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Assessment of an intervention experience using appropriate technologies in Santiago del Estero (Argentina)

Valoración de una experiencia de intervención con tecnologías socialmente apropiadas en Santiago del Estero (Argentina)

Valoração de uma experiência de intervenção com tecnologias socialmente apropriadas em Santiago del Estero (Argentina)

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Abstract

In previous discussions about technological change, appropriate technologies emerged as one of the alternatives to the modernizing technology transfer model that prevailed for many years in Latin America. However, despite the time elapsed since its conceptual creation, it is not easy to find studies assessing interventions carried out with this type of approach. This paper addresses this subject by analyzing a technology transfer experience using goat manure as a fertilizer for household crops in Santiago del Estero (Argentina). Despite having an appropriate *a priori* design, the technology was not replicated by all the experimenters. A quantitative and qualitative two-stage approach was used to address it: the first approach explored structure variables used by each experimenter and correlated these with the times that he/she repeated the practice; and in the second one, an analysis of the farm operations through case studies was carried out. The results indicate that a particular farm structure did not guarantee a result in terms of adoption of an appropriate technology, and that the operation and the survival strategy (or peasant strategy) of each family gave the farm an individual dynamic that often was decisive in adopting the proposal. In addition, at least for the current experience, technology design using locally controlled resources and the presentation of a unique proposal for all the experimenters was not enough. The multiple adjustments used by peasants suggest the need to investigate local innovation processes.

Keywords: Technological change, survival strategies, predial structure, predial functioning, Santiago del Estero (Argentina), appropriate technology

Resumen

En el marco de las discusiones sobre el cambio tecnológico, las tecnologías socialmente apropiadas surgieron como una alternativa al modelo de transferencia modernizante que predominó durante muchos años en Latinoamérica. Sin embargo, a pesar del tiempo transcurrido desde su creación conceptual, no es sencillo encontrar estudios que valoren procesos de intervención realizados con este tipo de abordaje. Este trabajo busca aproximarse al tema mediante el análisis de una experiencia de estercolado de cultivos prediales con estiércol de cabra, en Santiago del Estero (Argentina). A pesar de contar con un diseño socialmente apropiado *a priori*, la tecnología no fue replicada por todos los experimentadores. Para abordarlo, se utilizó un enfoque cuantitativo y cualitativo de dos etapas: en la primera se prestó atención a las variables de estructura de cada experimentador y se hizo una correlación con las ocasiones en las que reiteró la práctica, y en la segunda se analizó el funcionamiento predial, mediante estudios de caso. Los resultados indican que una estructura predial determinada no garantizó un resultado en lo que se refiere a la adopción de una tecnología socialmente apropiada, así como que el funcionamiento predial y la estrategia de sobrevivencia de cada familia otorgaron al predio una dinámica propia, que muchas veces resultó determinante en el momento de adoptar la propuesta. Además, en la experiencia estudiada, no resultó suficiente diseñar la tecnología empleando recursos con control local ni presentar una única propuesta para la totalidad de los experimentadores. Los múltiples ajustes utilizados por los productores sugieren investigar los procesos de innovación local.

Palabras clave: cambio tecnológico, estrategias de sobrevivencia, estructura predial, funcionamiento predial, Santiago del Estero (Argentina), tecnología socialmente apropiada

Resumo

No âmbito das discussões sobre a mudança tecnológica, as tecnologias socialmente apropriadas surgiram como uma alternativa para o modelo de transferência modernizante que predominou durante muitos anos na América Latina. Contudo, apesar do tempo transcorrido desde sua criação conceitual, não é fácil encontrar estudos que valorizem os processos de intervenção realizados com essa abordagem. Este trabalho pretende aproximar-se ao tema mediante a análise de uma experiência de esterco de cultivos prediais com esterco de cabrito em Santiago del Estero (Argentina). Embora conte com um desenho socialmente apropriado a princípio, a tecnologia não foi reproduzida por todos os experimentadores. Por tanto, utilizou-se uma abordagem quanti-qualitativa de duas etapas: na primeira, prestou-se atenção nas variáveis de estrutura de cada experimentador e fez-se uma correlação com as ocasiões nas quais reiterou a prática; na segunda, analisou-se o funcionamento predial, mediante estudos de caso. Os resultados indicam que uma estrutura predial determinada não garantiu um resultado no que se refere à adoção de uma tecnologia socialmente apropriada, bem como que o funcionamento predial e a estratégia de sobrevivência de cada família outorgaram ao prédio uma dinâmica própria, que muitas vezes foi determinante no momento de adotar a proposta. Além disso, na experiência estudada, não resultou suficiente elaborar a tecnologia empregando recursos com controle local nem apresentar uma única proposta para a totalidade dos experimentadores. Os múltiplos ajustes utilizados pelos produtores sugerem pesquisar os processos de inovação local.

Palavras chave: estratégia de sobrevivência, estrutura predial, funcionamento predial, mudança tecnológica, Santiago del Estero (Argentina), tecnologias socialmente apropriadas

Introduction

The technology transfer processes that originate in modern or developed sectors and are directed towards traditional or underdeveloped peasant or family agriculture have not always showed the expected results. This has produced a gap between available technology and the one that is actually used by producers, due to the conditioning that multiple factors have imposed on adoption (Forero-Camacho, Rojas-Carvajal, & Argüelles-Cárdenas, 2013; Garrido-Rubiano, Martínez-Medrano, Martínez-Bautista, Granados-Carvajal, & Rendón-Medel, 2017; Rodríguez-Espinosa, Ramírez-Gómez, & Restrepo-Betancur, 2016).

There are many critical studies on the topic, and the conclusions that can be drawn out of these range from considering failures as mere technical and accidental issues (Cernea, 1991) up to questioning more profound issues that point out to the reductionism, dualism and marked ethnocentrism implicit in a modernizing view (Cáceres, 2015; Kay, 2001; Machado-Aráoz, 2007; Van der Ploeg, 2014).

As a result of these critical positions and from the seventies, different alternative approaches to the technology transfer concept that promoted the modernizing vision emerged (Soto, 1996). Among all of these, perhaps one that has received more attention from the academy has been appropriate technologies (AT).

With a direct precedent from intermediate technologies published by Schumacher (1973), there were numerous discussions regarding the scope of the AT definitions (Cáceres, 1998). Some of these emphasized technologies that had one or more of the following characteristics: simplicity, local control, job generators, low capital investment and care for the environment, among others. More radical authors directly elaborated lists of techniques and materials that they considered *a priori* AT, as: compost, organic agriculture, adobe and wood stoves, among others.

Other broader AT definitions posed its endogenous origin and its adaptation to a sociocultural and historical context, and its transcendence to broader political planes (Stewart, 1985). Willoughby (1990) points out that these technologies are "custom-made in order to adapt to the prevailing psychosocial and biophysical context in a particular place and in a certain period of time"; this emphasizes the importance of considering them as dynamic, depending on a historical time and in a given environment.

From this conceptual basis, the AT include several issues. The probability of their adoption would increase on one side, by allowing the producer decrease its market dependence and, on the other hand, it would be eased by including technological changes made endogenously by direct beneficiaries (Serrano, 2015). In this way, the implicit idea in this conceptual framework evolved from *transfer and adoption* to *technological change*.

