referring to acceptance of it. However, adoption, as outlined here, goes beyond just the acceptance of a technological system. A concept more closely related to that of adoption herein proposed, is that of "technological translation" (Vega-Encabo, 2004), which refers to a process of profound transformation and of "design reconsideration" of the technologies (Vega-Encabo, 2004: 58). This concept is diametrically opposed to the transfer approach.

An essential process to social adoption is that of introduction of ways in which the population can improve the technological systems. This means selecting and getting comfortable with the technology, understanding how it works, and adapting it to specific local needs and conditions. This is how we believe the concept of translation is closely related to that of adoption; however, we add the sustainability and replicability dimensions.

The transfer approach can be measured in the very short term: built technologies are accounted for and the time of use becomes less of a priority. In the appropriation process, the time frame is within the short and mid-term run once the recipients learn how to operate and maintain a technological system. However, in the social adoption of technologies process, the time frame is in the long run. It does not focus on the construction, operation, skill-learning, use processes, nor does it focus on maintenance, added improvements, and replicability of the technologies. It does not focus on social organization for its use and maintenance either. Rather it emphasized the lasting attention to a need. The term "adoption" differs greatly from "appropriation." To adopt something or someone is to introduce it to a quotidian, familiar, intimate environment; the term appropriation has a negative connotation in the form of "to take from," adoption implies "to take in, to embrace."

Social adoption, then, includes the active social participation of the beneficiaries – training and guidance that facilitates the learning processes, and as such those of social adoption. Such training is a key point for the proper running of the technological systems and to ensure replicability processes. Engaging the beneficiaries and their own technology to the technological process is key. The technology-user interaction forms a parallel process of sustainability, which involves a time dimension that can be measured. In other words, we are speaking of technological sustainability.

Generally speaking, in technology transfer processes one finds a chain of processes (García-Vargas, 2014: 20), more or less composed of:

a) Promotion of the technologies.
b) Construction of the technologies with the labor of the beneficiaries (participation in construction).
c) Social organization (committees are formed to maintain the technological systems).
d) Beneficiary training.
e) Technology use guidance.
f) Maintenance for the technological systems.

Step g) – evaluation of the technological systems – is not always considered, because as mentioned above, many programs short-sighted views of the technological processes, believe they take care of a need when a technological system is installed. That is to say, they believe the technology itself satisfies a need.

In social adoption of technology processes, however, these steps are considered too, including evaluation at different scales and over different periods of time (for example, short, mid-term, and long run. To help understand the sustainability of use of a technology or an integrated technological system). Another aspect that shows up across the board is engagement, or degree of engagement with the technology. That is to say, interaction. Since this aspect is more subjective, measuring it poses a degree of difficulty, for example, when creating an appraisal or a social adoption index. The engagement process between people and the technological systems goes beyond use, processes and maintenance periods, and the type of information at hand to transmit to new users. It goes beyond improvements introduced to the technological systems based on observation, experience and use. It goes beyond the ability to replicate such systems in different places or under different conditions. Engagement also has a cognitive dimension, and one might argue it possesses an affective component too, not to the technology per se, but to the *relation* between the technology and the specific *need* that it takes care of.

In the processes of technology introduction, there exist very similar processes: introduction, explanation of operation, training, construction, organization for maintenance and use. However, the key to understanding why technological transfer processes do not work properly and where adoption processes might be more long-lasting is not in the process. It is about the approach with which the technological system is introduced, and the environmental, social, cultural, and economical context (Murphy *et al*., 2009). The social adoption approach hypothesizes that the more training, the more active social participation by the population, and the more engagement (interaction), the more technological sustainability there will be.

To summarize, the dimensions that social adoption considers are: taking care of a need, technological sustainability, replicability, active participation, training, interaction, and social organization.

Context: the Agua Cerca de Todos program

One of the state-sponsored programs to attend underdevelopment regarding drinking water services was the Agua Cerca de Todos program. It was designed and operated by the Comision Estatal de Agua de Queretaro (CEAQ). The Agua Cerca de Todos program is part of a wider state program called "Soluciones," that aimed at "Integrally improving the quality of life of the Queretaro families more affected by scarcity, through distinguished support that tends to their needs" (Diario Oficial de Gobierno del Estado, 2010).

The goal of the Agua Cerca de Todos program was that the Quererato inhabitants had access to drinking water. The main goal was that by the year 2015 the entirety of the state's population had access to the service. To achieve this goal, the methodology the program followed was to create municipal diagnoses. One of the main components of these diagnoses would be drinking water service coverage, considering criteria such as the number of inhabitants per municipality, the demand of drinking water, hydraulic infrastructure, and the supply sources. Additionally, there were four regional consultation and citizen participation forums that included the 18 municipalities of the state, aimed to directly identify the communities and citizens that lacked the service (CEAQ, n/d). CEAQ signed collaboration agreements with the 18 municipalities of the state to incorporate municipal action to the solution to this problem.

The target population – defined by the information obtained from the forums and from statistic information – was 145 thousand inhabitants, located in hard to reach and dispersed areas, as well as an urban population that lacked the drinking water service (CEAQ, n/d).

According to the program's rules of operation, the assistance given was formulated generically as: "integral drinking water supply system and/or master waterworks, expansion and/or rehabilitation of drinking water distribution networks, hydrant installation, installation of protected sources (communal water tanks, cisterns, and drinking water supply through tanker trucks), hydrotechnology and ecotechnology implementation, funding schemes to hire drinking water services following existing agreements, diversified support (good practices regarding water and sanitation, filters, etc)" CEAQ, 2013: 6).

Additionally, the rules of operation state that the Program will follow international standards in five areas: quality (the regulating organization will design a Water Security Program); quantity, defined as the distance and time it takes beneficiaries to access water; affordability, defined as the official fee in relation to use, sources, socioeconomic and environmental diagnostics, investment plans, and other tools to determine the proper fees for each user; and continuity, defined as the time the population will have access to water (CEAQ, 2013: 9/10).

To achieve total coverage, the program implemented different solution strategies. These consisted in dividing formal settlements, communities with more than two household, and informal settlements. In formal settlements the expansion and rehabilitation of existing systems were considered; many of these projects benefited urban populations who settled in the vicinity of cities and who did not have access to the service. For communities bigger than two households, formal or conventional systems were designed.

In the case of one or two households – more complex due to scattering and isolation - "hydrotechnologies" and ecotechnologies were proposed. This was based on a study on the socioenvironmental operation feasibility of these technologies, considering sociocultural economic, and environmental aspects, and using technologies such as ecological households, rain harvesting systems, and purification of water through filters. The Universidad Autonoma de Queretaro carried out the socioenvironmental diagnostic, in the municipalities of Arroyo Seco, Jalpan de Serra, Landa de Matamoros, and Pinal de Amoles (UAQ, n/d).

In the case of informal settlements – defined as irregular in shape, lacking basic services, they generally obtain them through self-built systems and community cooperation – the measure chosen was to build community hydrants. Regarding the need to formalize such settlements, there were attempts at formalizing land ownership and, in some cases, to make expansions to the transportation and distribution lines, as well as to the installation of water tanks or household hydrants, and the construction of storage tanks located at strategic places easy to access by the inhabitants.

As a result of this part of the program, 177 water storage deposits were installed in 131 communities, and 30 water tankers were acquired to distribute water (UAQ, n/d; CEAQ, 2013).

