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Biotechnologies for inclusive development: scaling up, knowledge intensity and empowerment (the case of the probiotic yoghurt 'Yogurito' in Argentina)

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ABSTRACT

This paper analyses how technological and institutional innovation strategies were deployed towards achieving a high-scale, sustainable, knowledge intensive, locally grounded project, through the experience of an Argentinean biotechnology-based nutritional supplement delivered in schools to solve child malnutrition led diseases. The paper focuses on how the case of 'Yogurito' managed to address three challenges within recent Innovation for Inclusive Development literature: (1) involving heterogeneous actors in the innovation process within knowledge intensive technologies, (2) gaining scale while fostering participatory technology development processes, and (3) promoting the articulation of science, technology and innovation (STI) programmes with wider (social, sanitary and productive) policies. Through the trajectory of the probiotic yoghurt, the article examines learning and innovation strategies in technological design and institutional arrangements. We argue that the organizational strategies deployed to articulate scientific and locally grounded capacities were key elements that allowed the programme's working, its sustainability over time, and the unfolding of a regional development policy scheme.

KEYWORDS

Innovation for inclusive development; biotechnology; 'Yogurito'; local development; organizational technologies; knowledge intensive technologies

1. Introduction

This paper aims to analyse how technological and institutional innovation strategies are deployed towards achieving a high-scale, sustainable, knowledge intensive, and locally grounded project, through the experience of an Argentinean biotechnology-based nutritional supplement distributed in schools to solve child malnutrition and related diseases.

It is currently argued by an emerging group of scholars that science, technology and innovation (STI) in knowledge intensive technologies can play an important role in solving the problems of social exclusion by providing alternative pathways for inclusive development. At an international policy level, several international agencies have designed specific programmes based on what has been called 'inclusive innovation' (Utz and

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Dahlman 2007; Heeks, Foster, and Nugroho 2014) or 'innovation for inclusive development' (IDRC 2011; OECD 2013; Cozzens and Sutz 2014).

At a national policy-making level, Argentina has attempted several STI policies that strive to combine innovation and inclusion.[1] Biotechnology has been considered as a main strategic area in this political agenda (MINCYT 2012), following an over 30-year trajectory of capacity building in biotechnology in public research and development (R&D) laboratories and private and public–private firms (MINCYT 2010). Nevertheless, an analysis of policy implementation so far reveals that is hard to establish a correlation between these efforts, STI investment and the generation of solutions to the country's major social problems (Thomas, Fressoli, and Becerra 2012).

Despite the official political stance of the last decade, which sustained that STI activities 'can and must contribute to an improvement of the conditions of development and social inclusion' (MINCYT 2012, 33), knowledge intensive projects geared towards social inclusion still occupy only a marginal place (Brieva et al. 2015). Moreover, even when it is possible to register an increase in assigned budgets to inclusive development projects since 2010, most STI priorities, programmes and resource mobilization are still focused either on basic research and/or remain oriented towards economic competitiveness (MINCYT 2012; Brieva et al. 2015). At the same time, several works have shown how incentives from paper-based evaluation systems hinder researchers from engaging in agendas based on local problems (Kreimer and Thomas 2001; Kreimer 2003; see also Frickel et al. 2010). Meanwhile, projects that explicitly attempt to develop biotechnological solutions to social problems are still minimal and face several obstacles: they result in prototypes without implementation or – if applied – remain low scale and barely visible, have limited resources and rarely articulate with local social and productive development agendas (Bortz 2016).

This research departs from the general question: how are scientific and technological capabilities oriented towards the generation of socially inclusive technologies in the case of biotechnology? Specifically, we aim to respond to three challenges for STI management of knowledge intensive technologies within recent Innovation for Inclusive Development literature:

(1) How can local scientific capacities be directed into high-scale solutions to the pressing problems of developing countries? Is it possible to achieve scaling up processes, and at the same time, foster participatory technology development?
(2) How can heterogeneous actors be empowered in the innovation process within knowledge intensive technologies?
(3) What organizational strategies can be deployed to articulate biotechnologies for inclusive development with wider social, sanitary and productive policies?

This work addresses these key issues through the case of the 'Yogurito Escolar', a probiotic yoghurt designed to prevent respiratory and gastrointestinal diseases by enhancing the immunological system. It was developed by a public R&D institute and manufactured by a small local firm from the Tucuman Province, Argentina, in conjunction with provincial and national organizations. The yoghurt became the central feature of a public alimentary social programme: while addressing nutritional and health deficiencies – by delivering the 'Yogurito' to children in public primary schools, the programme articulated a strategy

for local development through the upgrading of the impoverished provincial dairy chain and small and medium producers. The initiative has been running since 2008 within the provincial territory, achieved a process of scaling up by distributing the probiotic yoghurt to over 200,000 children, and has engaged in new projects in order to achieve its sustainability.

The 'Yogurito' constitutes a fertile case to obtain lessons for technology and policy management within the realms of inclusive innovation. This paper examines the learning and innovation strategies in terms of technological design and institutional arrangements that were deployed along the trajectory of 'Yogurito'. It explores the tension between the need of scaling up (to stimulate far-reaching social policies), of developing knowledge intensive technologies (to promote socio-technical change), and creating local empowerment strategies (to build local adequacy and foster local capacity building). Within the triangle between *scale*, *knowledge intensity* and *empowerment*, we analyse how the case managed to go beyond a knowledge intensive technology to solve a specific problem (malnutrition led diseases) to become a mobilizing axis of a social and productive development strategy by adding value to the local dairy chain.

We will argue that the organizational strategies that were implemented to bring together these three elements, by articulating scientific and locally grounded capacities, a productive platform to achieve provincial scale, and local empowerment mechanisms through heterogeneous knowledge negotiation, were crucial for its working and sustainability over time.

The investigation was conducted within a socio-technical analysis framework (Thomas 2008) that triangulates heuristic tools from a constructivist approach to Sociology of Technology (Callon 1992; Bijker 1995), learning conceptualizations from the economics of technological change (Lundvall 1988; Lundvall and Johnson 1994) and a 'backwards mapping' approach to policy analysis (Elmore 1979). The framework allowed overcoming micro-macro distinctions in the analysis, moving from the particular to the general in an integrated approach: that is, departing from the probiotic yoghurt (product technology) and problem-solving strategies in policy implementation and decision-making at the actor's level to analyse wider features of STI policies for inclusive development.

Research is based on a methodology of instrumental case study (Stake 2005). The case was selected after a survey of 29 cases using biotechnologies for inclusive development in Argentina through snowball detection, with over 30 interviews to their respective scientific or technical project leaders. The case of 'Yogurito' was chosen for its heuristic potential, as it was representative in terms of scientific background (microbiology and immunology-based biomedical research) and applications (health and food production), but surpassed the others in terms of its development, geographical and productive scale, time continuity and inter-institutional dynamics. For the 'Yogurito' case study, the following qualitative data collection methods were used: (a) identification of relevant actors through snowball techniques; (b) 13 in-depth interviews with researchers, technicians, users, public officers, and dairy producers, held during 2013–2014; (c) documentary analysis (programmes and projects, patents, government documents, newspaper articles, reports and statistics, biochemical papers, etc.); and (c) review of secondary sources (evaluations, technical reports, sectoral and case studies).