Thus, the local technology control that beneficiary populations could have would encourage the emergence of an autonomous economic, productive and social process. Likewise, from an environmental point of view, these alternative technologies were considered more sustainable than the classical modern ones, and they became conceptual pillars of new promotion practices and political discourses (Cáceres, 1998; Cáceres, Silvetti, Soto, & Rebolledo, 1997; Serrano, 2015).

However, although the time elapsed since its emergence is certain, the achievements obtained in terms of the sustainability of the proposals and the numerous efforts that have been made at the institutional level, in practice it is observed that technological change processes conceived from this alternative and conceptual tool, still show —in many cases— difficulties in terms of adoption.

Likewise, although there are documentary sources available on these alternative attempts, it is also a fact that these citations are part of a less abundant literature than the one that refers to modernizing experiences (Cáceres, 2015; Moors, Rip, & Wiskerke, 2004; Van der Ploeg, 2014).

In addition, these experiences have not been sufficiently systematized nor evaluated (Norgaard & Sikor, 1999), especially when compared with the amount of literature that has analyzed the causes of

why institutions that work within the framework of modernizing paradigms fail (Cáceres, 2015; Cernea, 1991; Mazoyer & Roudart, 2006; Ruttan, 1996; Van der Ploeg, 2014).

Consequently, the aim of this study is to explore the above-mentioned issue analyzing an experience with peasant's communities in Santiago del Estero (Argentina), promoted by a non-governmental organization (NGO). The interesting aspect of this case is that, although the practice was designed concerning AT principles, in joint work with the communities and taking into account local resources, there were several producers that did not implement AT in their farm.

It has also been considered that in order to understand the causes of lack of AT adoption by producers, it is possible to use the traditional structure and production systems operation concepts (Aguinsaca-Caraguay, 2014; Berdegué & Larraín, 1987; Hart, 1990; Kaminsky, 1988). In this way, this work also provides a particular way to analyze this type of experience, providing useful information for institutions that promote technological change processes.

Background on technological change and its relation to farm structure and operation

AT assessment is immersed in the broader problem of technological change. Therefore, before continuing with the study, it is convenient to show some preliminary considerations.

The technological change processes imply, essentially, behavioral changes because they are influenced by numerous economic, social, cultural and historical variables (Aguinsaca-Caraguay, 2014; Cáceres, Silvetti, & Soto, 1999; Forero-Camacho et al., 2013). Although the producers do not show a conservative behavior in relation to the context, given that they are modifying their practices permanently depending on the same through adjustments (Norgaard & Sikor, 1999), and through the incorporation or generation of new technologies, characteristics of these modifications are linked with the relative position that they occupy in the social field in which they develop their economic activity; this occurs with the amount of risk that this position allows assuming —without compromising— their social reproduction (Cáceres et al.,1997).

When interpreting the technological change processes, the relationship between the behaviors shown and the social field cannot be ignored. The relative position shown by the producers in this social field is linked to structural variables that define each case, as well as to productive and social reproduction strategies that they implement (Aguinsaca-Caraguay, 2014; Cáceres et al., 1999). It is in this topic that studies on the structure and operation in the field of domestic-productive systems are of utmost importance.

On one hand, structural variable studies can be useful to make an approximate prediction of how the farm will behave depending on diverse situations, as a proposal of technological change (Kaminsky, 1988). In specialized literature consulted regarding this topic and that was mostly selected for the study region, references were found on numerous structural variables; among these, the most repeated ones were prioritized with the sole intention of showing a general idea about the type of variables involved: size of the farm or its form of tenure; round-up size; capital and income; family labor or number of children, and finally, age of the producer (Aguinsaca-Caraguay, 2014; Crespo, Cáceres, Robledo, Soto, & Silvetti, 1996; Forero-Camacho et al., 2013; Garrido-Rubiano et al., 2017; Villalba, Gómez-Herrera, Concha-Merlo, & Ferreyra, 2016).

On the other hand, structural differences of the farm are not the only factors that might condition the adoption of technical proposals and the behavior of the producers. Moreover, internal organization of their activities, which is related to the presence of different social operation logics, must also be taken into account (Aguinsaca-Caraguay, 2014; Berdegué & Larraín, 1987; Graziano da Silva, Kageyama, Romão, Wagner-Neto, & Wanderley, 1986; Stuiver, Leeuwis, & Van der Ploeg, 2004).

Given its temporal dynamics, studying operational variables requires special data collection techniques. For this reason, several works published by Paz

(1998; 2002), as well as by Paz, Lipshitz, Álvarez and Usandivaras (2003) demonstrated the need to work with modal follow-ups of producers, with the purpose of learning how their farm operates, in order to implement the most adequate design for the intervention proposal.

Materials and methods

Study area

The area where the study was developed corresponds to the rural area of the departments of Río Hondo and Guasayán, in the western region of the province of Santiago del Estero, and is located in the western Chaco district or semi-arid Chaco (Cabrera, 1976), in the north of the Argentine Republic (figure 1).

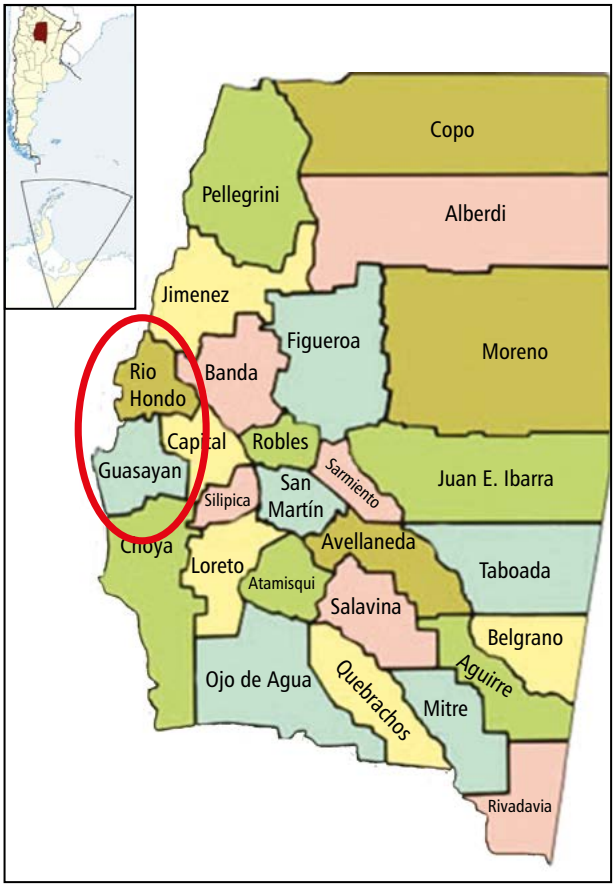

Figure 1. Location of the study area in the province of Santiago del Estero, departments of Río Hondo and Guasayán, Argentine Republic.
Source: Adapted from Mapoteca (s. f.) and Mapas Escudos Banderas (s. f.)

The area had expelled labor force and active population, and a significant proportion of the local inhabitants are incorporated into seasonal migratory currents towards other provinces in the rest of the country (Forni, Benencia, & Neiman, 1991). In line with the aforementioned, the area shows indicators that exceed the provincial average of urban and rural poverty, with more than 36 % of unsatisfied basic needs (UBN) (Tasso, 1998).