For communities with one or two households fifty ecotechnologies or hydrotechnologies were established for strategic installation in the above mentioned municipalities. This was the technological offer considered: concrete and iron cisterns, capuchin brickwork or polyethylene water tanks, dry toilets, rain harvesting systems (which in some cases meant renewing the roof of the household), water-proof pumps with photovoltaic panels, water purification through nets, modular sediment filter, and family purification filters. To complement the technologies, there were projects to conserve water and soil, especially in rain harvesting or natural spring areas, as well as reforestation (UAQ, n/d).

The funding for this part of the Program was simultaneous and came from private foundations (Fundacion Gonzalo Rio Arrionte and Agencia de Desarrollo Sierra Gorda, A.C., currently called Fundacion Latinoamericana para el Agua y la Vivienda Sustentable, A.C.), from CEAQ, from the Universidad Tecnologica de Queretaro, and from the Universidad Autonoma de Queretaro. The iggest contributions came from the Fundacion Gonzalo Rio Arronte (37.2%) and CEAQ (34.2%). The total investment for this program was 6,364,900.00 MXN (CEAQ, n/d).

Regarding supply through formal systems, 4,079 inhabitants in 153 Queretaro communities benefitted from the installation of hydraulic infrastructure, the perforation of new supply sources, the construction of new storage tanks, and transportation lines.

An additional activity added to the program, was the creation of a social accountability office, which urged the creation of committees that oversee construction, the results from technical inspection visits, report irregularities, and participate in delivery and receipt of projects. The program reports having built 143 such committees in an equal number of communities. The rules of operation of the program state that each committee "be created in an orderly, independent, voluntary, and honorable manner, with equal parity of representation of men and women and under the regulating organization" (CEAQ, 2013: 8).

The case of the Chiteje de Garabato community, municipality of Bonfil, Queretaro

The Amealco de Bonfil municipality is located on the southernmost part of Queretaro state. It shares its northern border with the Huimilpan and San Juan del Rio municipalities; to the east with San Juan del Rio and the State of Mexico; to the south with the states of Mexico and Michoacan de Ocampo; to the west with the states of Michoacan de Ocampo and with the municipality of Huimilpan (Gobierno del Estado de Queretaro, 2013).

The municipality has a surface 628.1km, equivalent to 5.8% of the total land of the State. It is composed of 159 communities, out of which two are urban and 157 are rural. The one on which we focus here is Chiteje de Garabato, located 19.6 km away from the municipal head, two kilometers from the limits of the state of Michoacan, and approximately 2.7 km from the Lerma river. Chiteje de Garabato spans 1,063 hectares (Guzmán, 2014). Its population is of 1,625 inhabitants; 48.18% are women and 51.82% are men. Age-wise, the structure of the population is divided as follows: 56.18% are of productive age (between 15 and 59 years of age), while 43.81% are of dependent age (0 to 3 years of age, 3 to 15, and 60 and over) (INEGI, 2010). The indigenous population of Chiteje de Garabato makes up 42% of the total population, equivalent to 698 inhabitants (CDI, 2010). According to the Consejo Nacional de Población (Conapo, 2012). Chiteje de Garabato has a high degree of marginalization. This index is one of the eligibility criteria for different social programs.

In the span of ten years, the percentage of households with dirt floors decreased 27%; households with electric energy went from 87 to 94%; households with water within the house went from 59% to 82%; and sewage increase by 41 percent, as seen in table 1. These numbers make apparent the need to take action directed at increasing the coverage of drinking water and sewage services in the community where this study was carried out.

Table 1. Characteristics of the households in Chiteje de Garabato. Source: Made by the authors with data from INEGI.

Year	Total # of households	Dirt floor (%)	Electricity (%)	Water DV (%)	Toilet (%)	Sewage (%)
2000	305	35.73	86.55	58.68	50.16	24.59
2005	328	30.18	90.85	75.30	52.43	46.64
2010	343	9.07	93.58	82.21	66.76	66.18

If we analyze access to water according to the variables set up by INEGI, we can observe that for the years 2000 and 20005, only one fifth of the households that had access to water from the public network, had this service within the home. The rest had the service outside the home but within their own plot of land (INEGI, 2000; INEGI, 2005). However, these numbers reverse by the year 2010, when a majority (82.21%) had access to the service within the home and only 17.79% has it outside the home but within the land. Until 2005, when there was no access to water within the household, supply came mainly from the natural springs near the community.

On the other hand, out of the total number of households with sewage in 2000, 64% were connected to the public network, 13% had a septic tank, and 22.7% drained their sewage down gullies or crevices. By 2010, the percentage of water with sewage service increased, however we do not have data broken down into the different types of drainage.

It was under these conditions that the Agua Cerca de Todos Program intervened in Chiteje de Garabato, starting in 2007 (Conagua, 2016). It incorporated the construction of water and sanitation systems through appropriate technologies. As such, the Fundacion Latinoamericana para el Agua y la Vivienda Sustentable A.C. (FLAVSAC) developed a project to build different technological packages, which included different ecotechnologies, amongst which there were: rain harvesting systems, cisterns, dry toilets, biofilters, burners, heaters, and solar pots. However, it must be mentioned that there were several governmental interventions in this community that set out to and built technological systems to take care of the water and sanitation needs. The Secretaria de Medio Ambiente y Recursos Naturales (Semarnat) intervened there in 2007; Semarnat, the Fundacion Mariana Trinitaria, the State Government, the Comision para el Desarrollo de los Pueblos Indigenas (CDI), the Secretaria de Desarrollo Social, and the Amealco de Bonfil municipality in 2008; the State Government, Semarnat and CDI in 2010, tending to 70 families in three years (Conagua, 2016: 57). Under these conditions, the inhabitants cannot clearly identify the specific intervention of each of the above-mentioned government institutions, or the technologies introduced by each of them, nor can they identify the direct intervention of FLAVSAC.

To precisely understand the impact and operation of such technologies, as well as their potential degree of social adoption, a specific study was carried out, considering that an *expost* evaluation of the operation of the appropriate technologies is not usual. As a result, the situation of the technologies built in rural environments is unknown. The current study was carried out by IMTA in 2015. It uses data collection as part of its methodology, as well as a survey of 35 Chiteje de Garabato inhabitants, 34 women and one man (each one representing a household). It is estimated that the survey gathered the opinions of half of the families that the aforementioned institutions sought to help throughout the entirety of their technological interventions. The ages of the respondents range from 15 years of age to 78. There was an emphasis on surveying women, given that they are the ones who tend to use most of the technologies. The average of inhabitants per household is five, although there were homes with up to 10 inhabitants or with as few as one. The survey focused on three aspects, considered to be key: participation in the construction of the technologies, training received to operate and maintain the technologies, and the operation of the technologies. The working hypothesis of this study is that the greater the community engagement or the greater their need to solve the scarcity, the greater the degree of social adoption of these technologies should be.

Appropriate technologies in Chiteje de Garabato

The distribution of built echotechnologies in the surveyed households is shown below in Figure 1.