The paper is structured as follows: Section 2 builds on prior work on the Innovation for Inclusive Development literature to highlight some contradictions that lead to the three

challenges stated above. Section 3 presents the trajectory of the 'Yogurito Escolar', from its conception to the current phase of generating sustainable local development dynamics. Section 4 focuses on the organizational strategies implemented to address the tensions between the alleged barriers for participation that come with scaling up projects and fostering user involvement in knowledge intensive technologies. It examines how those strategies were key for achieving the project's sustainability over time. The conclusion with obtained learnings aims to serve as a resource for re-thinking technology management and STI policies oriented towards inclusive development.

2. Innovation for inclusive development: three persistent challenges

The association between innovation, development and social inclusion is not new. Since mid-1960, social movements in developing and developed countries tried to generate alternative technological dynamics towards socially inclusive and environmentally sustainable development through experimentation with alternative forms of innovation. They called themselves names such as 'appropriate', 'intermediate' (Schumacher 1973; Herrera 1981; Willoughby 1990), 'alternative' (Dickson 1974) or, more recently, 'grassroots innovations' (Gupta et al. 2003), 'social technologies' (Dagnino 2010) and emerged as a response to the conventional models and patterns of industrialization and technological development (Smith, Fressoli, and Thomas 2014). In the last decade, new approaches have also started to emerge from an innovation background, such as Prahalad's ([2004] 2010) approach on innovation for the 'bottom of the pyramid' (BoP), which started to focus on the role of the private sector (mainly large companies) in developing and distributing products that meet the needs of people with fewer resources. The 'below-the-radar' innovation approach, gaining momentum since 2010s, focused on the role of local small and medium companies in rural areas and industrial towns in informal settings, developing BoP markets in emerging economies (Kaplinsky 2011; Foster and Heeks 2013; Chataway, Hanlin, and Kaplinsky 2014). Also, in Latin America, especially in Argentina, Brazil and Uruguay, various cases of R&D by public institutions for social purposes can be surveyed ('socially oriented public R&D'); they are related to conceptions about the social mission of public higher education and research but without ascribing to any of the above approaches or movements (Thomas, Bortz, and Garrido 2015).

The explicit aim of these technologies has been to respond to community development problems, by generating goods, services and techno-productive alternatives in scenarios characterized by extreme poverty, particularly in developing countries in Asia, Africa, and – most recently – Latin America. These scenarios have tended to emerge within the civil society and the social economy in rural, urban and peri-urban areas, involving the participation of individuals and groups who experiment with innovations and develop new knowledge and technologies (Smith, Fressoli, and Thomas 2014), in many cases supported by international development agencies and STI institutions. The key players in the development of technologies for social inclusion are social movements, unions, NGOs, public R&D units, public higher education, government agencies, international financial institutions and public or private companies.

In this scenario, while there seems to be some consensus, both in academia and policy-making, on the need to address STI efforts to build answers to the problems of poverty and social exclusion, it is still unclear what ideas, strategies and institutional designs are better

suited to achieve these objectives (Fressoli et al. 2014; Heeks, Foster, and Nugroho 2014). Also, while on the one hand there is a general predisposition to declare knowledge intensive technologies as engines of social change and development, STI agendas have rarely managed to effectively coordinate with development agendas to solve some of the most pressing problems of the region (malnutrition, housing, access to water, healthcare, energy, among others) (Arocena and Sutz 2012; Thomas 2012).

The issue of which STI approaches are best suited for each scenario has resurfaced after the first decade of the century, reinforcing the question of how to combine locally available STI capabilities with population needs. Departing from a literature review on technological development, innovation and inclusion (Thomas, Bortz, and Garrido 2015; Bortz 2016), three problematic axes that raise divergent views were identified: (1) cognitive intensity of experiences; (2) normative views and practical problems in scaling up and building project sustainability over time; and (3) the construction of technology management models and participation schemes.

2.1. Knowledge intensity

The concept of 'knowledge intensity', associated with the ideas of 'high technology' or 'knowledge frontier', is usually framed within the rhetoric of the 'knowledge economy' as the importance of R&D activities for growth and competitiveness (Smith 2000).

Although public STI policies in Argentina point to the importance of 'knowledge intensive technologies' in triggering dynamics of social change (MINCYT 2012), so far coordination with STI agencies has been scarce (Thomas, Fressoli, and Becerra 2012). In most cases, these policies assume a kind of 'trickle down' development model where 'high tech' capacities lead to development through industrial growth. 'Inclusion' is thus framed as industrial job increase (ECLAC and UNESCO 1992; ECLAC 2012) but not as an upturn in population welfare, capacities and freedom (see Illich 1978; Sen 1984, 1987). Therefore, policy instruments and R&D initiatives that have managed to effectively coordinate their activities to act on (and solve) pressing problems of the region are still infrequent.

The 'knowledge intensity' concept is also problematic because it reduces 'knowledge' to scientific-based capacities (Smith 2000), and excludes other types and sources of knowledge and skills (Rylander and Peppard 2005). However, a vast literature has pointed out the relevance of other forms of knowledge for innovation and technological change (see Lundvall and Johnson 1994; Jensen et al. 2007). Following this, opening up the notion of 'knowledge intensity' within an inclusive innovation framework may involve analysing negotiation between different sources of expertise, inter-organizational learning, empowerment through cognitive participation in technology building, through tacit knowledge and local-based problem-solving capacities.

In the inclusive innovation literature, visions about cognitive intensity within diverse currents are usually discussed with reference to the *product* dimension. On one hand, normative standpoints of technological simplicity may be found which support simple technological devices, that are low in S&T (Schumacher 1973; Willoughby 1990) or that are easy to build, operate and maintain by the community (Dagnino 2010) or a local micro-entrepreneur (Gupta et al. 2003). Among these, while in some positions prevailed the role of technical 'experts' in technology design (e.g. 'appropriate technology movement', Willoughby 1990), others promoted the use of indigenous knowledge (e.g.

'grassroots innovation', Gupta et al. 2003) or collective learning processes and knowledge negotiation for technical and organizational problem-solving, as a means for social transformation (e.g. 'social technology movement', Dagnino 2010).

On the other hand, there are visions that promote the use of new technological knowledge to generate goods and services for the less privileged population. In some studies, the development of products for the 'BoP' (Prahalad 2010) has led to learning and capacity building but within firms, turning them into organizational competitive advantages. In others, as can be seen in 'social innovation' and 'socially oriented R&D' practices, the development of new technologies to generate dynamics of social and environmental change has tended to the prevalence of experts in the process of problem framing and in-lab technology design, usually outside its context of application (Fressoli et al. 2013; Benneworth et al. 2014). Meanwhile, other works have paid renewed attention to the poor as producers and innovators 'below the radar' in low and middle-income economies (Foster and Heeks 2013; Chataway, Hanlin, and Kaplinsky 2014). In the cognitive dynamic that deploys, even when it is possible to register the generation of new local capacities and networks among the low-income population, their participation in late stages of technology development tends to remain circumscribed to technology adaptation or to become micro-entrepreneur intermediaries between a manufacturer firm and the low-income end user (OECD 2013). In this sense, innovation results more in an adaptive or subsistence strategy than a capacity building and systemic community problem-solving practice.