Due to environmental conditions, production is oriented to forestry, extensive livestock breeding (Giménez & Moglia, 2003; Vargas-Gil, 1990), and the cultivation of rainfed maize in fenced plots (2.2 hectares in average per family), usually associated with cucurbits.

Nonetheless, the rest of the activities such as having orchards or the presence of exotic fruit trees (peaches and citrus fruits, among others) depend on the availability of irrigation. Maize is a central element in the domestic system due to its contribution to diversified livestock production (Machado-Aráoz, 1998).

Selection of the experience addressed

This research work is based on an experience carried out by the Christian-inspired NGO *Bienaventurados los Pobres (BePe)*, that has intervened in Río Hondo and Guasayán (province of Santiago del Estero, Argentina) since the end of the eighties decade. This NGO promotes improvement of the living conditions of producer families, through projects financed by different international cooperation agencies.

Given the difficulties of the population to obtain a subsistence income, and derived from the neoliberal context of the end of the last century, the NGO proposed working with several producer families in the fertilization of enclosed plots (fenced parcels of less than 5 ha to plant maize and cucurbits) with goat manure; this type of fertilization was selected due to the importance of goats in domestic systems, and its impact on soil conditions and crops.

This proposal was designed in 1999 together with the project's target families, seeking to respond to the main AT principles, and with the intention of

achieving cultural, social, historical and physical-environmental balances between the same, and also the place as well as the customs where it would be applied.

Its technical features included the collection of goat manure in pens, bagging and transfer of manure to the fenced plots, and its application (at least one month before planting and in a dose of 10-20 t/ha [1-2 kg/m^2]) in the ones that had yield problems; this was carried out using family labor and local traditional tools such as shovels, bags, buckets and *zorras* (two-wheeled carts with blood traction), among others.

Furthermore, dissemination methodology included, after testing the proposal and with the support of the technical team, the experimenters themselves were the ones who had to disseminate it to the rest of the community (Martínez-Mendoza, Bakker, & Gómez-Hernández, 2010; Pan para el Mundo, 2008; Pan para el Mundo y Programa de Intercambio, Diálogo y Asesoría en Agricultura Sostenible y Seguridad Alimentaria en Latinoamérica [Pidaassa], 2006; Programa de Diálogo y Asesoría en Agricultura Sostenible y Seguridad Alimentaria [PDAAS], 2001; Rodríguez-Espinosa et al., 2016).

Although many families ended up adopting the proposed practice and disseminating it, there were others that did not adopt it, especially in the critical dissemination stage and by the producers themselves (Díaz-Ártico, 2013).

Current research was carried out with 17 peasant families with which the NGO experimented directly in their farms, and were chosen from a non-probabilistic sampling depending on the convenience of the total population of families targeted for the intervention project. To preserve their identity each family was identified with the letter "E" (experimenter) and a number between 1 and 17.

Research design and data collection

Design of the methodology combines quantitative and qualitative techniques in search of a combination of the positivist and interpretative paradigms (Guber, 2001; Gurdián-Fernández, 2007; Vargas-Beal, 2011).

With that in mind, the study was carried out in two successive stages: the first, called *structural study*, involves a quantitative approach which basically investigates the farm's structural variables and relates them to the response showed by the producers towards the proposed technological change.

The second, called the *operation study*, includes case studies and a qualitative nature approach that seeks to deepen the knowledge on farm operations, understood as the way in which productive resources are organized during certain agricultural practices.

This analytical approach of a quantitative nature is followed by an in-depth qualitative nature that has been adapted from various peasant's typology works published by Paz (1998; 2002) and Paz et al. (2003).

Structural study

According to background information found in the bibliographic exploration that was previously detailed, in each sampling unit the variables for the structural study were determined: age of the head of household (in years); land (surface of the farm expressed in hectares, almost in its entirety in the form of possession with owner intention or *animus domini*); labor (in equivalent wages per family); livestock quantity (equivalent goat heads per family, using the daily metabolizable energy and gross protein requirements of different domestic species) (National Research Council [NRC], 2000; Roig, 2003), and off-farm fixed income (salaries, social plans, pensions and retirements, all of a permanent nature, and measured in Argentine pesos per month [ARS]).

Then, we analyzed the number of autonomous repetitions of the practice per experimenter (NRP), which measures the positive cases in which the practice was repeated spontaneously (without the presence of technicians) in each operation. The NRP is an indicator of the response of farm operations against the proposed technological change; to establish this indicator the period from 1999 to

2008 was assessed. Then, we sought to verify if there was a relationship between each of the variables and the NRP through individual correlation tests.

Subsequently, it was considered necessary to design an index that would allow comparing the relative availability of structural resources possessed by each experimenter. This was elaborated in an aggregate way, with the objective of encompassing the possible interactions between each producer resource (Kaminsky, 1988).

This index was called the relative factor endowment (RFE), and is the result of the sum of the proportions that each variable acquires for each experimenter, in relation to the maximum value observed, expressed in percentage/100. Finally, the relationship between both indexes (NRP and RFE) was analyzed.

Due to the nature of the variables involved in different comparisons carried out, the Pearson correlation coefficient was calculated; and to make inferences about the population, level of significance was evaluated through the Spearman correlation coefficient test ($\alpha = 0.05$). For this purpose, the Statistical Package for the Social Sciences (SPSS) program version 19 of was used.

Finally, the data used in this stage, that was collected in mid 2008, was obtained through an open and structured survey applied to two key informants who for more than fifteen years have remained in the NGO's technical team— as well as through the consultation of the farm tracking forms shared by the organization.

Operation study

This operation study aims at providing evidence of different behaviors that occur in face of technological change, which are not explained solely by the exploitation structure, and that derive from the way in which producers organize their activities.

The approach consisted in carrying out farm monitoring to 10 out of the 17 experimenters who participated in the experience with the NGO during one semester; these were selected trying to cover the heterogeneity of the cases, and also considering the easiness to access the farm. Due to extent issues, in this paper only three case studies will be described, selected because they are considered transcendental for the work's objectives.

Moreover, the approach technique consisted of in-depth semi-structured interviews with the experimenters, and in direct observation of their farms. Interviews were aimed at capturing the exploitation's general organization with special emphasis on fertilization practices in fenced plots.

Attention was also given to income acquisition strategies (such as migration, intensification of intra-farm work, extra-farm work in the area, state subsidies or retirement benefits, among others), to complement the information previously obtained in the structural study.

The case studies and field-walks on the experimenters' farms were carried out from mid 2008 to January of 2009.

Results and discussion

Structural study

Table 1 shows values found by different variables analyzed for each of the experimenters, as well as the relative factor endowment (RFE) and degree of adoption of the technological change proposal, measured by the number of autonomous repetitions of the practice by each experimenter (NRP).

At first glance, the data show the diversity of the situations that occur in the farms that comprise the experience studied, and this suggest a relationship between RFE and NRP.

When performing the correlation analysis for each of the variables separately (Table 2), the presence of linear and positive associations was observed, among which three were significant: the relationship of NRP with age, fixed income and land. The other variables showed lower association values and statistical significance in relation to NRP.