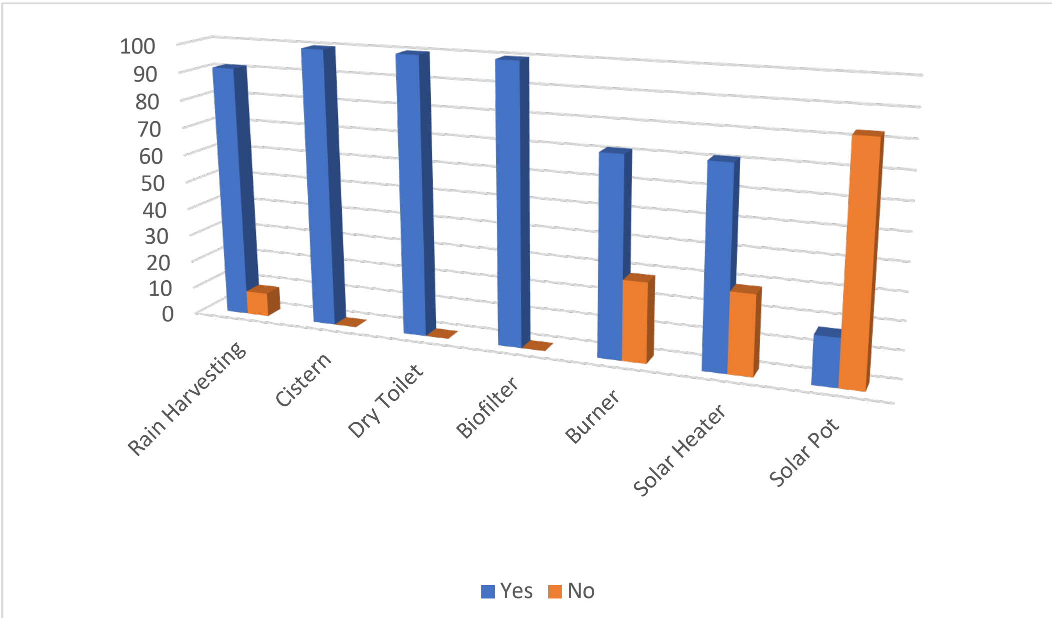

Figure 1. Built echotechnologies in the Chiteje de Garabato community (%).

As shown in Figure 1, all surveyed people benefitted from the technologies, although not all of them required or benefitted from all technologies offered by FLAVSAC in their project. As such, the beneficiaries have different opinions on how the program arrived at their community. They are divided between those who believe the community applied for it, those who believe the authorities gave them the project, some others say it was a non-Governmental Organization that carried out the program, and even a percentage of people who mentioned a leader or neighbor. This situation is understandable, given that the program developed by FLAVSAC was carried out several years ago, and the people don't have an exact memory of which institution or organization built it. This can be seen in Figure 2.

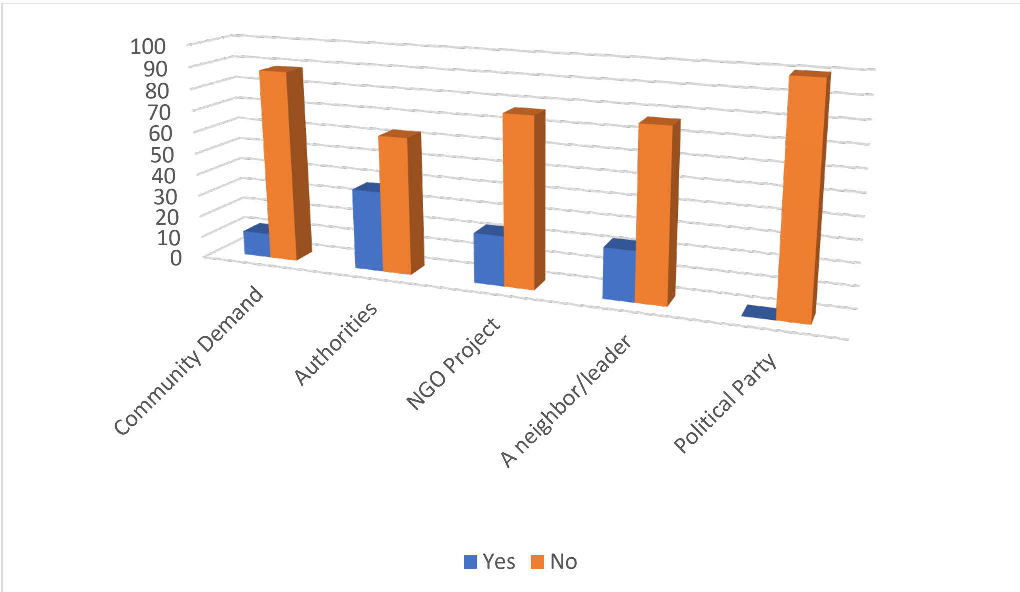

Figure 2. How did the idea for the project come about? (%)

As we can see in Figure 2, the respondents have a wide variety of competing ideas as to who brought the program to the community. The only agreement was on the fact that the program was not implemented by a political party.

Assuming the importance of participation, and to make sense of the data, and to make sense of how the program came to the community, the respondents were asked how they participated in the project – what were their contributions. The results show that out of the 35 beneficiaries who partook in the project's activities, the biggest contribution was in manual labor for the construction. These results can be seen in Figure 3.

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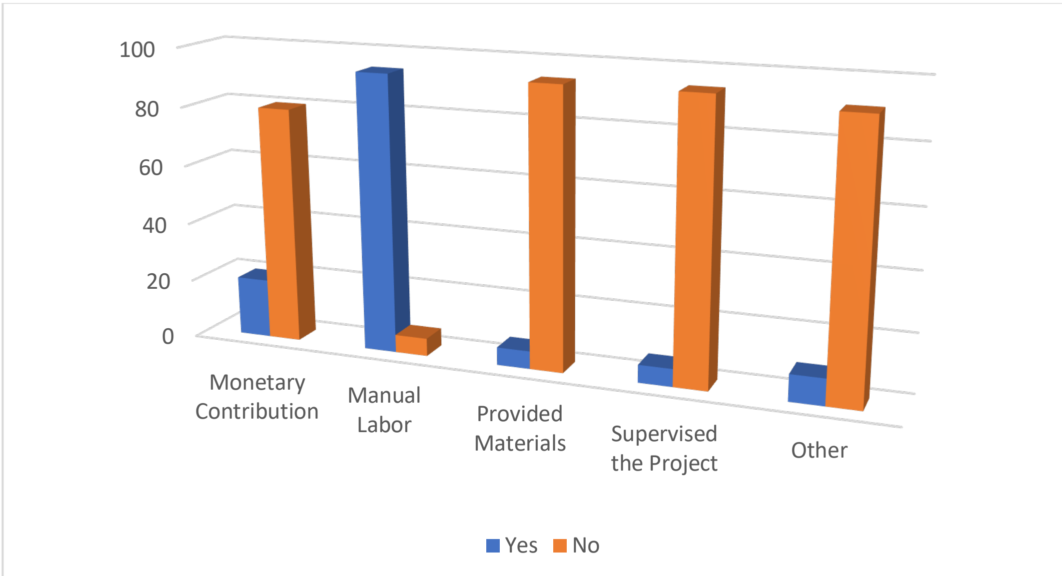

Figure 3. How did you participate in the project? (%).

Regarding built technologies, 33 people answered that they were installed in all households, and only 2 of them answered that they didn't know. An important aspect for the purpose of this study has to do with how it was decided which households would receive the technologies. When asked "how was your household selected to be a beneficiary?" the answers varied, as seen in Figure 4.

