Agricultural Systems 216 (2024) 103880

Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

# The unpacking and repacking of agricultural innovation: Embrapa's translation roles and positions in the introduction of the pyramid model and hybrid pigs in Brazil

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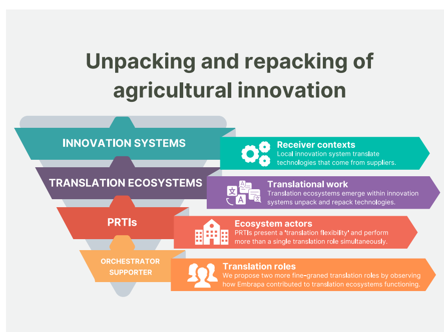
## HIGHLIGHTS

- Innovations go through translational processes when going to scale.
- This study unravels how research institutes deal with global flows of knowledge.
- Analysis of translational roles played by Embrapa in unpacking and repacking innovation.
- Translation processes unfold through translation ecosystems.
- Research institutes perform translation roles as supporter and orchestrator.

## GRAPHICAL ABSTRACT




## ARTICLE INFO

*Keywords:*
Agricultural innovation systems
Public research and technology institutions
Technology transfer
Scaling of innovations
Translation
Unpacking-repacking
Brazilian pig production

## ABSTRACT

*Context:* The notion of simply transfering agricultural innovation from suppliers to receivers as a strategy to improve agri-food systems globally has been strongly criticized and has raised debates in the field of agricultural technology development and innovation. Previous studies have shown that there is translational work to be done within agricultural innovation systems when technologies travel from one context to another, and they have also increasingly focused on how public research and technology institutions (PRTIs) participate in such efforts. However, previous literature has not sharpened such translation roles played by PRTIs into local innovation systems to interpret and adapt foreign agricultural technologies.
*Objective:* This study aims to analyze translation roles played by Embrapa (a pivotal PRTI in Brazil) into the innovation system linked to Brazilian pig production. It analyses how Embrapa took part in the decontextualization and recontextualization of the pyramid model and hybrid pigs in the Brazilian setting.
*Methods:* This study applies a qualitative research approach based on a case study method. Its primary data sources are 21 in-depth interviews with key actors involved with Brazilian pig production. Furthermore,

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https://doi.org/10.1016/j.agsy.2024.103880
Received 24 August 2023; Received in revised form 11 January 2024; Accepted 23 January 2024
Available online 8 February 2024

interviewee's content was triangulated with secondary data and interpreted using our conceptual understanding as an analytical lens.
*Results and conclusions:* Our findings add to theory on agricultural technology development and innovation systems in threefold way: 1) we show that PRTIs get involved in what we dub 'translation ecosystems' when helping to interpret and adapt imported innovations; 2) we uncover that PRTIs may present a 'translation flexibility' and perform more than a single translation role simultaneously within translation ecosystems; and 3) we propose more fine-grained translation roles (orchestrator and supporter) by observing how Embrapa contributed to translation ecosystems functioning.
*Significance:* This study enhances previous knowledge on how PRTIs can better deal with global flows of knowledge and traveling of innovation. It also evidences that PRTIs should be highly regarded in terms of how to approach imported innovations in terms of scaling readiness as they can perform pivotal functions to assist actors who may become marginalized by innovations from abroad, by providing options that suit local contexts.

## 1. Introduction

The notion of merely transferring agricultural innovation (i.e., scientific knowledge turned into concrete technologies, methods, or concepts) from 'supplier contexts' to 'receiver contexts' as a strategy to improve agri-food systems globally has been sharply criticized and raised several debates in the field of agricultural technology development and innovation since the 1980s (Jansen, 2004; Adolwa et al., 2017; Barnard and Chaminade, 2017; Binz and Truffer, 2017; Glover et al., 2019; Alexander et al., 2020). Scholars have used examples such as drip irrigation, which did not take off in many sub-Saharan African countries, to argue that innovations need to be interpreted and adapted by a cohesive and supportive local network when they move away from the context in which they were conceived (Evenson and Gollin, 2003; Basu and Leeuwis, 2012; Garb and Friedlander, 2014; Higgins et al., 2017; Harwood, 2018; Valerio et al., 2022).

Previous literature in Science and Technology Studies (STS) and agricultural innovation studies, has shed light on this issue by drawing on an emerging cluster of thinking about technologies-in-context (Jansen and Vellema, 2011; Venot et al., 2014; Ingram et al., 2018; Faure et al., 2019; Naouri et al., 2020; Ingram and Maye, 2020; Torres-Avila et al., 2022). Drawing upon on translation theory, these studies emphasized that innovations go through translation processes when they travel (Glover et al., 2017; Ingram et al., 2018). In such processes, innovations are decontextualized (abstracting the technology or practice from the context in which it originated) and recontextualized (turning the innovation into action in the receiving context) (Sahlin and Wedlin, 2017; Westney and Piekkari, 2020). Previous studies have applied 'translation tools', such as the disembedding and re-embedding concept (Czarniawska and Joerges, 1996) and the unpacking and repacking concept (Jansen, 2004; Stone and Glover, 2016). The latter concept is employed in this article to operationalize analysis focused on understanding decontextualizing and recontextualizing of imported innovations through translation (see further in Section 2).