Contrary to what was expected, labor force did not have a decisive weight in the results, which is

Table 1. Resources allocation and levels of technological change for 17 experimenters

Experimenter	Age[a]	Labor[b]	Land[c]	Livestock[d]	Fixed income[e]	RFE[f]	NRP[g]
E1	55	4.50	18	95	650	2.18	1
E2	50	7.25	2.5	20	400	2.00	2
E3	80	3.00	160	85	1,200	3.37	6
E4	48	3.25	30	15	300	1.47	0
E5	55	2.50	2	40	300	1.39	0
E6	54	1.25	18	100	0	1.25	0
E7	70	2.50	200	90	1,000	3.24	3
E8	59	2.75	30	320	580	2.70	1
E9	24	4.50	0.1	0	0	0.92	0
E10	46	3.50	20	95	150	1.57	3
E11	43	7.25	7	20	500	2.01	3
E12	68	1.50	40	30	1,000	2.09	4
E13	46	1.00	15	0	0	0.79	0
E14	57	3.50	12	25	1,000	2.07	3
E15	53	6.50	2.5	0	600	2.02	0
E16	60	7.25	80	100	1,350	3.46	6
E17	66	3.25	80	80	600	2.37	2

Note: a: Age (years); b: Labor (equivalent wages/farm); c: Land (hectares); d: Livestock (equivalent goat heads per farm); e: Fixed income (ARS/month); f: Relative factor endowment (RFE); g: Number of autonomous repetitions of the practice by experimenter (NRP).
Source: Prepared by the authors

attributed to the possibility of making endogenous adjustments that would solve such restriction (Van der Ploeg & Wiskerke, 2004).

Conversely, land availability (probably as an indicator of the possibility of betting on intra-farm productive activities) and, above all, fixed income, seems to indicate that economic resources play a decisive role when adopting proposals; this is even the case when technologies —that seem very convenient for the farm— could be considered *a priori* independent of that variable (Cáceres et al., 1997).

Table 2. Associations between individual variables (including RFE) and the number of autonomous repetitions of the practice by experimenter (NRP)

Variables	Association (a)	Significance (b)
Age	0.582	0.021
Fixed income	0.811	0.000
Land	0.586	0.012
Labor	0.229	0.397
Livestock	0.123	0.126
RFE	0.764	0.001

Note a: Pearson's *r* coefficient; b: Spearman's *rho* coefficient ($\alpha = 0.05$)
Source: Prepared by the authors

Because producers are more concerned with daily propagation than with the benefits that the new technology could bring in the future (Cáceres et al., 1997), it is likely that land availability associated with producing possibilities and the fixed extra-farm income will help reduce the pressure derived from daily survival needs; this will lead to a higher level of association between these factors and AT adoption.

Finally, age variable shows a behavior that is contrary to what was expected, given that there is an increase in the practice as age increases; this could be related to the possibility of improving fixed income level derived from pensions and retirements when members get older.

Although preliminary results of each isolated variable could be discussed in the light of studies carried out by various authors (Aguinsaca-Caraguay, 2014; Crespo et al., 1996; Forero-Camacho et al., 2013; Garrido-Rubiano et al., 2017; Villalba et al., 2016), we consider that their transcendence for this work would be relative, because these were carried out in an aggregate way and therefore, these show interactions with each other (e.g. between age and extra-farm income).

Paraphrasing Forero-Camacho et al. (2013), the use of technologies designed or adapted by producers is a consequence of scientific designs that do not contemplate the multiple dimensions that influence technology adoption. In this sense, Garrido-Rubiano et al. (2017) point out that "there is no strategic and determinant attribute in the use of agricultural practices", but there are several factors that influence the use of these practices; this however, reinforces the fact that it is not really convenient to evaluate variables separately.

Precisely, with this comprehensive view, the statistical analyses showed a positive and highly significant association between RFE and NRP (the correlation study between both indices shows an *r* of 0.764, with an associated probability of 0.001); this result shows a direct relationship between the farm's structural characteristics and the AT's use degree, as was initially observed in Table 1. As an example, we can see that in most cases where AT was not repeated, RFE values were less than 1.5.

Still, it is noteworthy that, although some punctual experimenters had a similar structure index, they responded differently to technological change (e.g. E2, E11, E12 and E15, that show similar structural values); or, on the contrary, that those who had differences in their structural resources allocation behaved similarly in AT (e.g. E6 and E15; or E7 and E10) (figure 2).

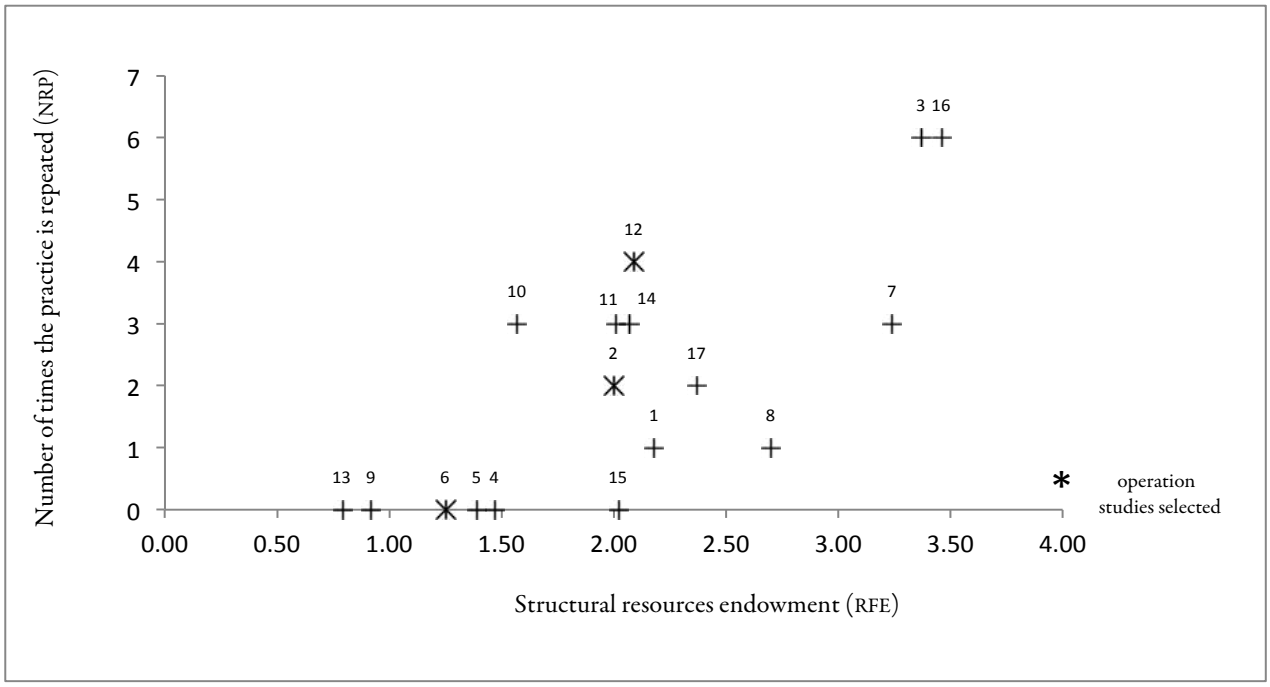

Figure 2. Relationship between the structure and the use of AT.
Source: Prepared by the authors

In this way, the experience analyzed provides information that allows stating that although the behavior when there is a technological change proposal shows an association with the resources endowment exploitation, it is not always an exclusive consequence of it.