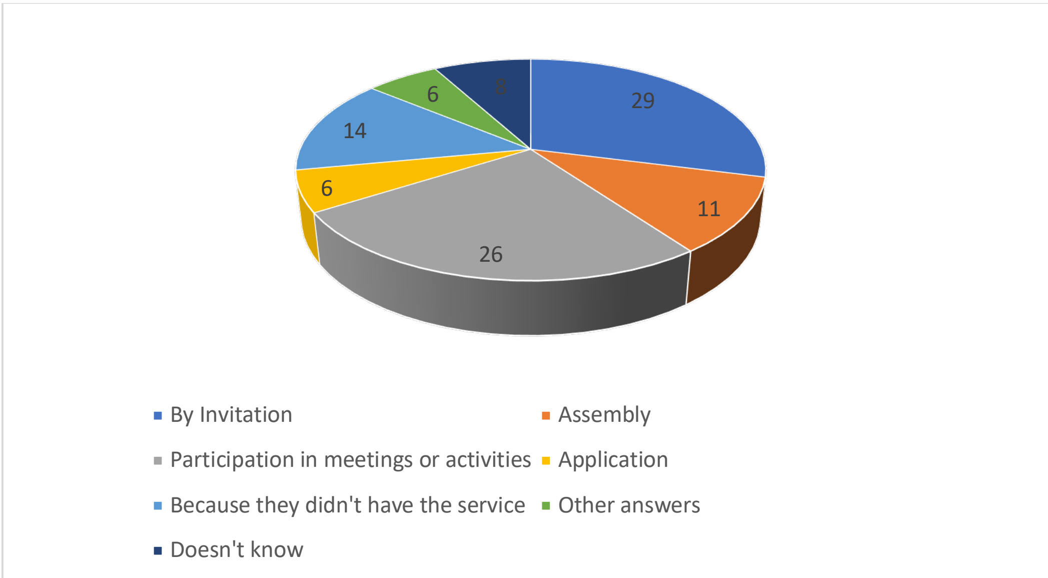

Figure 4. How was your household selected to be a beneficiary?

As can be seen in Figure 4, the majority of the respondents were invited (29%), another percentage claims to have participated in meetings (26%), some others in assemblies (11%), and a smaller percentage (14%) said that it was because they didn't have the service. If we add up these percentages, we obtain an 80% of people that, after interpreting the answers, we believe were invited. This invitation to those who did not have the service or who needed to complement their household services, was developed in assemblies or meetings attended by the respondents. This, however, does not help us understand how the technologies were implemented.

In line with this and considering that 94% of the respondents claim to have participated through manual labor in the construction process of the technologies, we asked them who had built the technologies. 83% of the respondents were directly involved in the construction of new technologies, only 9% had help from a construction worker, and only 8% left the job entirely at the hands of a construction worker. To summarize, the majority of surveyed people participated directly in the construction of ecotechnologies or appropriate technologies.

Regarding problems surrounding the construction of the projects, these were mostly related to lack of materials or unforeseen issues regarding the construction of the projects itself. Only one of the respondents mentioned having had issues with the construction, and the problem was related to a lack of material.

Training for the operation and maintenance of the project was a key aspect: 33 of all respondents mentioned having undergone training, while only 2 of them gave a negative answer. The 33 who answered positive were asked about the quality of the training they received. The results can be seen in Table 2.

Table 2. Training was:

	Frequency	**Percentage**
Good	28	80.0
Regular	5	14.3
Total	33	94.3
Didn't receive training	2	5.7
Total	**35**	**100.0**

Another key aspect that the survey explored had to do with the creation of a social organization for the construction and maintenance of the technologies – in this case, the creation of a committee. Regarding this, the inhabitants were asked if "a committee or organization was created during the execution of the program?" 97% of the respondents answered "yes." When asked what their responsibilities were, the responses were varied, as shown in Table 3.

Table 3. Did a committee or organization formed during the execution of the program? (%)

	What were your responsibilities?							**Total**
	Supervise and organize projects	**Supervise and organize material**	**Monitored the progress of the project**	**Notified about informational meetings**	**Training and motivation**	**Other**	**Didn't participate**	
Yes	17.1	40.0	17.1	5.7	14.3	2.9	0.0	97.1
No	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.9
Tota	17.1	40.0	17.1	5.7	14.3	2.9	2.9	100.

As seen in the table above, a majority of the responsibilities revolved around supervision and organization of materials, less so around supervising the projects and their progress. However, even though the beneficiaries thought the committee was important, currently 65% of respondents say that the committee is no longer operating. 14% claim that they don't know whether the committee is running, and only 8% mentioned that it is still functioning. They were also asked if upon finishing the construction of the technologies, the institutions who introduced the technologies verified that they were functioning: 88.1% said yes, and 11.4% said no.

The above results were a key point to this work – learning if the technologies were still operating and if so, what the reasons were. The answers to the question regarding the operation of the appropriate technologies built in the community can be seen in Figure 5.

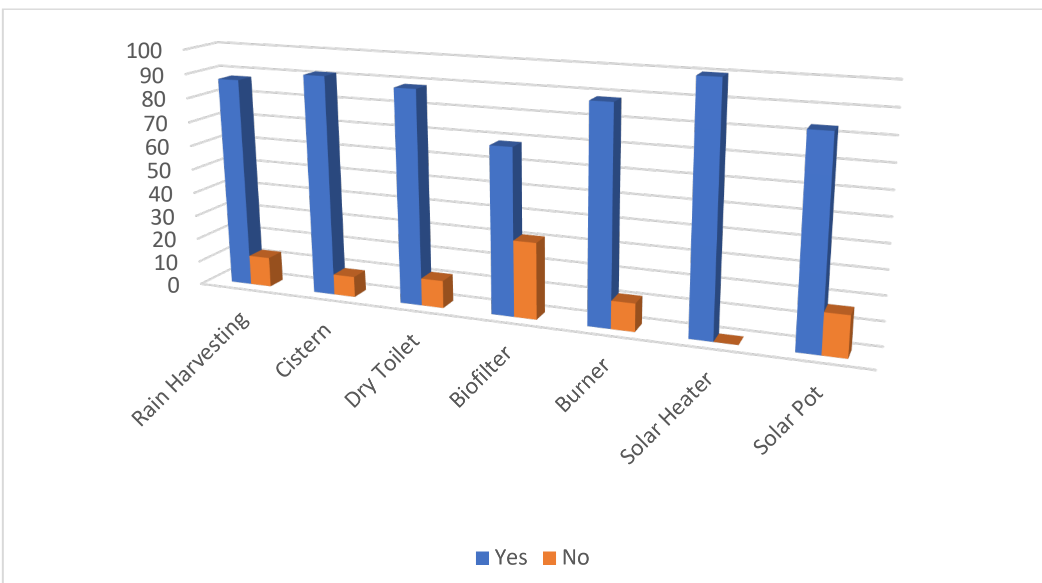

Figure 5. Is your technology still operating? (%)

As Figure 5 shows, 91% of the technologies are still working, and only 9% are no longer operating. Out of all the technologies, solar heater is the only one that is still operating in all cases. The most used appropriate technologies that continue to function, for the most part, are the cistern in first place, dry toilets in second place, and in third place, rain harvesting systems. The most neglected technologies are biofilters.

The amount and percentage of technologies that no longer function is very low. When exploring the reasons why they are no longer running, in virtually all cases the causes have to do with family decisions – lack of interest in repairing or maintaining the technology, giving it a different use (for example, as storage in the case of dry toilets), it is no longer being used or its use is considered dangerous to children.

Nonetheless, the majority of the appropriate technologies in this community are still operating. We considered it pertinent to investigate how the users rate their functioning. The considerations for each technology can be seen below in Figures 6, 7, 8, and 9 in percentage form.

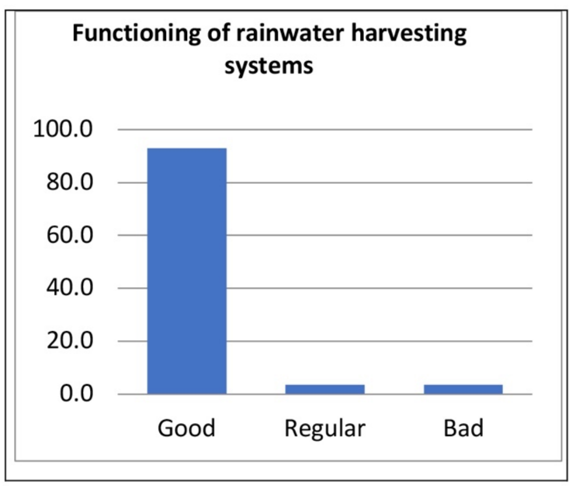

Figure 6. Rainwater harvesting.