In practice, translation processes are about tailoring innovations to meet specific local needs and about developing local innovation networks that can support the adopted innovation and help to reshape receiver contexts to some extent so that these become conducive for uptake of the innovation (Garb and Friedlander, 2014; Naouri et al., 2020; Eastwood et al., 2017; Klerkx et al., 2017; Schut et al., 2020). Extant work has also paid attention to who contributes to translation processes related to innovations that flow from suppliers to receivers. There are different actors involved in the translation of innovation – e.g., research institutions, non-governmental organizations, researchers, and consultants. Research efforts have increasingly focused on how particularly public research and technology institutions (such as universities, technology institutes, and advisory services) participate in translation processes of knowledge, technologies, methodologies, and international food governance regimes in receiver contexts (Biscola et al., 2017; Friederichsen et al., 2013; Kruss, 2019; Sheth et al., 2019; Lazaro-Mojica and Fernandez, 2021; Stræte et al., 2022).

Public research and technology institutions (henceforth PRTIs) are key actors in the agricultural innovation system involved in the translation of innovations and therefore often get the label of 'intermediaries' in agricultural innovation processes (Spoelstra, 2013; Dutrénit et al., 2012; Ingram et al., 2018; Iyabano et al., 2021; Turner et al., 2023). They are described as such because, commonly, PRTIs intermediate the building of interfaces and skills needed to interpret and adapt suppliers' innovations in local contexts. For instance, previous literature underlines that PRTIs articulate technical cooperation between suppliers and receivers, deploy among receivers the skills to handle knowledge and technologies from suppliers, translate and interpret knowledge made available by suppliers, and allow stronger connections between suppliers and receivers (Nelson, 2007; Spielman et al., 2010; Klerkx and Guimón, 2017; Iyabano et al., 2021).

Although previous studies provide valuable information, there is still room for further clarifications on how PRTIs take part in the translation of innovation in receiver contexts (Furtado et al., 2011; Iizuka and Gebreeyesus, 2016; Goyal and Nash, 2017; Reardon et al., 2019). We underline particularly one point that needs further investigation: previous literature has not sharpened the translation roles played by PRTIs to interpret and adapt innovations coming from supplier contexts to receiver contexts. This is the debate to which this study aims to contribute by looking at the transition from pork lard to lean meat, a socio-technical transformative process that relied on innovation coming from supplier contexts to change how pig genetics developed in Brazil in the last decades.

Bringing innovation from supplier contexts has been a common development strategy employed by Brazilian pig production, the world's fourth-largest producer and exporter (Talamini and dos Santos, 2017). In the case of the transition from pork lard to lean meat, the decontextualization and recontextualization of two innovations were pivotal: 1) the pyramid model, concept that changed pig genetic improvement programmes worldwide and came to Brazil in the early 1980s; and 2) hybrid pigs (boars and gilts), which were introduced in the Brazilian context in the early 1990s. Different actors worked to move these models and technologies from where they were conceived (Europe and the United States), and to fitting them into the Brazilian pig production context. One of the PRTIs involved was the Brazilian Agricultural Research Corporation (henceforth Embrapa). Since the mid-1970s, Embrapa has been the leading public research and technology institution linked to pig production. It contributed to evolving pig production sector by decontextualizing and recontextualizing imported innovation (Souza et al., 2011; Talamini et al., 2014). Embrapa is also one of the most relevant PRTIs worldwide specializing in tropical agriculture (Nehring, 2016; Schmidt, 2017).

Applying a qualitative research approach based on a case study method, we looked at Embrapa's roles in the transition from pork lard to lean meat by asking the following question: Which translation roles did Embrapa play to decontextualize and recontextualize the pyramid model and hybrid pigs in the Brazilian pig production? Answering this question is timely as it enhances previous knowledge on how PRTIs can better deal with the global flows of knowledge and traveling of innovation. Besides, it is pivotal to tackling current and long-term complex challenges that pressure agri-food systems worldwide, such as climate change and unsustainable agricultural practices (Kang, 2019; Nelson and Tallontire, 2014; Sharif and Baark, 2011; Thornton et al., 2017; Boillat et al., 2022), and contributes to current debates on the scaling of innovations (Sartas et al., 2020; Schut et al., 2020) and the roles of agricultural research organizations therein.