There are also other important dimensions that establish the degree of adoption of a proposal. Consequently, the structural study only allows demonstrating an approximate relationship between structure and degree of technological change, and invites to make other additional considerations, such as those that are discussed below.

Operation study

Based on the operation study performed, case studies: E2 (case study No. 1) and E12 (case study No. 2) are showed a similar structure index and a different technological change behavior. In addition, we decided also to incorporate case E6 (case study No. 3) because it is a non-technology-adopting experimenter and, therefore, it has interesting issues to show.

Case study No. 1

This case study refers to experimenter 2 (E2) located in Guasayán, and the practice has two autonomous repetitions plus a structural index of 2.00.

> Applying fertilizer is more hard work than planting, because you have to take the guano [manure] out of the goat's pen [goat's corral], and leave it for three months! [...]. We apply fertilizer each year in the orchard, in the fenced plot we have made space to carry out the experience; then we didn`t, because it was not raining; I have fertilized only once in the trial, but always in parts, in different places (twice). It has been two or three years since we last cultivated something because it does not rain. Every time I clean the goat's corral, we take it out in a wheelbarrow, not in a cart" (E2's wife)
> "It is not as hard work as planting. He throws it out where water runs. ¡water alone scatters it! (E2)

The experimenter is 53 years old and his wife is 44, and they have ten children.

The total farm area is 2.5 ha and their flock is comprised by 20 goats, an activity with few animals compared to the average farm in the area (i.e. more than 60). The farm is characterized by having capital restrictions (such as relative lack of land, draught animals, or farming tools). The size of the fenced plot is 2 ha that are not cultivated entirely, and it is considered smaller in comparison with other experimenters in the area.

It is evident the great need that the family has for a subsistence income due to the large number of household members. Furthermore, the limited amount of land that the family has determines their agricultural and livestock production; this is the reason why they have a reduced number of animals.

Therefore, their main source of income is selling extra-farm labor, and family labor is used to find work (mainly sporadic) in the area or in the capital city (ca. 400 ARS/month). The head of household and some of his sons are the ones who carry out these activities, especially in the construction sector (masonry).

On the other hand, organization of the practices and transportation and distribution of manure is carried out by hand with a wheelbarrow when the corrals or *chiqueros* are cleaned, or with a small cart pulled by a donkey when the place where it will be thrown is far away, and there is time available to carry out this activity. Distribution of the manure is done in parts, according to the crop's yield and applying a dose *at a guess*.

Using a wheelbarrow to clean the corral is adequate as there are only few draught animals and there is lack of available resources for intra-farm tasks (time and labor); this latter is due to a high extra-farm demand for work in the area and the great subsistence needs of the family.

Consequently, there is an adaptation that draws attention: once the manure is placed in the fenced plot, its distribution is completed with rainwater that spreads it when the animals graze or with a tractor when planting is carried out (practice included recently). In the same way, and due to scarce time availability, crops are planted in old goat pens.

Verification of favorable results by fertilization practices and its conflict with time available, are clearly evident in the significant use it has in the family garden, given that it is the woman (who in this case does not perform extra-farm work) that usually takes care of this productive activity; therefore, she uses precarious tools like a wheelbarrow or buckets, and receives help from children that stay at home.

On the other hand, planting is carried out with a tractor that belongs to the municipal commission, and it is usually done after *one rain*, although, if there is time and labor availability, they will do it twice, after each of the first *two rains*, without sowing schedule. They carry out the direct planting after one rain in a soil without previous tillage, spreading the seed through broadcast sowing, and then incorporating it immediately by tractor and a plow.

In relation to planting after *two rains*, plowing is carried out with a tractor after the first rain, and *scratching* the soil is carried out after the second rain (opening a small furrow through manual plowing or animal traction), plus sowing and covering the seeds. This last practical sequence is more efficient to retain water than planting after one rain.

Case study No. 2

This case study is about experimenter 12 (E12) located in Guasayán. Four autonomous repetitions of the practice were carried out and the structural index was 2.09.

> This demands a lot of time [fertilization], I take it in a cart and I shovel it. This year I left it on the rill to see if it takes it [...]. She [his wife] cleans [the corral] with *haragán* (*an adapted implement*), after releasing the goats in the morning while I load. We eat and I continue in the afternoon; it would be more than 8 hours until the sun comes in. And at noon I pull several carts [...]. Planting tasks consist of plowing first, broadcasting seed and continue plowing, covering with the tractor, since there are people who make the broadcasting directly. (E12)

The experimenter is 72 years old and his wife is 62. The couple have 9 children but they are

currently living by themselves on the farm. Every day one of their children visits them —who is their neighbor— and eventually helps them with some tasks.

Total land area of the farm is 40 ha and they have a flock of 30 goats. The farm has a medium productive resources capitalization (it has rustic sheds for storing grains, corrals, work tools, two carts and harnesses, among others) and the family has secure and important incomes from the social benefits they receive, but they have a low family labor provision. They cultivate maize and cucurbits in a 4-ha fenced plot. They complement the production with fruit trees and orchards (where they are innovating with peanuts and sugarcane).

Due to their work experience, they have achieved income security derived from retirements and pensions (1,000 ARS/month). They supplement their family income by selling 50 % to 70 % of the maize they obtain from each harvest (the rest is destined for intra-farm consumption), artisanal sweets (pralines and popcorn, among others) and fresh fruit for recreational events in the area (soccer or football tournaments, lotteries and horse races, among others). It has been noted that the operation of this farm is based on income diversification, i.e. both extra- as well as intra-farm.

The experimenter collects the manure from corrals with his wife, and he then distributes the fertilizer alone or in some cases with his son; he uses for this a horse-drawn cart and a shovel. This last activity is done in parts, according to the crop's yield and applying an estimated dose by guess, as in the previous case. If he cannot distribute the fertilizer due to lack of labor, he places it close to the fence's rills so it is distributed with rainwater, which is an innovative adjustment.

These adaptations are not only seen in fertilization practices (in rills) but also in sowing. Thus, despite the fact that in the past they have planted after two rains and in staggered dates, currently they have adopted direct sowing of the entire fenced plot after one rain, with a tractor that has been rented from the neighbors.

Case study No. 3

This case study is related to the experimenter 6 (E6) in Guasayán. This case does not show any autonomous reiteration of the practice and has a structural index of 1.25.

> I do not clear the land. I have been sowing and harvesting in the same place for 30 years, every year on the same soil; but I suppose it is because of the animals' [winter] grazing and the field [maize] that I chop with the tractor -the stems, because I give the husk to my animals- besides the *ataco* and the *chamico* [weeds] as well as everything else that remains there. [...] I almost do not apply guano [manure] here, because in winter I send the animals to herd in the fenced plot and there are many goats, and they fertilize it directly, although it is not the same as fertilizing it the other way. [...] The fertilization is not so heavy but it takes time, even I could do it with a wheelbarrow, so therefore, this year I will get a horse. (E6)

Experimenter 6 is 54 years old; she became a widow in the early 2000 and lives with her daughter and 4-year-old grandson. She has a fenced plot of 2.5 ha where she plants to feed her animals, within a total exploited area of 18 ha. Her flock has 100 equivalent goats and has no fixed monetary income.