These different streams show (schematically) a plurality of visions concerning techno-cognitive dynamics. While some stances, in order to promote wider participation, advocate for developing simple technologies, those that resource to knowledge intensive technologies tend to draw a boundary line of expertise that limits who may or may not be included in technology development in each stage. They both assume that knowledge intensive technologies imply in their ontology a barrier of access related to the necessary (STI) expertise for its practice. So, despite a normative shared vision of empowering the less privileged at the grassroots level, the practices and policies framed under both perspectives tend to preserve the asymmetries in terms of knowledge and skills. How is it possible, then, to promote the active engagement of different actors and kinds of expertise in processes of inclusive socio-technological change?

2.2. Scaling up and sustainability

The concern about scale may be addressed within the dimension of productive *processes*. The basic scaling up idea, which involves moving from small to high volumes of production and distribution of goods and services, aims to achieve economies of scale from the distribution of fixed costs across more production units. Different normative visions concerning the production and distribution of goods and services within the diverse inclusive innovation perspectives have conditioned the strategies to sustain practices and networks over time.

Some of the aforementioned innovation approaches advocate for small-scaled locally generated technologies. In some cases, it is seen as inherent to the construction of alternatives to poverty, providing meaningful work and environmental care, in opposition to industrial production (e.g. 'appropriate technology' and 'alternative technology'). In others, the small scale relates to the need of engaging in community participatory

processes (and decision-making) in technology building that may build its adequacy to socio-technical settings (e.g. 'social technology'). In the latter, scaling up is not conceived as product *replication* but as the *reapplication* (Miranda, Lopez, and Couto Soares 2011) in adequacy to different socio-technical contexts. Within this first standpoint, scaling up processes have usually arisen from the demand of political (national or international) actors to increase the reach of assistance programmes or from the movement's need to gain further influence to pursue their goals (Dias 2013; Fressoli et al. 2014). In terms of sustainability, these initiatives have usually depended on grants, donations and international, public and private funding, involving a persistent uncertainty about the continuity of experiences.

Other inclusive innovation streams present variable approaches and strategies towards scaling up and sustainability. Those range from projects that focus on prototyping, not concerning on scale and continuity of the experience over time, to dependence on public STI or development funding, public–private partnerships (e.g. 'socially oriented R&D'), 'social entrepreneurship' or even high-scaled development programmes, replicated in several locations, that depend on international funding (e.g. 'social innovation').

Meanwhile, other stances have deepened the analysis and strategies towards scaling up. The 'BoP' innovation approach (Prahalad 2010) attempted first to displace aid initiatives from the public and third sector and/or international aid towards the private sphere. With a business-oriented management perspective, it considers low-income population as a potential market and frames their needs as unsatisfied consumer demand. Secondly, those who advocacy for 'below the radar' innovation, also look for the role of the private sector on inclusive innovation, but in this case returning to innovation systems analysis to explore strategies to strengthen productive chains by small and medium local producers and favour technology adoption (Hanlin and Muraguri 2009; Foster and Heeks 2013; Chataway, Hanlin, and Kaplinsky 2014).

The implicit or explicit, internal or external expectation that lies behind the demands of scaling up technologies for inclusive development is the ability to replicate a 'successful' experience in other cities, regions, countries or even economic sectors, and it brings with it the need to standardize the production of goods and services. In this endeavour, however, most of these attempts overlook the complexity of developing inclusive technologies in three important ways: first, by reducing the concept of what is 'inclusive' to solving specific problems through 'pro-poor' technology fixes (instead of focusing on the systemic deficits) (Fressoli, Dias, and Thomas 2014). Second, by considering the concept of scaling up as a problem of quantity and reach, it overlooks issues about the direction, quality and appropriateness of innovation (Smith 2014). Here the insertion of the same element – even supposedly 'well designed' – in several socio-historically situated dynamics comes into tension with socio-technical adequacy/inadequacy processes (Thomas and Dagnino 2005). And third, by usually understanding 'scaling up' as the mechanical replication and distribution of goods and services but not necessarily of local socio-technical systems of production and distribution.

2.3. Participatory schemes and empowerment

While most of the literature on innovation for inclusive development has focused on product technology developments, the inquiry about the institutional strategies to conceive, design, implement, produce and evaluate technologies is still incipient (Chataway

et al. 2010; Heeks, Foster, and Nugroho 2014). As was seen in previous sections, the organizational arrangements or models of inclusive innovation come into correspondence and/or tension with views about the productive scalability of the technologies, the political demands for establishing replicable models for intervention and aid and knowledge management and negotiation. But they also have agency on the possibilities of participation of heterogeneous actors in technology development, and how and when it takes place.

The third problematic axis is, then, how participation is conceived within inclusive innovation. Furthermore, although there is a general normative consensus within the literature on the desirability of encouraging user participation in technological development as an inclusive 'good practice', what is 'participation' and what is its extent in practice varies across the different streams. It may range from framing the poor as end-of-pipe consumers (e.g. Prahalad 2010), participation as generating technological adaptations, participation in informal small-scale marketing through local networks (e.g. Foster and Heeks 2013), consultation, to even the involvement in the selection of materials and technology co-design by users themselves (e.g. Dias 2013; Thomas et al. 2017). Normative stances on 'participation' and organizational strategies that were proposed by the diverse approaches also show the assumptions about what is considered 'inclusive' in each case: the *intention*; the possibility of access to goods (*consumption*), its direct *impact* on the excluded group's life, framing thus inclusion as a *result*; or if what is inclusive is the *process* by which technologies are developed, the *structure* where they are developed and the knowledge frames that come into play (Heeks, Foster, and Nugroho 2014).

A definition of what is 'participative', its dimensions, desirable and/or possible scope, and what institutional models may favour the involvement of a plurality of actors in technology development, is still under discussion. Gaining clarity through specificity requires deeper attention to the use of the concept in each case, analysing who is included, when along the technology development process and how (being involved is not the same as making decisions) (Cornwall 2008). Participation is framed in this work not only as the voices sitting at the table but also as the actual involvement of those voices in technology building and the knowledge negotiation processes between different kinds of expertise that take place. Consequently, in this paper we will consider 'participation' as dynamic techno-cognitive practice that takes place in a contested ground, where different actors immersed in power and micro-power relations shape the limits of their agency in relation to their interests, motivations, rationales and capacities (cognitive, technological, social, economic and symbolic). We will use here a dynamic understanding of 'participation', defining it as the ability to influence in techno-cognitive building and decision-making in different levels.

2.4. Three persisting challenges

Along the three axes presented above, three main tensions arise that challenge the diverse organizational arrangements or models of inclusive innovation that were reviewed.