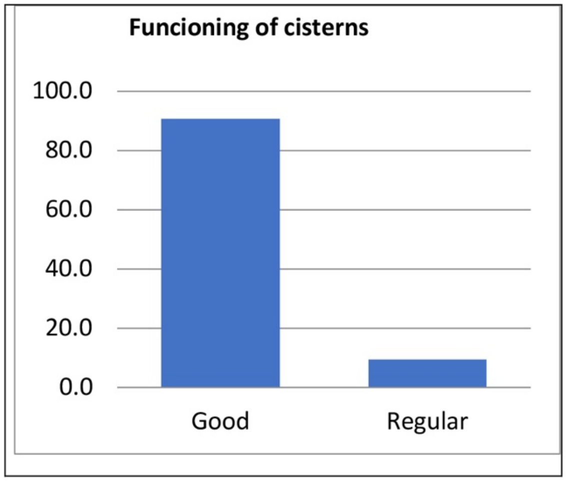

Figure 7. Cisterns.

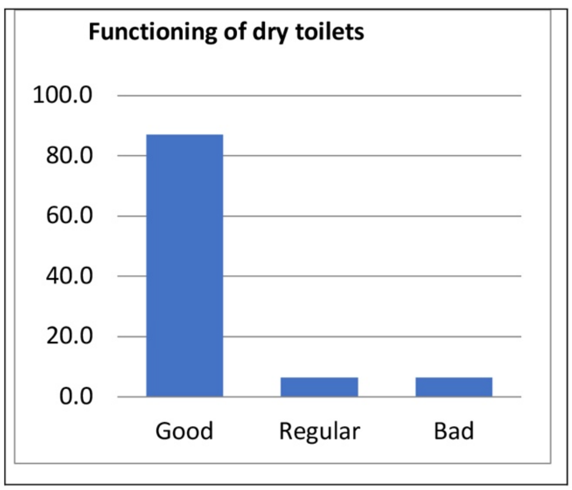

Figure 8. Dry toilet.

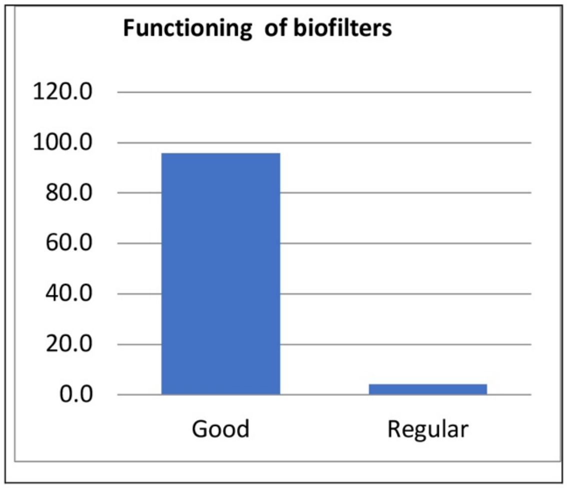

Figure 9. Biofilter.

As seen in the figures above, most users consider their technologies good. This is due to the projects still being useful to the users; they consider that they have been very helpful for the everyday activities of their household and their families.

An important aspect that was investigated had to do with the maintenance of the project (Table 4), since, as we know, it is a key aspect in their proper functioning – so the technological instrument can fulfill its purpose. It is part of the degree of interaction with the technology.

Table 4. Do you give maintenance to your..? (%)

	Rainwater harvesting	**Cistern**	**Dry toilet**	**Biofilter**
Yes	57,1	56,3	80,6	70,8
No	39,3	40,6	12,9	25,0
Didn't answer	3,6	3,1	6,5	4,2
Total	**100,0**	**100,0**	**100,0**	**100,0**

As can be seen in Table 4, of the total of the technologies, between 45 and 50% of surveyed users claim to give them maintenance. According to the results of this survey, such maintenance consists in the activities required by such projects, such as cleaning the canals and roofs in the case of rainwater harvesting systems; emptying and cleaning the chamber in the case of dry toilets, etc.

Alongside questions regarding maintenance, the users were asked if they had modified the technologies. On average, the percentage of modifications was between 2 and 3%, as such we do not consider them relevant to the purpose of this study.

Another aspect that was investigated had to do with the improvements the users see in their household, product of the construction and use of the technologies. Except for the dry toilets, which a majority of the respondents acknowledged had improved their households, when it comes to cisterns and biofilters there were different opinions, as shown in Table 5. This perception can be explained by the fact that the benefits of a dry toilet are more *visible* and require a greater *interaction* between the technology and the users than a cistern or a biofilter.

Table 5. Has the technology helped improved your household? (%)

	Cistern	**Dry toiler**	**Biofilter**	**Other technology**
No	46.9	28.6	58.3	12.5
Yes	53.1	71.4	41.7	87.5
Total	100.0	100.0	100.0	100.0

Discussion: Social adoption of built technologies in Chiteje de Garabato

The underlying idea of social adoption is that the more training, participation and involvement (interaction) of the beneficiaries (or future users) of the technologies in the action plan of the program, the more efficient the use, operation and maintenance will be. Consequently, the technologies will be better used. In this sense, we explored some basic relations between the answers obtained in the surveys and the aforementioned concepts. To this end, we decided to address two specific moments. The first one is regarding the construction and use of the technologies, insofar as it involves the tacit participation of the users. For our analysis, we considered the following social adoption parameters: interaction when building, training, interaction with the operation, social organization and replicability. We omitted the following parameters, due to the aforementioned results, that show up as constants: tending to a need, sustainability, and active participation.

a) Contributions made by the user for the construction of the project

The raw results of the survey conducted in Chiteje de Garabato, show that 94% of the users contributed with manual labor for the construction of the technologies. Correlating the specific data for each project built, there seems to be a direct relation between user manual labor contribution and the operation of the project. According to the results of the survey, the users did not contribute money, materials or supervision significantly. Contributions of this last type represent very small percentages, and as such we infer a direct correlation between manual labor participation by the users and the good operation of the project. This hypothesis would reinforce the notion that, the bigger the direct involvement by the beneficiaries of the project in its construction, the better its operation will be (this is also one of the conditions of social adoption, as defined in previous sections). This is due to the fact that this participation presupposes that the user is aware of the personal cost of having built the project, and consequently they *place higher value on its utility*.

When cross-referencing the number of technologies no longer in use to the type of person who built them (figure 10), we find that when the technologies were built by a construction worker, the number of technologies no longer in use is higher that when they were built by the same families that use them. Figure 10 shows 5 sets of bars, each corresponding to the number of technologies in disuse. The first group of bars indicate that all technologies are in constant use.