She is dedicated to the seasonal sale of kids, as well as cheese and eggs. The farm has insufficiency in the availability of traditional farmland resources such as working animals, plows and harnesses.

In this case, the strategy is based in the intensification of intra-farm activities (especially those typically feminine as goat breeding) that is focused on selling in the local market, obtaining seasonal monetary resources as well as self-consumption products. Due to lack of labor and social plans or pensions, this experimenter sells her products and uses other strategies to guarantee the farm's operation.

In this way, she carries out the sowing after two rains in a staggered way, using the tractor to speed

up the work inside the fenced plot, and she also establishes *settlements* (reciprocal contracts) or eventual exchanges with her brother, who provides her with some services as performing soil scratching with a hand plough to open furrows, planting the seeds and then covering these with the same hand plough; this technique is called *partiendo bordo* or splitting ridges. Anyway, he contributes with the animals, pieces for the plow and the male labor.

As there is lack of draught animals and male time and labor availability she has recurred to certain alternative fertilization practices, such as chopping mulch during preplanting with the tractor and fertilizing directly from the numerous goats that herd her fenced plot during winter.

The experimenter mentions that she always allows the goats to eat the maize leaves and she then takes out the goats so that there is a remnant of the stems left that can be chopped and incorporated to the soil with other plant species. However, she has not carried out the practice that was suggested by the NGO.

Interpretations about the operations of the case studies and final considerations

In the first case of study, we observed that there is a need to have income that satisfies the basic needs of a large family in a monetized context —in which the results of agricultural production cannot easily be commercialized and there are no sources of stable income due to climatic risks—. Therefore, the family gives a relative low importance to the productive sector, so its strategy prioritizes extra-farm work as a source of income, leaving little time available for intra-farm work.

On the contrary, in the second case, lower subsistence needs and greater capital and fixed income availability allows the two-family members to remain on the farm for prolonged periods of time, and the fact that the commitment to the agricultural productive system is higher, contributes to the more frequent fertilization of the plot than in the first case, although with some adaptations due to lack of labor.

In the third case, the strategy consists in the intensification of intra-farm productive activities focused on goats. In this case, the incorporation of AT would be feasible *a priori*, taking into account the importance assigned to the productive sector. However, due to the lack of working capital and labor for the heavier tasks (male related), it is likely that there will be conflicts between intra-farm activities. The fact that there are other alternatives to maintain plot fertility suggests that fertilization is a difficult job.

In this regard, it should be noted that the different survival strategies of the three case studies analyzed do not assign the same importance to intra-farm production, which conditions the possibility of technological change towards AT.

This relationship between technological change and the importance that is assigned in the family strategy to the productive area to which the innovation is destined, has been mentioned before by Crespo et al. (1996), when studying the adoption of goat antiparasitic products in the north of Córdoba (Argentina).

It is however, precisely this diversity in family strategies and modes resources are combined that are responsible for the fact that experimenters —with similar structure levels— show different behaviors, e.g. in the adoption of AT.

These results coincide with those reported by Stuiver et al. (2004) and Aguinsaca-Caraguay (2014), who found different situations in which similar structural conditions subject to the same environmental and sociocultural contexts, showed different economic behaviors or productive outcomes.

This has to do, first of all, with the diverse strategies, ways of thinking and aspirations that the producers have in their own context; and, second, with the different ways in which they organize their livelihoods, such as the role of agriculture within their systems in relation to non-agricultural activities (Stuiver et al., 2004), as has been shown in this study.

The same considerations correspond to the cases of experimenters who, having different structural

levels, adopt the same behavior in relation to AT (e.g. E7 and E10) (Figure 2).

Despite the fact that several family strategies and behaviors were observed, we did not measure contrasting social operation logics in this study that have been described by other authors as Aguinsaca-Caraguay (2014), Berdegué & Larraín (1987), Graziano da Silva et al. (1986) and Stuiver et al. (2004).

Rather, we understand that with the relative closeness of their structural values and operation, all the case studies analyzed —not only the three cases exposed in this study— correspond to peasant-type experimenting families.

On the other hand, it is worth mentioning that, although the proposal design included traditional tools and supplies from the area, it was important to generate local and autonomous control; however, it was not enough to achieve a total adaptation to the farm's reality and, therefore, the adoption of the AT was not homogeneous.

On the contrary, in the results of the experience, a tension was perceived among the focus and adaptation of the proposal to the farm's diversity instead of the diffusion of a universal AT, through knowledge exchange and knowledge networks (Rodríguez-Espinosa et al., 2016); this was in fact the NGO's initial ideal participatory planning intention.

In a way, the idea of a universal proposal restricted its functionality to the farms, given that its implementation generated more inconveniences than those it solved.

When presented rigidly, AT did not differ too much from being a *technological fix*, a characteristic modernizing agribusiness design, which Cáceres (2015) states as modern technologies that solves specific problems quickly and universally, but with questionable final effects (Rosner, 2004).

Following this line of argument, beyond discussing the technological origin of the proposal in a dichotomous way (exotechnologies vs. endotechnologies, modern vs. traditional, and modern vs. intermediate or AT), it would be convenient to solve the causes of the problems and not its effects (Cáceres, 2015), in order to achieve a really *appropriable* or *adoptable* technology instead of an *appropriate* one (Serrano, 2015).

Recent research studies carried out mostly in Europe have revived interest in adjustments made by producers in an innovative way, without direct intervention of other agents. Although there is still no significant empirical support for these studies, it has been estimated that these adjustments —called *novelties*— are capable of generating a total reconfiguration of the growth factors under certain conditions, instead of solving each one in a timely manner; in this way, these can improve yield or income (Van der Ploeg, 2014; Van der Ploeg, Verschuren, Verhoeven, & Pepels, 2006; Van der Ploeg & Wiskerke, 2004). This reconfiguration would occur when there are adjustments that are capable of influencing several growth factors that cause imbalance instead of doing so over their effects separately.

In the analyzed experiences, different innovations generated by the experimenters themselves were observed, without direct intervention of other agents, which consisted of the multiple technological substitutes of those who did not adopt AT (as E6), and in various adjustments and redesigns of those that adopted AT (e.g. E2 and E12).

It is possible that this is an important path for the production of scientific knowledge in the medium term, which will improve the understanding of innovation processes in the territory and increase the probability of an effective implementation of appropriate and sustainable technologies.

Conclusions

In relation to the experimenters, it can be highlighted that, in part, different AT use-levels have been directly associated to different farm structures. However, this structure alone was not sufficient to explain the behavior of the entire group of experimenters studied.

Results of the case studies analyzed showed that other dimensions played an important role. On many occasions beyond the structure, dimensions as farm operation was responsible for the result observed in terms of AT adoption, given that the survival strategy of the family gave it a specific dynamic; this often ended up modifying the technological behaviors that *a priori* could have been expected from the experimenters, according to their structure.

In addition, in relation to the general research topic substitute practices or multiple readjustments made by the experimenters to the original proposal, demonstrated that designing AT using resources with local control was not enough to guarantee its effective implementation, and that it was also not convenient to show a single technological proposal to all the experimenters.