The remainder of the paper is structured in six sections. The conceptual approach is explained in Section 2. Section 3 presents the methodology for applying the conceptual approach in the Brazilian pig production case. Section 4 presents the findings of the case study. Section 5 presents the analysis, a discussion, and lessons learned from the Brazilian case, and conclusions are drawn in Section 6.

## 2. Conceptual framework: translation through unpacking and repacking

As indicated in the introduction, decontextualization and recontextualization are central concerns for STS and agricultural innovation studies focused on unraveling technologies-in-context (Jansen and Vellema, 2011; Naouri et al., 2020; Ingram and Maye, 2020; Chowdhury, 2020). To operationalize such analysis of technologies-in-context, authors have applied different concepts derived from the sociology of translation, as elaborated by Michel Callon (1986) in his article about scallop fishing in Northern France. Examples of such concepts are the disembedding-re-embedding lenses, developed by the Scandinavian translation studies stream (Czarniawska and Joerges, 1996; Wedlin and Sahlin, 2017), and the unpacking-repacking assumption, originated from studies focused on knowledge in development (Jansen, 2004; Stone and Glover, 2016). In turn, the sociology of translation belongs within the broader theoretical framework of actor-network theory (ANT) (Latour, 1986), which became popular in analyzing rural development processes in the last decades (Chen and Knierim, 2020; Massey et al., 2021; Castella et al., 2022).

For the purposes of this paper, it seems appropriate to look at the decontextualization and recontextualization of agricultural innovations through the unpacking-repacking lenses. Authors focused on how agricultural innovations acquire site-specific configurations when they move between places have often applied this theoretical tool (Jansen, 2004; Maat and Glover, 2012; Orr, 2018). The unpacking-repacking concept implies that the 'same' innovation will be different when, and because, it leaves its supplier context and is embedded in a receiver context (Marfo, 2004; Dowd-Uribe, 2014). Innovations emerge from particular networks of people and groups interacting with local material resources and biophysical conditions. It means that innovations will go through unavoidably a sort of translation when those networks and conditions change (Glover et al., 2017; Constance and Moseley, 2018).

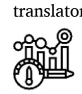
Unpacking and repacking are interlinked steps of the same translation process. The unpacking step means achieving a comprehensive view of innovations that come from abroad, translating their technical, social-organizational, economic, and biophysical features (Jansen, 2004; Wigboldus and Brouwers, 2016). Unpacking often demands practical actions such as establishing international research agreements or capacity-building strategies with supplier contexts (Stone and Glover, 2016). In turn, the repacking step comprehends the ability to adjust innovations to technical, social-organizational, economic, and biophysical characteristics of receiver contexts (Glover et al., 2017). Repacking also requires adapting the local context to innovations coming from suppliers (Berger and Hofer, 2011; Hornum and Bolwig, 2021). Thus, the repacking step can go through an array of actions to provide adjustments in innovations and local settings – e.g., the building of innovation networks, new regulations, new structures, the introduction of development projects focused on fostering an imported production model, and the implementation of educational programs (Stone and Glover, 2016).

Additionally, the unpacking-repacking steps are frequently operated by more than an isolated actor (Dutrénit and Vera-Cruz, 2018; Hainzelin et al., 2016). Every translation of innovation at stake presents particular demands. It also fosters specific interactions between actors – whether institutions or individuals, often played out within a network with some degree of structuration (Dowd-Uribe, 2014). Such interactions may result in synergies between institutions and individuals, although they also provoke struggles and overlaps somehow (Glover et al., 2016). Actors who take part in the unpacking-repacking steps of agricultural innovations vary from research institutions, advisory services, non-governmental organizations, and suppliers to consultants, brokers, policy makers, scientists, and farmers (Garb and Friedlander, 2014; Glover et al., 2016; Ingram et al., 2018).

As already underlined, PRTIs involved in the translation of innovations intermediate the building of interfaces and skills needed to decontextualize and recontextualize what comes from abroad. In doing so, they fill duties that unfold in practice as 'translation roles.' They form part of what has been referred to as an 'ecology' or 'ecosystem' of intermediaries that operates on interfaces in the broader agricultural innovation system, fulfilling connecting and translating roles (Kivimaa et al., 2019). Drawing upon previous literature, this study infers that PRTIs often play five translation roles while taking part in the unpacking-repacking steps: knowledge translator, capacity-building, cooperation-building, regulation-building, and technology broker (see Table 1). The knowledge translator role relates to how PRTIs interpret knowledge made available by suppliers. They perform this role by capacitating their researchers abroad, making international research partnerships, promoting scientific events, publishing scientific articles, and offering consultancy services (Intarakumnerd and Chaoroenporn, 2013; Klerkx and Guimón, 2017; Prabhakar et al., 2019).