(1) *Developing knowledge intensive technologies while fostering wider participation in technology design*. Studies that focus on the implementation of knowledge intensive technologies have tended to frame 'inclusion' as 'access to goods' and 'the poor' as 'consumers'. By building a passive user (i.e. a consumer), these end up disregarding

empowerment processes that may include broader participation in technology building and decision-making, local capacity building and the integration of indigenous knowledge. On the other hand, while STI sectors assume a hierarchy of knowledge, in which scientific and technical knowledge prevails and grassroots and traditional knowledges are left out, those advocating 'simple' technologies pose an alternative hierarchy that advocates grassroots knowledge and sidesteps scientific knowledge, equally precluding further interactions. The involvement of wider actors and forms of knowledge into technological decision-making may contribute to technology blending experiences that result socio-technically adequate in diverse scales and scopes. Then, how can knowledge dialogue and negotiation be promoted?

(2) *Searching for large-scale influence and sustainability while meeting specific local needs (adequacy) through participatory dynamics* (Smith, Fressoli, and Thomas 2014). There is a tension between the search for the 'right device' (a technological fix), the development of replicable standardized technologies and the suitability of the technology for a specific socio-technical configuration. Inclusive development policies are being challenged by the need of wide implementation and the risk of generating socio-technical inadequacy processes (and, even, unintended effects). However, while studies that focus on small-scaled technologies have contributed pointing out the relevance of user involvement in technology design and construction to achieve socio-technological adequacy, those that have deepened on scalability and sustainability strategies tended to disregard user participation, being decision-making processes and narratives focused on the firms, policy-makers or technicians. Then, how can inclusive development technologies be scaled up and remain locally adequate?

(3) *Consensus on the role of STI policies and R&D for inclusive development but scarce experiences of articulation with wider policy and technology implementation*. Despite the general agreement of the role of STI as an engine for social change, local STI policies have rarely been articulated with social development agendas to solve the pressing problems of developing countries (i.e. malnutrition, lack of access to secure water, healthcare, therapeutics, energy, etc.).

In these alleged 'coordination failures', it can be seen how the state and state agencies are fragmented actors, leading to difficulties in policy consultation and coordination, through heterogeneous problem-solver framings (Santos and Becerra 2012; Thomas et al. 2017). In technological projects for inclusive development, this manifests itself at three main levels: (1) at the level of product technology, characterizing the problems to be solved, what technological solutions to develop, how and what type of knowledge to resort to; (2) at the level of process technologies, what techno-productive systems are adequate and needed to solve the problem; and (3) how each public actor involved understands 'participation': who participates and how in the construction of problems and solutions, who participates in decision-making, when, and with what leverage on the outcome. These problems underlie technological decision-making in all democratic states in the search to reconcile heterogeneous interests through planning and technological implementation.

In the following sections, we will examine how the probiotic yoghurt 'Yogurito', a case that can be identified as an experience of biotechnology-based 'socially oriented public R&D', managed to address these questions and challenges.

3. The 'Yogurito Escolar'

The 'Yogurito Escolar' is a fermented dairy product containing the probiotic *Lactobacillus rhamnosus* CRL 1505 whose consumption strengthens the immune system, fostering the prevention of respiratory and gastrointestinal diseases (Villena et al. 2012). The product was developed by an Argentinean public R&D institute, the Reference Centre for Lactobacilli (Centro de Referencia para Lactobacilos, CERELA) and manufactured by a small dairy company, both located in San Miguel de Tucuman, capital city of the Tucuman Province, in Northwest Argentina.[2]

Its development represented an intersectoral work that involved the provincial ministries of Social Development, Education, Health and Productive Development, the national Ministry of Science, Technology and Productive Innovation and the Dairy Farmers Association of the Region of Trancas (APROLECHE). Since 2008, the 'Yogurito' has been included in the provincial alimentary social plan and distributed by the Ministry of Social Development (MSD), reaching currently 200,000 children in public primary schools, who receive the probiotic three times a week as a food supplement. The project gained increasing visibility through media, broadcasting, awards, and is usually presented by the national authorities as an emblematic case of innovative scientific development to solve a social problem in coordination with a large-scale social policy (*Agencia CTyS*, January 9, 2012; *CONICET*, July 28, 2014).

3.1. Project set-up (2003–2007): from the strain to the alimentary project

The 'Yogurito' is rooted in a previous socially oriented R&D attempt by the CERELA in the mid-1980s. Departing from the demand of a group of physicians at the local children's hospital to find a way to treat hospitalized, undernourished children dying from summer diarrhoea, they developed in 1986 a fermented probiotic milk that enhanced the immune response (Perdigon et al. 1986a). The 'Leche Bio' was transferred to a local private industry in 1989. However, launched in 1995 as a differentiated 'niche' product, its access became excluded from sectors with unmet basic needs, initially conceived as its beneficiaries.

The new project was initiated then between 2003 and 2004, after the deep socio-economic Argentinean crisis of 2001, which brought to light the problems of severe unemployment, high rates of poverty and indigence, extended undernourishment and health and sanitation deficits (Svampa 2005). These became increasingly visible in the public agenda, especially in Tucuman (*La Nación*, November 26, 2002). By the early 2000s, the CERELA had a 25+ year trajectory of R&D and capacity building in lactobacilli. After noticing the encouraging technological performance of a *L. rhamnosus* strain[3] (CRL 1505) on the immune response to digestive and respiratory infectious diseases associated with high nutritional deficits, the intention of developing a functional dairy product to address undernourishment in children with unmet basic needs re-emerged within the CERELA. The idea was taken to a regional multi-actor workshop arranged in 2004 by the former national STI Secretariat (SECYT). The workshop had the participation of representatives of scientists and higher education systems, local producers, SME entrepreneurs, recovered companies, NGOs and political officers and was aimed at identifying problems and demands from the territory and articulating diverse actors into their solution through R&D associative projects. This policy scheme sought to

differentiate from science-push technology transfer schemes, through the organization of regional multi-actor forums as a technology management model. After the forum and subsequent conversations with national and provincial STI officers, the idea of a functional food to address malnutrition resulted in a first draft for the development of a probiotic yoghurt aimed at malnourished children (Font de Valdez, personal communication, 2013; Galante, personal communication, 2014).

3.2. The evaluation study (2007–2008): from the clinical trial to result validation

By 2006, although the product was already set-up at the laboratory level, its potential implementation required an assessment of its working by stimulating children's health. In this scenario, in order to implement a clinical study, the local STI authorities engaged a secretariat within the provincial MSD. The CERELA then obtained a small grant from the SECYT for a double blind trial with 298 children – 2–5 year olds – attending community kitchens in peri-urban areas of Tucuman to assess the health effects of administering a lactic probiotic (Font de Valdez 2007).