In future studies, it would be interesting to explore local adjustments that producers made to the original proposals, especially those capable of generating impacts on problem causes rather than on their effects. It is possible that this is an important path for the generation of scientific knowledge in the medium term, which will improve the understanding of innovation processes in the territory and increase the probability of effective implementation of adoptable and sustainable technologies.

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References

Aguinsaca-Caraguay, R. X. (2014). *Dinámica productiva agrícola: la estructura y funcionamiento de los sistemas de producción de los agricultores de las parroquias del noroccidente del cantón Loja, Ecuador* (Master thesis, Universidad Nacional de La Plata (UNLP), La Plata, Argentina). Retrieved from http://sedici.unlp.edu.ar/handle/10915/46809.

Berdegué, J., & Larraín, B. (1987). *Cómo trabajan los campesinos*. Santiago, Chile: Grupo de Investigaciones Agrarias, Academia de Humanismo Cristiano.

Cabrera, A. L. (1976). Regiones fitogeográficas argentinas. In W. F. Kugler (Ed.). *Enciclopedia argentina de agricultura y jardinería* (pp. 1-85). Buenos Aires, Argentina: Acme.

Cáceres, D. (1998). Tecnología apropiada y desarrollo rural: una revisión crítica. *Población & Sociedad*, (6-7), 197-227.

Cáceres, D. (2015). Tecnología agropecuaria y agronegocios. La lógica subyacente del modelo tecnológico dominante. *Mundo Agrario, 16*(31). Retrieved from http://www.mundoagrario.unlp.edu.ar/article/view/MAv16n31a08.

Cáceres, D., Silvetti, F., & Soto, G. (1999). Seguimiento de los procesos de cambio tecnológico en sistemas de pequeños productores agropecuarios. *Agro Sur, 27*(1), 57-71.

Cáceres, D., Silvetti, F., Soto, G., & Rebolledo, W. (1997). La adopción tecnológica en sistemas agropecuarios de pequeños productores. *Agro Sur, 24*(2), 123-135.

Cernea, M. (Ed.). (1991). *Putting people first: sociological variables in rural development*. New York, USA: Oxford University Press.

Crespo, H., Cáceres, D., Robledo, W., Soto, G., & Silvetti, F. (1996). *La adopción tecnológica en sistemas de producción caprina del noroeste de Córdoba* (Informe científico). Córdoba, Argentina: Secretaría de Ciencia y Técnica (SECyT), Universidad Nacional de Córdoba.

Díaz-Ártico, J. P. (2013). *Cambio tecnológico, tecnologías socialmente apropiadas y desarrollo rural participativo. La introducción del abonado con estiércol de cabra en comunidades campesinas de Río Hondo y Guasayán (Santiago del Estero)* (Master thesis) Universidad Nacional de Santiago del Estero, Santiago del Estero, Argentina.

Forero-Camacho, C. A., Rojas-Carvajal, G. H., & Argüelles-Cárdenas, J. H. (2013). Capital social y capital financiero en la adopción de tecnologías ganaderas en zonas rurales altoandinas de Colombia. *Corpoica Ciencia y Tecnología Agropecuaria, 14*(2), 149-163.

Forni, F., Benencia, R., & Neiman, G. (1991). *Empleo, estrategias de vida y reproducción. Hogares rurales en Santiago del Estero*. Buenos Aires, Argentina: Centro Editor de América Latina.

Garrido-Rubiano, M. F., Martínez-Medrano, J. C., Martínez-Bautista, H., Granados-Carvajal, R., & Rendón-Medel, R. (2017). Pequeños productores de maíz en el Caribe colombiano: estudio de sus atributos y prácticas agrícolas. *Corpoica Ciencia y Tecnología Agropecuaria, 18*(1), 7-23.

Giménez, A. M, & Moglia, J. G. (2003). *Árboles del Chaco argentino. Guía para el reconocimiento dendrológico*. Santiago del Estero, Argentina: Universidad Nacional de Santiago del Estero.

Graziano da Silva, J., Kageyama, A. A., Romão, D. A., Wagner-Neto, J. A., & Wanderley, M. N. (1986). Diferenciación campesina y cambio tecnológico: los productores de frijol en São Paulo, Brasil. In M. Piñeiro & I. Llovet (Eds.). *Transición tecnológica y diferenciación social* (pp. 85-141). San José, Costa Rica: Instituto Interamericano de Cooperación para la Agricultura (IICA).

Guber, R. (2001). *La etnografía. Método, campo y reflexividad*. Bogotá, Colombia: Norma.

Gurdián-Fernández, A. (2007). *El paradigma cualitativo en la investigación socio-educativa*. San José, Costa Rica: Coordinación Educativa y Cultural Centroamericana (CECC) y Agencia Española de Cooperación Internacional (AECI).

Hart, R. (1990). Componentes, subsistemas y propiedades del sistema finca como base para un método de clasificación. In G. Escobar & J. Berdegué (Eds.). *Tipificación de sistemas de producción agrícola* (pp. 45-62). Santiago, Chile: Centro Latinoamericano para el Desarrollo Rural (Rimisp).

Kaminsky, M. (1988). Referencias, comentarios y posiciones preliminares en torno al tema de enfoque de sistemas de fincas y tipificación de unidades de producción agropecuaria. In G. Escobar (Ed.). *Clasificación de sistemas de finca para generación y transferencia de tecnología apropiada* (pp. 27-36). Ottawa, Canada: Centro Internacional de Investigaciones para el Desarrollo (IDRC).

Kay, C. (2001). Los paradigmas de desarrollo rural en América Latina. In F. García-Pascual (Ed.). *El mundo rural en la era de la globalización: incertidumbres y potencialidades* (pp. 337-430). Madrid, Spain: Ministerio de Agricultura, Pesca y Alimentación.

Machado-Aráoz, H. (1998). *Diagnóstico externo zona Santiago del Estero. Departamentos de Río Hondo y Guasayán* (Informe interno). San Fernando del Valle de Catamarca, Argentina: Bienaventurados los Pobres (BePe).

Machado-Aráoz, H. (2007). *Economía política del clientelismo. Democracia y capitalismo en los márgenes*. Córdoba, Argentina: Encuentro Grupo Editorial.

Mapas Escudos Banderas (s. f) Santiago del Estero. Retrieved from http://mapasescudosbanderas.blogspot.com.co/search/label/Santiago%20del%20Estero.

Mapoteca. (s. f.) Santiago del Estero. Retrieved from http://mapoteca.educ.ar/.files/index.html.1.6.html.

Martínez-Mendoza, F. Z., Bakker, N., & Gómez-Hernández, L. (2010). Herramientas para la metodología campesino a campesino. Innovación pedagógica para construir saberes agroecológicos. *Leisa. Revista de Agroecología, 26*(4). Retrieved from http://www.leisa-al.org/web/index.php/volumen-26-numero-4/1692-herramientas-para-la-metodologia-campesino-a-campesino-innovacion-pedagogica-para-construir-saberes-agroecologicos.

Mazoyer, M., & Roudart, L. (2006). *A history of world agriculture: from the neolithic age to the current crisis*. New York, USA: Monthly Review Press.