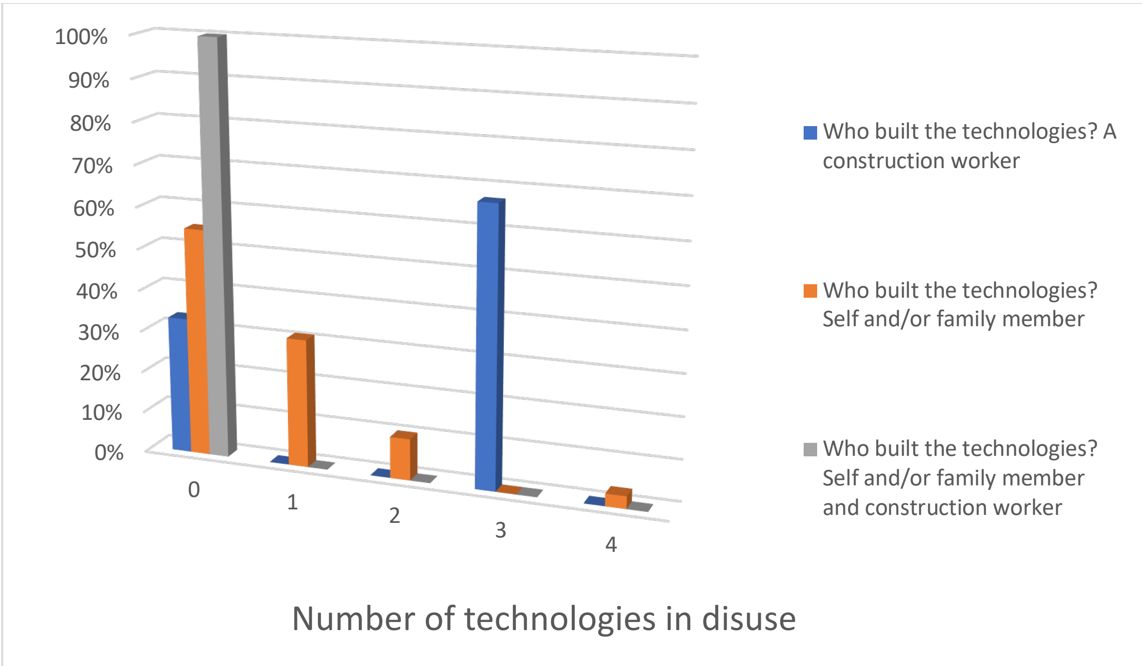

Figure 10. Number of technologies in disuse and who built them (%)

Given the trend in self-construction, we can confirm that the use and utility of manual labor in this typo of process generates a better operation or longer operation of the technology. That is to say, interaction with the construction of the technology generates increases its own sustainability.

b) User training and project operation

Another presumption of social adoption concerns user training – the better the training provided to the users of the technologies, the better their operation will be. Here again, the data from the interview shows that training has a favorable impact in the operation of the technology. Correlating training and the current operation of technologies that are still being used, in virtually every case, the technologies that are still in use are linked to training provided. However, we also observe other factors at play, namely personal or familial matters, that in some cases have made families to stop the correct use of the technology or discontinue its use altogether.

When cross-referencing the data from the survey, as shown in figure 11, we may observe that the better the training the users have received on using the technologies, the less likely it is that the technologies will be in disuse. That is to say, it is not enough to provide training (and, as was the case in Chiteje de Garabato that this training was provided to all the people involved), rather the *quality* of the training is what matters.

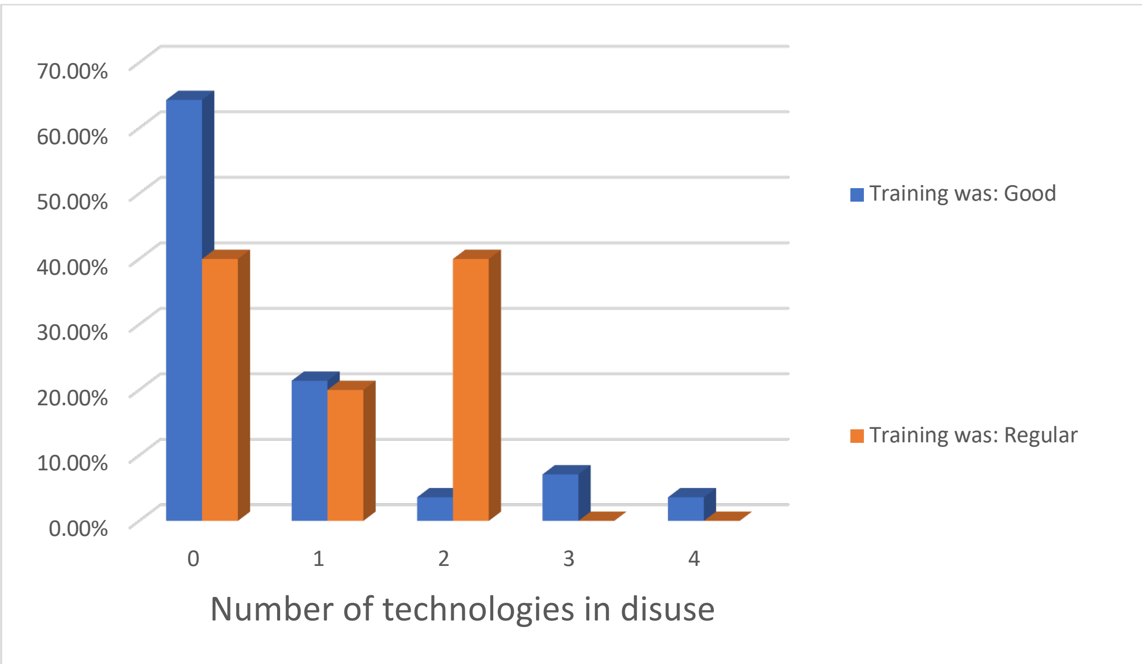

Figure 11. Number for technologies in use/disuse and evaluation of the training.

c) Interaction of users with the technology

There are two types of interaction with the technologies: the first one is that of maintenance, the second one is the modification or adaptation that the users make on the technologies, as an additional step of social adoption.

Let us look at the first case – the relation between maintenance and operation of the technologies. When correlating the data and verifying for the maintenance that the users have given the technologies versus their operation, the numbers show slight variations. As can be seen in Table 6. Around 60% of the users have given maintenance to their technologies, while the rest of them (around 40%) do not provide the necessary maintenance. That is to say, even when the technologies are still operating, the percentage of people that give them maintenance is reduced. As mentioned above, this situation means that if this trend continues, there is a risk that in the short term the operational capacity of the technologies will be strongly impaired.

Table 6. Cross-reference of the information about maintenance and current operation of some technologies (%).

Do you give maintenace to your:		**Is your rain harvest system still in use?**
		Yes
Rain harvest system	Yes	57.1
	No	39.3
	Didn't answer	3.6
	Total	100.0
		Is your cistern still in use?
		Yes
Cistern	Yes	56.3
	No	40.6
	Didn't answer	3.1
	Total	100.0
		Is your dry toilet still in use?
		Yes
Dry toilet	Yes	80.6

	No	12.9
	Didn't answer	6.5
	Total	100.0

The second case of interaction with the technology is adaptations (the flexibility criterion mentioned by Murphy *et al*., 2009) made by the users. When the technologies are still in use in a household., little less than half of them have been adapted, as can be seen in Figure 12. It is important to note here that having all technologies operational, or even three in disuse, adaptations have been made to them. The only exception is when there are four technologies in disuse, which may be indicative of lack of interest in the appropriate technologies.