The implementation of the study required the involvement a 150 person team, including CERELA researchers, nutritionists, MSD officers, which in turn enrolled community kitchens' staff, social workers, dairy manufacturers and physicians from the Provincial Health System. The latter discussed the initiative with parents and surveyed respiratory, gastrointestinal and dermatologic problems that the children were suffering from, monitoring their health and markers before and after consuming the probiotic. The project involved not only the product set-up (the probiotic yoghurt and placebo) and the study of intake results, but also the control of the children's social, health and sanitary living conditions, the acceptability of the probiotic yoghurt (taste and general acceptance by the children and their parents), and the development of a working associative scheme between a plurality of actors (Font de Valdez, personal communication, 2013; Gonzalez, personal communication, 2013).

The results obtained showed a reduction in the frequency of respiratory, gastrointestinal and dermatological infectious conditions and an improvement in the natural defence system of the children's organism (Villena et al. 2012). Based on these outcomes, the various participants in the experience appraised the 'working' (Bijker 1995) of the experience: first, on the noticeable improvement in the nutritional and infectious situation of the children, legitimated by the 'scientific validation' of the essay (*La Gaceta*, February 15, 2008; *Diario Panorama*, November 29, 2008). Second, both CERELA and MSD appraised the associative and problem-solving capacities that emerged from the experience. Problem-solver dynamics, in the tension from what was planned and the arising contingencies along the evaluation study, generated a process of active involvement, training and coordination of actors, as well as the need of negotiation between different capacities to meet the challenges that arose from the project.

The favourable results of the study also benefited from extensive regional media coverage, gaining public support and visibility. This implied the displacement of 'Yogurito' from the lab and a neglected peri-urban field to the public sphere, showing a knowledge intensive technological alternative developed to meet a social problem that had been built in the public agenda as a pressing one.

3.3. Adoption in Tucuman (2008–2010): from the socio-political decision to the provincial alimentary plan

The favourable results of the trial project conducted by CERELA, coupled with its wide public resonance, influenced the decision by the provincial Minister of Social Development to include 'Yogurito' as part of the provision of the alimentary social programme 'Copa de Leche' (Glass of Milk).[4] Since 2008 the MSD started to distribute the yoghurt three times a week in public primary schools of urban and peri-urban San Miguel de Tucuman (*La Gaceta*, February 15, 2008; *Diario Panorama*, November 29, 2008).

Following the decision to adopt the 'Yogurito' as a part of an alimentary social policy, the MSD summoned both CERELA and the dairy farmers from the Trancas region to produce 'Yogurito' at a large scale, as well as the provincial ministries of Education, Health and Productive Development to coordinate the implementation of the Social Probiotic Programme. This required not only the set-up of the product and the production infrastructure within the local dairy manufacturing firm, but also a hard training process with teachers and principals in schools – who were to distribute the yoghurt – and physicians in primary healthcare centres in the Province to create awareness and address possible side effects by starting probiotic consumption in malnourished kids. These contacts and exchanges led to the formation of an Intersectoral Board to discuss and lead the management of the project (Font de Valdez, personal communication, 2013; Gonzalez, personal communication, 2013). This process implied broadening previous learnings in inter-institutional links and the stabilization of the connections that had begun to develop during the exploratory study. This relates as well to the need of the MSD to build the working of 'Yogurito' (product technology) and the programme (organization technology), which required the coordination of different actors and actions, strengthening all links in the policy implementation chain, and aligning heterogeneous elements that could result in obstacles of both artefact and policy.

When the programme was launched in 2008, it provided 'Yogurito' to 56,000 children from San Miguel and Great San Miguel de Tucuman three times a week and then, in 2009, the recipients increased to 100,000 (*Agencia CTyS*, January 9, 2011). By including children from the rest of the Province through the distribution of the probiotic in a dehydrated form ('Biosec'), the programme reached 200,000 children across the Province. In 2012, the programme also incorporated a probiotic chocolate milk ('Chocolet') to seasonally alternate with the yoghurt. The programme was resourced not only from provincial funds allocated to the 'Copa de Leche' but also, since 2009, from complementary national funding.

The various actors involved in the Social Probiotic Programme point out the resulting improvements in health, by reducing and preventing gastrointestinal and respiratory infectious diseases. The Ministry of Education has also pointed out the reduction of absenteeism and better school performance in the areas where malnutrition remained most critical (*Diario Panorama*, November 29, 2008; *La Gaceta*, February 15, 2008).

But, at the same time, for the dairy farmers of Tucuman, the programme prompted a dynamic of valorization of the provincial dairy sector. Trancas, in north-central Tucuman had historically been integrated by small- and medium-sized dairy farms, mostly family-based. In the 1990s, with the process of opening up and economic deregulation, land concentration and the national economic crisis, the dairy producing hub of Trancas came into crisis and contracted. The producers, previously partnered in a dairy cooperative, were

atomized and most of them impoverished to subsistence levels (Garrido 2005). In the years that followed between 2001 and 2008, dairy farmers made several re-association attempts, in part to comply with the provisions stipulated for the 'Copa de Leche' law. In 2006, some negotiations began for the creation of the Dairy Board of Tucuman, to be compounded by institutions involved in the dairy production chain and to promote activities for its recovery (*La Gaceta*, April 1, 2006).

The beginning of the 'Yogurito' project in 2008, which required the coordinated provision of raw material on a large scale, prompted the formation of APROLECHE, Dairy Farmers Association of the Trancas Region, under a partnership of business cooperation. APROLECHE's mission was to consolidate the scattered producers to market their production, looking for their profitability and stability in order to overcome the structural problems of Tucuman dairy production: its small scale and its entrepreneurial and financial weakness (*La Gaceta*, October 4, 2013).

3.4. Towards the generation of sustainable production dynamics (2010-present): the creation of the Dairy Technological Hub

In the following years, APROLECHE's entity and identity were shaped by the development of the 'Yogurito', as it got reinforced as a local actor geared by the growing milk state demand to implement the Probiotic Social Programme. This was not only achieved through the provision of fluid milk as stipulated by the administrative structure of the 'Copa de Leche', but also under an organizational arrangement where the associated primary producers controlled the whole production, from raw material to finished product, selling it to the MSD (Sanchez Loria, personal communication, 2013; Navarro, personal communication, 2013). Through this scheme, APROLECHE gathered the milk brought by each farmer and coordinated the production, outsourced the yoghurt's industrial manufacturing to the dairy SME, which included the probiotic provided by CERELA, and delivered the manufactured value-added product to the MSD. The state provision contract was signed between the MSD and APROLECHE, the latter becoming the executor of the project and the supplier of the finished product. After that, APROLECHE distributed to each farmer an amount equivalent to the quantity of milk supplied to the pool, to the SME for the product manufacturing and to CERELA by the probiotic and a royalty for further research. This way, the farmers assured themselves of the volumes of milk purchased and a 20–25% increase in their income by delivering a value-added product (*La Gaceta*, July 16, 2010).