Moors, H. M., Rip, A., & Wiskerke, J. S. C. (2004). The dynamics of Innovation: A Multilevel Co-Evolutionary Perspective. In J. S. C. Wiskerke & J. D. Van der Ploeg. (Eds.). *Seeds of transition: Essays on novelty production, niches and regimes in agriculture* (pp. 31-53). Assen, Netherlands: Van Gorcum (European Perspectives on Rural Development).

National Research Council (NRC). (2000). *Nutrient Requirements of Beef Cattle. Seventh Revised Edition: Update 2000*. Washington, USA: The National Academies Press.

Norgaard, R., & Sikor, T. (1999). Metodología y práctica de la agroecología. In M. A. Altieri (Ed.). *Agroecología. Bases científicas para una agricultura sustentable* (pp. 31-46). Montevideo, Uruguay: Nordan-Comunidad.

Pan para el Mundo (PPM). (2008). *Plan estratégico de los departamentos para Latinoamérica. Enfoque horizontal de asesoría: de campesino/campesina a campesino/campesina* (Fragmento de informe final). Berlin, Germany: PPM, Programa de Intercambio, Diálogo y Asesoría en Agricultura Sostenible y Seguridad Alimentaria en Latinoamérica (Pidaassa).

Pan para el Mundo (PPM), & Programa de Intercambio, Diálogo y Asesoría en Agricultura Sostenible y Seguridad Alimentaria en Latinoamérica (Pidaassa). (2006). *Construyendo procesos "de campesino a campesino"*. Lima, Perú: Espigas.

Paz, R. (1998). Tipologías y estrategias de intervención en el sector campesino. Los proyectos de mecanización agrícola y su evaluación *ex-ante*: el caso de El Pirucho. In R. Álvarez, C. Canevari, R. de Dios, R. Paz, A. Tasso, J. Williams & J. Barco (Eds.). *Sistemas productivos campesinos en Santiago del Estero. Organizaciones y unidades de producción. Uso de tipologías en los procesos de reconversión* (pp. 19-58). Santiago del Estero, Argentina: Barco Editó.

Paz, R. (2002). Estudio del caso modal: establecimiento JMR. In R. Paz (Ed.). *Sistemas de producción campesinos caprinos en Santiago del Estero. Proyección y desafíos para el desarrollo del sector* (pp. 181-212). Santiago del Estero, Argentina: Fundación para el Desarrollo en Justicia y Paz (Fundapaz).

Paz, R., Lipshitz, H., Álvarez, R., & Usandivaras, P. (2003). Diversidad y análisis económico en los sistemas de producción lecheros caprinos en el área de riego del río Dulce, Santiago del Estero, Argentina. *ITEA, 99A*(1), 10-40.

Programa de Diálogo y Asesoría en Agricultura Sostenible y Seguridad Alimentaria (PDAAS). (2001). Capacitación en el método participativo "campesino a campesino (CaC)". In *Análisis y evaluación de las actividades del PDAAS* (Resumen de informe final). Berlin, Germany: PPM.

Rodríguez-Espinosa, H., Ramírez-Gómez, C. J., Restrepo-Betancur, L. F. (2016). Nuevas tendencias de la extensión rural para el desarrollo de capacidades de autogestión. *Corpoica Ciencia y Tecnología Agropecuaria, 17*(1), 31-42.

Roig, C. A. (2003). *Alimentación del ganado caprino*. Colonia Benítez, Argentina: Instituto Nacional de Tecnología Agropecuaria (INTA).

Rosner, L. (2004). Introduction. In *The technological fix. How people use technology to create and solve problems* (pp. 1-11). New York, USA: Routledge.

Ruttan, V. W. (1996). What happened to technology adoption-diffusion research? *Sociologia Ruralis, 36*(1), 51-73.

Schumacher, E. F. (1973). *Lo pequeño es hermoso*. Madrid, Spain: Tursen/Hermann Blume.

Serrano, M. (2015). Generación de nuevas tecnologías: la agrobiotecnología en la agricultura familiar. In N. C. Comelli (Ed.). *Agrobiotecnologías. Implicaciones éticas, sociales y jurídicas. Prodiversitas,* (1), 91-96. Retrieved from http://www.prodiversitas.org/argentina/noa1.pdf.

Soto, G. (1996). Análisis socio-político de las tecnologías de transferencia agropecuaria. *Agro Sur, 24*(2), 126-136.

Stewart, F. (1985). Introduction. In M. Carr (Ed.). *The AT Reader: theory and practice of appropriate technology* (pp. xiii-xvi). London, United Kingdom: Intermediate Technology Publications.

Stuiver, M., Leeuwis, C., & Van der Ploeg, J. D. (2004). The Power of Experience: Farmers' Knowledge and Sustainable Innovations in Agriculture. In J. S. C. Wiskerke & J. D. Van der Ploeg (Eds.). *Seeds of Transition* (pp. 93-118). Assen, Netherlands: Van Gorcum.

Tasso, A. (1998). Reproducción secular de la pobreza rural. Dimensiones sociohistóricas de un caso de exclusión estructural. In R. Álvarez, C. Canevari, R. de Dios, R. Paz, A. Tasso, J. Williams & J. Barco (Eds.). *Sistemas productivos campesinos en Santiago del Estero. Organizaciones y unidades de producción. Uso de tipologías en los procesos de reconversión* (pp. 135-156). Santiago del Estero, Argentina: Barco Editó.

Van der Ploeg, J. D. (2014). *Peasants and the Art of Farming. A Chayanovian Manifesto*. Winnipeg, Canada: Fernwood.

Van der Ploeg, J. D., Verschuren, P., Verhoeven, F., & Pepels, J. (2006). Dealing with novelties: a grassland experiment reconsidered. *Journal of Environmental Policy & Planning, 8*(3), 199-218.

Van der Ploeg, J. D., & Wiskerke, J. S. C. (Eds.). (2004). Seeds of Transition. Assen, Netherlands: Van Gorcum.

Vargas-Beal, X. (2011). *¿Cómo hacer investigación cualitativa?* Mexico City, Mexico: Etxeta. Retrieved from https://es.scribd.com/doc/94805617/Xavier-Vargas-B-COMO-HACER-INVESTIGACION-CUALITATIVA.

Vargas-Gil, J. (1990). Suelos de Santiago del Estero. In *Atlas de suelos de la República Argentina* (Tomo II). Buenos Aires, Argentina: Secretaría de Agricultura, Ganadería y Pesca, Proyecto PNUD ARG 85/019, Instituto Nacional de Tecnología Agropecuaria (INTA), Centro de Investigaciones de Recursos Naturales.

Villalba, A., Gómez-Herrera, A., Concha-Merlo, P., & Ferreyra, R. (2016). Procesos de producción y apropiación de novedades socio-productivas en el manejo del monte y el ganado. In M. E. Gutiérrez & V. G. González (Comps.). *Desarrollo rural, políticas públicas y agricultura familiar. Reflexiones en torno a experiencias de la agricultura familiar en Santiago del Estero* (pp. 75-87). Santiago del Estero, Argentina: Magna.

Willoughby, K. W. (1990). *Technology Choice. A critique of the Appropriate Technology Movement*. Boulder, USA/London, United Kingdom: Westview Press & Intermediate Technology Publications.