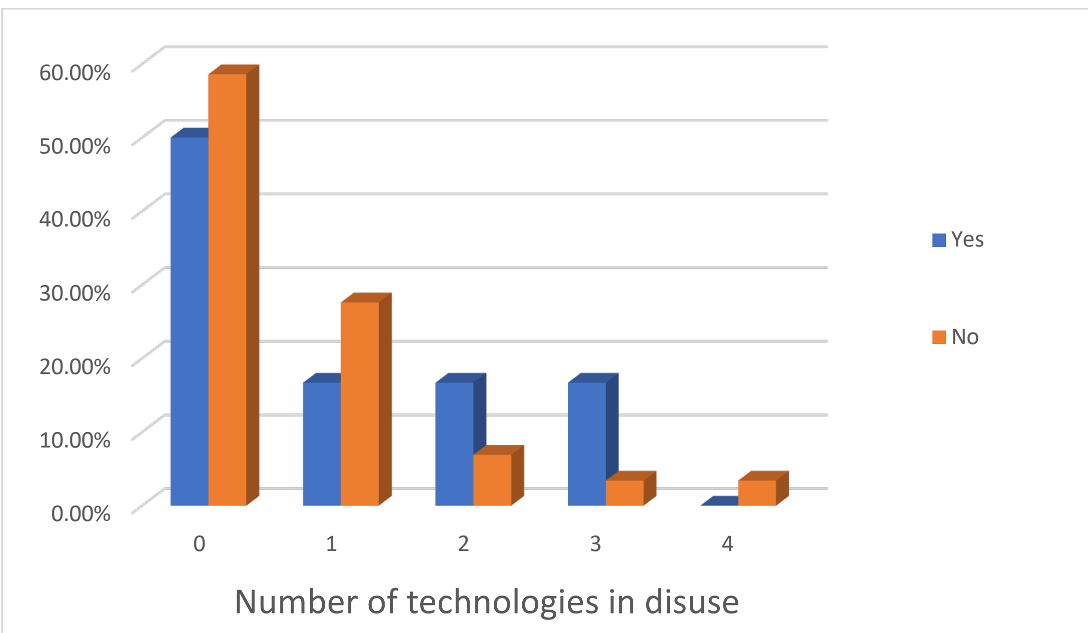

Figure 12. Modifications to some of the technologies and number of technologies in use/disuse (%).

d) Social organization and operation of the technologies

Another relevant aspect that was explored, refers to the formation of social organization during the development of the project and its relation to the operation of the projects. This relation rests on the underlying idea that the existence of some organizational figure (socially formed, i.e. communal) could contribute to improving the operation of the projects. This organization would serve as a *catalyst of the actions* of the institutions that intervened in the introductions of these technologies.

According to our survey (Figure 13) this idea shows contradictory data. When correlating the data obtained on the current operation of the social organization (committee) and the current operation of the technologies, there is no direct relation between the social organization and the operation of the technologies. That is to say, even when there does not exists a social organization formed by the community, the technologies are still operating. However, in two cases – when all technologies are still operating and when three are in disuse – the data show that when the committee is operational there is also a higher number of technologies still in use. Conversely, fewer technologies are operational when the committee is not operational either.

The absence of links between the creation or existence of an organizational figure and the operation of the technologies may be based on the fact that the latter fulfill a familial need, where an organization has a null impact on use, operation and function of the technologies. That is to say, in these cases the correct use of the technologies is the responsibility of the benefitted families. The level of service that these technologies provide will depend on their correct use and proper operation by the family members. Although, as mentioned above, the data here are not conclusive.

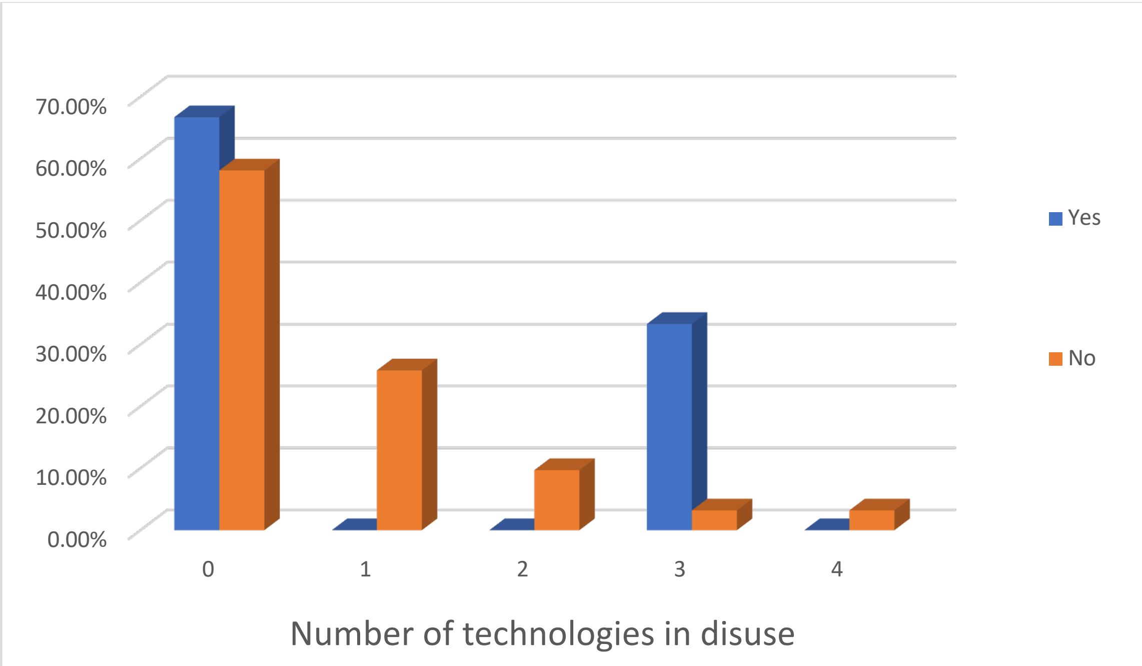

Figure 13. Social organization and technologies in use/disuse (%).

e) Replicability of the technologies

One of the dimensions of social adoption is technological replicability. That is to say, the ability of the users to build the same technologies in new households. Replicability starts by persuading the users that certain technologies fulfill family needs and that their benefit maybe replicated in other similar contexts. There are two levels to replicability: the first one is the promotion of the technologies that have previously worked, at the core of the community, and the construction of these technologies in other households. Some aspects of replicability can be seen in Figure 14, where we see a trend to promote and build new technologies in new households. However, the main trends can be seen when there is one or three technologies in disuse. When all technologies work, the percentage of replicability was lower.

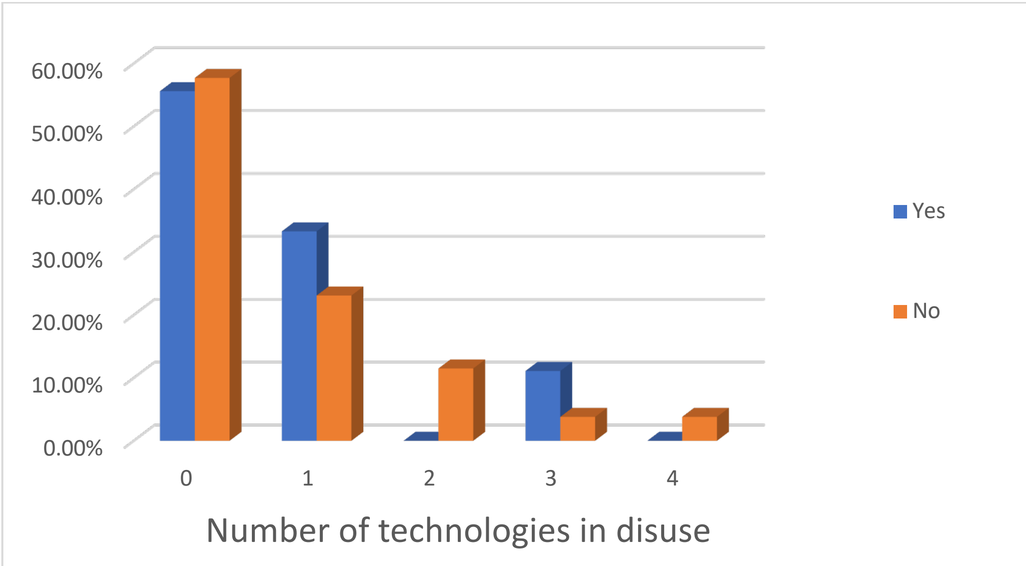

Figure 14. Promotion or construction of these technologies in a new households and number of technologies in use/disuse (%).