Moreover, the dynamics driven by the 'Yogurito' and the Probiotic Social Programme also prompted the creation of the Tucuman's Dairy Technological Hub (*La Gaceta*, June 3, 2011). This initiative departed from the Dairy Board of Tucuman, the Livestock Secretariat (Ministry of Productive Development of Tucuman) and APROLECHE, with the support of MSD and CERELA. The Technological Hub was created as a multi-actor strategy for regional development to strengthen the reduced production scale of Trancas through value-added dairy production for regional consumption. It was based on technical, productive, organizational and associative capacity building processes that were shaped with the 'Yogurito' (*La Gaceta*, June 3, 2011). They are currently developing a set of productive projects, including the launching of a commercial local brand to channel the milk production surplus during the year and summer break ('Ñulac') that offers a set of dairy

probiotic products affordable also for low-income families (*La Gaceta*, August 9, 2014). Through the Hub, new R&D projects are also being developed through a partnership between APROLECHE and CERELA, including the recovery of traditional knowledge and craft practices for cheese-making and a project to reuse and add value to the whey.[5] At this stage, the growing influence of the associated small and medium producers in decision-making processes may be observed, and also the alignment of new elements to assure the continuity of the local and productive development strategy over time, regardless of public funding.

4. Bridging scaling up and sustainability, knowledge intensity, user participation and empowerment

This section will focus on the organizational strategies attempted to address the tensions between the alleged barriers for participation that come with scaling up projects and fostering user involvement in R&D intensive technologies. It examines how those institutional arrangements were vital for achieving project sustainability over time and transforming a public aid approach into a local development systemic solution.

4.1. Developing knowledge intensive technologies while fostering wider participation in technology design

The 'Yogurito' emerged within a long trajectory of bacteriological and immunological biochemical research. In the 1980s, the positive results in terms of technological and immunological studies of lactobacillus immune activity and the effects and possibilities of oral administration accounted for a high degree of scientific novelty at an international level (Perdigon et al. 1986a, 1986b; Lorenzano 1995), and resulted in an initial prototype for solving childhood diarrhoea. From the scientific production point of view, this experience involved a turning point in the academic production of the institute and, in particular, of the groups devoted to the project, which began a solid research trajectory on the potentiating effect of lactobacilli in the immune system (probiotics). However, the construction of the 'Leche Bio' through a technology transfer strategy to the private sector, which presumed the adequacy of a 'well-designed' device for problem resolution, showed its inadequacy in the lack of access by the beneficiary population.

The 'non working' precedent of the 'Leche Bio' influenced subsequent organizational and technology management choices made by the CERELA and the STI officers that were involved. Departing from these learnings from previous 'failed' experience, the beginning of the design and conception of a new functional food for neglected sectors in 2003–2004 began to take shape as a local associative project from its outset. Based on regional needs, it was first proposed by the researchers in the 2004 regional forum. In this trajectory, the first multi-actor technology management scheme was developed through the design and implementation of the clinical trial held in 2007–2008. Even though in the beginning the project was led by the CERELA, the implementation of the trial in community kitchens required the alignment of diverse actors (MSD public officers, but also social workers, physicians, nutritionists, parents, children, among others) that began to shape the experience in turn. The study, initially conceived to assess the immunological and nutritional effects of the yoghurt, ended up also aligning an organizational arrangement that

enabled the development of the trial, laying the basis for the implementation of 'Yogurito' as a public policy, through the Social Probiotic Programme.

The adoption of 'Yogurito' as public policy in 2008 after the political decision of the MSD required building the 'working' of both product technology and organizational technology, generating their adequacy to the Tucuman setting. This process involved the circulation and negotiation between different types of knowledge and expertise. Interactive learning processes (Lundvall 1988) through an extensive problem-solving trajectory appear here as key to understand the gradual technological change through product, process and organizational innovations.

One of the most visible elements in terms of organizational learning was the alignment of the Intersectoral Board as an associated management mechanism. Its implementation was based on a previous associative experience that was deployed by the MSD along with the Ministries of Education and Health but, above all, on the experience of multi-actor work that was aligned for the clinical trial by the CERELA and the MSD, gathering the diverse parties into an organizational scheme that endured – and expanded – in subsequent phases. The Board arose in the tension between contingency and strategic planning, in the process of solving the problems that emerged during the implementation from the different areas. It gradually became a coordinating body between the various pillars supporting the programme: techno-scientific and productive set-up (CERELA and the dairy manufacturer), alimentary policy and logistics (MSD), local milk production and product distribution (APROLECHE and Ministry of Productive Development), distribution and consumption of yoghurt in schools (Ministry of Education) and healthcare assistance (Provincial Health System). The Board thus played a strategic role in stabilizing areas of interactive learning at both individual and inter-institutional levels, but also coordinating and/or negotiating interests between the diverse parties in the process of achieving a common project. Therefore, it emerged as a platform for raising difficulties and interactive problem-solving, but along the way it became institutionalized as a collective governance mechanism for technology management and decision-making.

The stabilization of the exchange between different types of knowledge and expertise among the various actors (scientific, productive, logistic, medical, nutritional, educational, political, etc.), facilitated the adequacy of 'Yogurito' to local practices and needs. The construction of this space, with biweekly meetings, gave continuity to extensive DUI (doing, using and interacting) learning trajectories (Jensen et al. 2007). These enabled solving from streamline production processes to refrigerated transportation problems, both through logistic adjustments to product innovations. The latter is, for instance, the case dehydrated probiotic 'Biosec', developed by the CERELA to meet the policy need of the MSD to include the inner regions of the Province into the probiotic alimentary programme. This innovation allowed, in turn, scaling up the programme from 100,000 to 200,000 beneficiaries. These processes of heterogeneous knowledge negotiation involved not only the generation of new knowledge through the interaction but, for all actors, also led to new techno-cognitive practices: the displacement of current practices, immersion in other domains of action where they were previously outsiders (e.g. researchers discussing social development policies, policy-makers and producers discussing probiotics, all of them discussing how to make yoghurt), developing skills to articulate with various actors, the 'intromission' of outside actors into their own domain – not free

from disputes and resistances, and negotiation between different types of legitimacy and rationality.

Moreover, the complexity of the product and organizational technologies, the need to coordinate the implementation of the programme in a provincial scale and to sustain its adequacy to various provincial settings, stimulated – through and from the Intersectoral Board – a process of construction of channels and communication strategies between the different sectors involved in the diverse levels of policy implementation.

First, it was necessary to make sure that the information and training necessary to implement the programme would come up to the last level of the implementation chain (Elmore 1979). That included activities to align the meanings that were assigned to the project: from conducting workshops with teachers, principals, parents, and doctors, to promoting a sense of appropriation of the 'Yogurito' by children (end users) and teachers (intermediate users), such as classroom activities on science, probiotics and nutrition and participative visits to the laboratory. Secondly, despite being a large-scale programme, the construction of communication channels with the different implementation sectors through and from the Intersectoral Board allowed including preferences, objections and resistances – developed through technology using – of children, teachers, doctors, families and dairy farmers to the design of the 'Yogurito'. This allowed, for example, the introduction of technological changes to enhance the acceptance of the product by children (end users) and teachers (intermediate users), in taste, consistency and even packaging, seeking its adequacy for the territory. But it also permitted introducing changes into the productive organizational scheme after the preferences and resistances of dairy farmers, as users of the socio-productive policy.

This way, despite the initially top-down nature of the public policy, it was sought to put in practice participatory spaces and empower – through various means and in different degrees – diverse actors (farmers, teachers, children, families, doctors, etc.) through mechanisms of techno-cognitive participation.

4.2. Searching for large-scale influence and sustainability while meeting specific local needs (adequacy) through participatory dynamics

Interactive learning was not only key to adequate the project to the preferences of final and intermediate technology users, or to the educational and classroom dynamics and state provision system. It was also the impulse and the result of building the suitability of the project to the local socio-productive needs and conditions, aiming (at the same time) to transform these conditions.

At the beginning of the policy implementation, the dairy farmers association was shaped and fuelled by a sustained milk demand by the State. As the project started gaining stability and scale augmentation, it drove an increase of participants joining the associative scheme. Joint production arrangement managed by APROLECHE implied new institutional strategies for cooperative partnerships and commercialization within the Province. The system devised by the small and medium dairy farmers of Tucuman to comply with the Social Probiotic Programme under the 'Copa de Leche', involved their full management of 'Yogurito's state provision. It sought to respond to the terminal crisis of the sector following 2001, the decline and impoverishment of the farms, low production scale, and their economic and financial weakness.

On a first level, the additional income from the sale of a value-added product, coupled with lowering the costs by averting the intermediaries and reducing the transportation of fluid milk to other Provinces, meant an incentive for more producers to join and broaden APROLECHE's production capacity[6] (*La Gaceta*, June 3, 2011). But on a second level, the shaping of APROLECHE and the farmer-based management of 'Yogurito' involved, in turn, the empowerment of these actors: not only by improving their livelihoods, the bond between the producers and their land and labour, and building new local productive and organizational capabilities, but also through the shaping of a new collective actor with decision-making capacities.

Thereby, the project's initial impulse resulted in the emergence of new bottom-up projects that aimed to build the sustainability of the local development programme, beyond social policy. In this regard, one of the main initiatives was the launch of the commercial brand 'Ñulac'. Drawing upon the probiotic product portfolio and the production and organization dynamics generated for the Social Probiotic Programme, this local brand aimed to capture the milk surplus from APROLECHE and provide manufactured dairy products for regional consumption, encouraging in turn more producers to join the farmer's association and broadening its production volume. This multi-actor initiative was driven by the impulse of the Dairy Board and framed within the activities of the Dairy Technological Hub, which involves APROLECHE, the CERELA, and the ministries of Productive and Social Development (*La Gaceta*, September 10, 2014).

Other initiatives were also generated to enhance the dairy productive chain and to foster the creation or improvement of regional SMEs. These can be seen in projects to strengthen traditional family-based cheese-making and preservation of ancestral knowledge and flavours, while promoting their compliance with quality standards, or even projects to recover the whey for nutritional use, thereby, adding productive value to formerly discarded 'waste' and reducing its pollutant effect. Especially in the case of small producers, these projects sought their inclusion in formal markets in the Province and other consumption centres, to improve their income and sustainable livelihoods (Font de Valdez, Sanchez Loria, Navarro, personal communications, 2013).

The activities for promoting and scaling up the dairy sector that arose from the Dairy Board and the Dairy Technological Hub, as sectoral associative management spaces, also included: livestock sanitation and improvement; purchase of equipment and livestock units; technical and financial support (loans and subsidies) to small producers; and even the organization of networking, training, and commercialization activities such as exhibitions and fairs, which also helped to make the efforts and development of the sector visible at a regional scale. These initiatives have been supported by the Ministry of Productive Development, with the aim of gradually reducing the relative incidence of State purchase and dependence, and contributing to the integrated growth of the sector, building its viability and sustainability (*La Gaceta*, October 4, 2013; *La Gaceta*, May 16, 2014).

These productive efforts, the participation of diverse actors, their capacity to influence decision-making processes, and highlighting the comprehensive local root of the 'Yogurito' and the boosting of the whole dairy production in the Province, has resulted in a reinforcement of the actors' Tucuman-based identity in connection with the production of their own land and techno-scientific capacities.

5. Conclusions and final remarks

This paper aimed to show, through the case of 'Yogurito', the diverse organization technologies at the institutional, inter-institutional and public policy levels that were deployed to implement a high-scaled, sustainable, knowledge intensive, and locally based project. The case explores a trajectory that went beyond a technology-fix public aid approach towards a systemic problem-solving strategy through the generation of local development dynamics. The case managed to tackle the tensions between the apparent barriers for participation that come with scaling up projects and fostering user involvement in R&D intensive technologies, present in the Innovation for Inclusive Development literature.

5.1. Scaling up and sustainability/participation and empowerment

(1) The case of 'Yogurito' shows the scaling up of processes beyond the mechanical replication of a product technology, but as the construction and growth of a techno-productive system at a regional level. Here, the focus has been placed not only on the product but especially on the process and organizational technologies, to shed light on the way that processes and production capacities can be scaled up within local socio-technical systems of production and distribution of goods and services. This allows the replication of the technology and, at the same time, the building of its socio-technical adequacy. Therefore, unlike visions that consider desirable the low scale of products and processes (e.g. 'appropriate technologies'), the case shows the possibility of generating high levels of local appropriateness while increasing production levels. At the same time, unlike visions that promote high-scaled technologies for the poor (e.g. 'BoP'), the case presents an effective possibility of generating instances of participation, substantive empowerment and local capacity building in scalable projects that are sustainable over time.

(2) The process of articulation of problems and solutions needs to be understood as a gradual and contingent process. The design of the 'Social Probiotic Programme' as a public policy to give scale and support the 'Yogurito' brought with it the necessity to solve the crisis of the dairy sector: the feasibility of the alimentary programme required the viability, scalability and sustainability of the dairy productive development programme.

    Thus, the scaling up process was marked by a strategy of local adequacy. First, to a pre-set public policy, with a prior learning trajectory on logistics, management and distribution and to local preferences. Second, to the socio-techno-productive settings of the Province becoming, in turn, a way to build the irreversibility of the local development programme dynamised by the 'Yogurito'. Product and process scaling up implied an increase in farmers' participation in the associative scheme; and, therefore, their strengthening as a collective actor, participating in interactive learning processes and decision-making and promoting new techno-productive initiatives. Thus, while the programme built the 'working' of the previously impoverished producers, they built up the 'working' of the programme, seeking new initiatives for its enhancement.