Conclusions

After reviewing the data obtained by the survey conducted at Chiteje de Garabato, we can link the concept and the application of social adoption of appropriate technologies. The first thing to highlight in this type of approach of introduction of new technologies, is that it must emphasize the entire process of the relationship between the user and the technology (from choosing the technological system to the long-term evaluation, as we will see below). We should not forget that this relationship fulfills a *specific basic need* or a group of basic needs. Thus, it is important to *emphasize the attention and satisfaction of needs and not the optimal operation of the technology per se.* As observed in the case of Chiteje de Garabato, families would maintain their systems operational as longs as they helped satisfy a need. Hence, certain technologies were used more, some less and some were no longer operational. The proposals of social adoption of appropriate technologies that we outlined at the beginning of this article are then insufficient. We previously mentioned seven dimensions: tending to a need, technological sustainability, replicability, active participation, training, interaction, and social organization.

Using the data obtained in this case study, we could emphasize the following dimensions, as well as an additional one – based on the observed data, the correlation of information, and the presumptions of the social adoption approach. The first one is the satisfaction of a basic need, already mentioned above. It is worth noting that asking through a survey or a questionnaire about the satisfaction of the recipient does not mean the permanent solution of a basic need. On the contrary, asking about the satisfaction of use of a certain technology, leads us to focus our attention, once again, on the technological apparatus and not its relationship to the user and the need being addressed.

The remaining dimensions are sustainability of the technology (duration and operation through time, that in the case of a social adoption approach would mean long-term, considering a temporal dimension); the dimension of interactivity (between the beneficiary and the technology; active participation of the users and training (both of these were seen in the case of Chiteje de Garabato); and social organization. This last one seems to require more case studies to observe a clear trend on the role of the committees formed after appropriate technological systems are introduced to rural communities.

A possible interpretation, according to the data obtained in Chiteje de Garabato, is that there are levels when it comes to decision making in communities. One of these levels takes place at home, where the technologies were built, and here the community social organization has no influence.

Perhaps when talking about social organization, future studies should consider the family organization, or as Warriner and Moul (1992) mention, the kinship ties. Nonetheless, according to the inhabitants, there has been a trend toward the strengthening of social organization in Chiteje de Garabato, as show in Figure 15.

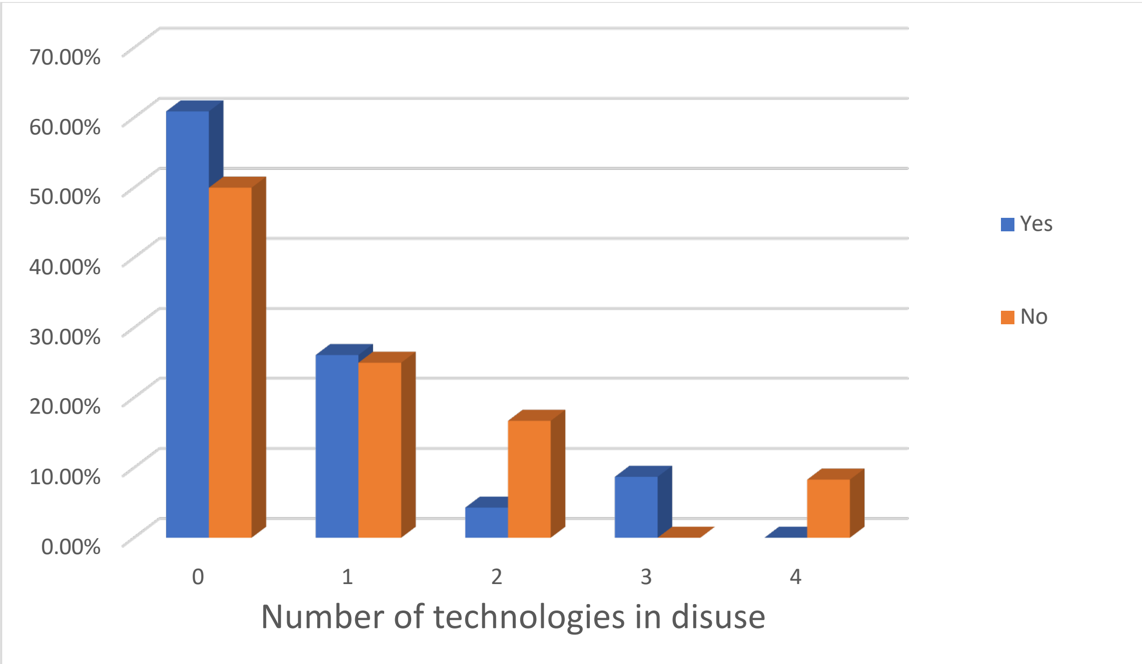

Figure 15. Strengthening of community social organizational and technologies in use/disuse (%).

There is another dimension that has been omitted and that is subjective and that can be incorporated to the technological process of social adoption: *impetus for change* of the recipients of the technological systems. This dimension shows ups when we find interest on the part of the inhabitants, driven by the construction of the technologies and up to the process of technological replicability. In the case of Chiteje de Garabato, we could say that there exists a high index of impetus for change. Even though it was not measured through the survey, the cross-reference of our data highlighted it: 91% of the built technologies is still operational, and a little less than half has been modified by the same inhabitants. These technologies have also been spread and built in other households (replicability dimension).

Hence, we may highlight two additional elements that are important in the process of social adoption of technology in Chiteje de Garabato: the temporal dimension (sustainability) and a perceptual dimension. This latter one may be explained as the continuous attention to a basic need, beyond immediate satisfaction of the recipient by his or her use of any given technology. We could say that although many programs that introduce drinking water systems and sanitation tend to be palliative in nature, in the cases where there is social adoption of the technology – as is the case in Chiteje de Garabato – there is continuous attention to a need. This becomes a temporal dimension that has nothing to do with palliative solutions. Further, we could venture to say that palliative technological solutions are abandoned in favor of those that show temporal durability and sustainability. Such is the case of the trend to abandon biofilters and solar pots in Chiteje de Garabato.

All of these considerations go beyond the traditional idea of technological transfer and of what is expected of the recipients in the process – active and real social participation, acknowledging the knowledge of the recipients, and environmental sustainability. We may also recognize that there are many more factors at play and that these require multifactorial approaches (Willoughby, 1990: 284). Not recognizing this multifactoriality, can cause the transferred technologies to not be used or to stop being operational. In fact, when the technologies are abandoned for several reasons, they invert their role as tending to a basic need and become technological trash. They become useless constructions or with problems that may result in pollution or health problems for the population. In the cases that focus mostly on processes and approaches of transference and technological appropriation, sustainability becomes a negative. In such cases, we could speak of an affectation to the environment and the inhabitants, instead of tending for a basic need. Non-functional or abandoned technology becomes, then a sign of environmental deterioration and an obvious failure of technological transfer.

This case study gives a sign that we can speak of creating an index of social adoption of appropriate technologies. However, this will not be possible until after we correlate data from other specific studies, in order to advance our understanding of the social, technological, and cognitive dynamics and interrelations that happen between users and the appropriate technologies used to tend to specific needs, such as water for domestic use and aspects related to the sanitation of their ow homes.

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