5.2. Knowledge intensity/participation and empowerment

(3) The case of 'Yogurito' can be addressed as an extensive socio-technical trajectory of intensive interactive learning, characterized by the widely heterogeneous sources of knowledge that were brought into interaction by the different actors. The trajectory departed from the prior 'non working' experience of the 'Leche Bio' to solve malnutrition and child mortality. Lessons learned by the actors at the scientific and organizational levels, allowed them to go from a linear technology management scheme (technology transfer to the private sector) to a multi-actor 'chain linked' technology management and learning processes with continuity over time. In this regard, sustained interactive knowledge construction was one of the strategic elements that was an essential feature of its trajectory. Hence, the 'knowledge intensive' nature of 'Yogurito' cannot be reduced to its R&D-based design. It has to be placed at the convergence of scientific, planning, managerial, productive, logistic, nutritional, educational and traditional types of knowledge, which symmetrically intervened in its design (as a product and organization technology), and built on its adequacy to the various provincial settings. Here, all of the above mentioned capacities (even R&D) were rooted into its territory, and articulated into the local development strategy. Additionally, the 'Yogurito' did not build (end-of-pipe) *consumers* but (active) *users*, who shaped the product and the public policy with their preferences, their resistances and – in the case of the farmers – even active technology decision-makers.

(4) The implementation of the 'Yogurito' project in its three major components, techno-productive set-up, the alimentary programme and the local development programme – or, from another viewpoint, product technologies, process technologies and public policy implementation – required the construction of a 'socio-technical alliance' (Thomas 2012): a coalition of heterogeneous elements to build up its 'working' and suitability to a given setting (Figure 1). In the tension between what was planned and what was contingent – as responses from the implementation process itself, new actors were aligned and new initiatives and institutional spaces were opened up, such as associated management boards. These organizational arrangements did not emerge as a project a priori or a pre-set management model, but were instituted through the interactive process as a negotiated response to implementation challenges.

5.3. Articulation of STI programmes with wider (social, sanitary and productive) policies

(5) In dynamic terms, the Intersectoral Board arose from the need of a scaled-up project implementation to resolve three overlapped crises: the dairy sector crisis, nutritional and health crises and alimentary policy crisis. The urge to act on these matters opened up a substantive change and an actors' opening to try associative problem-solving strategies. In this sense, the Intersectoral Board can be analysed as an organizational device, and as a place of convergence and coordination of the socio-technical alliance built around the working of 'Yogurito'. It operated on several intertwined dimensions: (a) as a space for interactive knowledge building; (b) as a space for dialogue and inter-

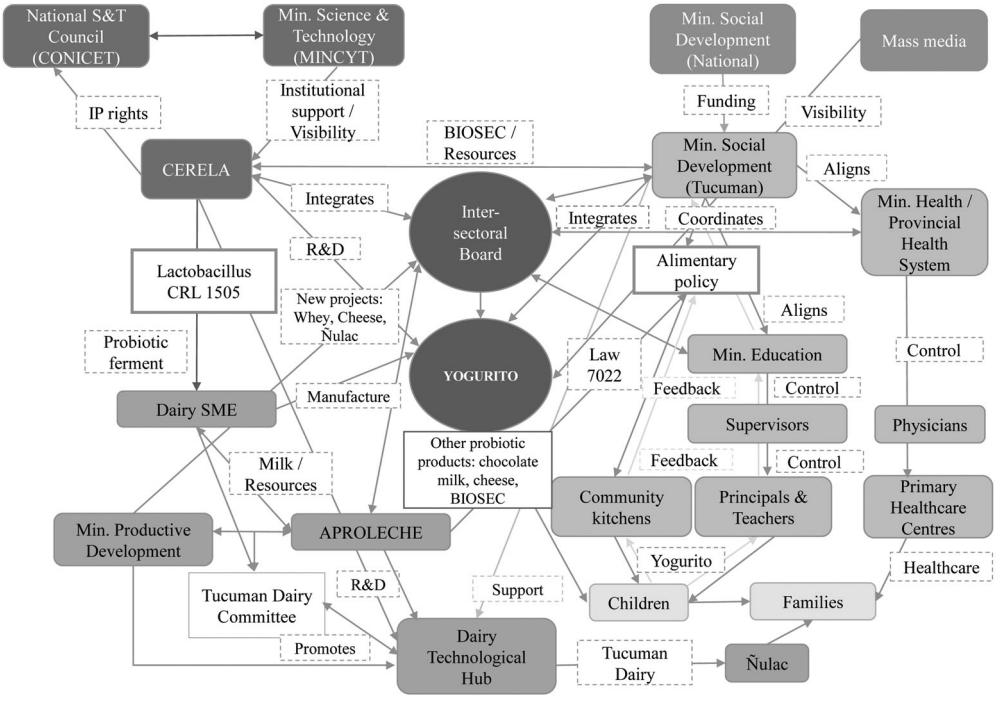

Figure 1. The socio-technical alliance of 'Yogurito' (2010-present). Source: own elaboration.

actor interest conciliation; (c) as a space for decision-making and horizontal policy coordination (on social development, STI, education, health and production); and (d) as a space for vertical coordination of multi-sectoral policy implementation. We can see here how the alignment and coordination of various elements around the 'Yogurito' emerged as a convergence of heterogeneous interests, problems and agendas that were reconciled into a single project, with diverse meaning attributions for each one of them. Moreover, this collective governance mechanism that took shape also allows to see multi-actor technology management 'in action', where the direction and outcome distribution of knowledge and technology development is negotiated and decided, choosing between diverse technological alternatives.

(6) The construction of this (bio-) technology for inclusive development is inseparable from the public policies and organizational arrangements that gave it scale and the knowledge negotiation processes that made its implementation possible. In this case, going beyond linear policy and technology management implied stepping aside from 'best way' or 'right device' approaches towards more relativist ones, seeking to build the socio-technical adequacy of the technology through problem-solving dynamics. It also implied developing an inclusive development strategy that, instead of *departing* from a technology, *arrived* to one: through interactive problem-solving (seeking for the convergence of heterogeneous interests), through knowledge negotiation between heterogeneous expertise (enhancing local capacities), through the expansion of local techno-productive systems, and through the

promotion of participative arrangements (empowering actors and their decision-making capacities).

Notes

1. Some of the most prominent are the creation of a Program for Social Actors' Demand within the Ministry of Science and Technology, specific funding lines for technologies for social inclusion and social development projects, and the inclusion of Social Development as a strategic sector in the National Science, Technology and Innovation Plan (MINCYT 2012), among others.
2. Tucuman Province is located in Northwest Argentina. With a territory of 22.524 km² and a population of 1.5 million habitants, it has the smallest surface and the second highest population density in the country.
3. A strain is a phenotypic variant of a species usually clonally propagated due to the interest in the conservation of its defining properties. The CERELA currently holds the largest collection of lactobacillus strains in Latin America.
4. The Alimentary Programme 'Copa de Leche', passed by the Legislature of Tucuman with Law No. 7022, stipulated the distribution of milk in schools in the Province every morning and the local origin of the provided milk.
5. Whey is a byproduct of dairy production of high protein value but highly contaminating when is discarded. Drying techniques allow transforming a waste into proteins with high nutritional value with productive use in the dairy industry.
6. After the crisis of the dairy sector in 2001, and due to the scarce industrial dairy capacity in the Province, the producers that remained on activity delivered their production to large milk broker companies outside the Province. Even when that solution implied a price decrease of Tucuman milk production due to shipping costs, it gave the farmers a certain income stability and predictability.

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