The capacity-building translator role relates to the work played by PRTIs to deploy to receivers the skills to handle knowledge and technologies from suppliers. They exert this role by offering training and education actions linked to imported innovation in the local context, such as theoretical and practical courses (via Internet or face-to-face), educational materials (books, guides, videos, leaflets), and advisory services (Biscola et al., 2017; Spielman et al., 2010). In turn, the cooperation-building role articulates networks of institutions and individuals that will allow communication and shared actions between

**Table 1**
PRTIs' roles related to innovation translation processes.

| Translation role | What is it about? | Translation actions |
|---|---|---|
| Knowledge translator  | Translating content from suppliers to receivers | Research partnerships, scientific events and publications, consultancy services |
| Capacity-building translator  | Training and education in the local context | Practical courses, educational materials, advisory services |
| Cooperation-building  | Articulating networks, communication, and collaboration | Research agreements, public-private partnerships, bilateral cooperation |
| Regulation-building  | Learning, interpreting, and implementing regulations | Consultancy and certification services, international standards, capacity building |
| Technology broker  | Local development of solutions based on imported innovation | Research and experimentation, partnerships, and consultancy services |

suppliers and receivers and among local institutions and individuals. PRTIs function as cooperation-building when they enable tools such as international research agreements and public-private partnerships to foster technological transformation in receiver contexts (Poncet et al., 2010; Ramirez et al., 2018; Dicecca et al., 2016).

The regulation-building role refers to PRTIs contributions to implement international certification regimes. In so doing, they carry out international standards implementation studies, consultancy services, certification services, and international standards capacity building actions (Giessen et al., 2016; Maciel et al., 2015). Finally, the technology broker role relates to the relationship between PRTIs and the private sector in developing local technological solutions adapted from imported innovation (Ekboir and Parellada, 2002; Figueiredo, 2016b; Klerkx and Guimón, 2017). PRTIs, when playing this translation role, develop research and experimentation actions, establish local partnerships to adapt foreign technologies, offer consultancy services, and carry out market studies. We now explain the research methods and, hereafter, we will analyze how Embrapa contributed to decontextualize and recontextualize the pyramid model and the hybrid pigs technology in Brazilian pig production through unpacking-repacking steps.

## 3. Methodology

This study's primary data sources are 21 in-depth interviews with key actors involved with Brazilian pig production. They are representatives of varied interests, such as industries, producers, pig genetic companies, non-governmental organizations, science institutions, and advisory services (see Appendix 1 for details on who the representatives are, and which positions they have in their organizations). We relied on previous knowledge about Brazilian pig production and additional information on publications and websites of industries, associations, public organizations, non-governmental organizations, and science institutions to reach a list of 15 interviewees. We also applied the snowballing method (Kumar, 2011), and from the initial round of interviews, we added six extra influential interviewees. The 21 in-depth interviews also represented regions in which pig production concentrates in Brasil proportionally. Most of the interviewees are from Rio Grande do Sul, Santa Catarina, and Paraná states, which accounts for more than 70% of the Brazilian pork meat production (ABPA, 2022).

The interviews, conducted between July and December 2017 and March and April 2019, lasted between half an hour and two hours and were tape-recorded and transcribed verbatim. Nine of 21 interviews occurred by phone due to the impossibility of setting an in-person appointment. They were recorded in a professional audio studio in Concórdia, Santa Catarina state. All the interviews followed a guide based on our literature review on pig genetic standards change in Brazil from the 1970s to the early 2000s. We focused on two main issues while approaching interviewees. First, the search for in-depth information on pig genetic trajectory in the Brazilian pig production. Second, Embrapa's contributions to decontextualizing and recontextualizing the pyramid model and hybrid pigs. We also collected core and additional secondary data. The core secondary data consisted of books, scientific papers, and policy briefs (see Appendix 2). In turn, additional secondary data came from official public reports and media articles published in newspapers and magazines.

The interview content was interpreted in a twofold way: 1) from a historical perspective, connecting the storyline told by interviewees in a single trajectory of the deployment of the pyramid model and the hybrid pigs in Brazilian pig production; 2) from an innovation translation perspective, looking at the translation roles played by Embrapa in the implementation of the pyramid model and hybrid pigs in Brazilian pig production. As suggested by Olsen (Olsen, 2004) and often applied in previous STS and agricultural innovation studies (Agogué et al., 2017; Vilas-Boas et al., 2022; Ankrah and Freeman, 2022), we triangulated the interview content with secondary data. This way, we could sharpen our understanding of Embrapa's contributions. The interview content and secondary data were also interpreted using our conceptual understanding as an analytical lens.

In terms of possible biases, as regards internal validity, the findings are based on respondents with a helicopter view (usually CEO or senior consultants), hence able to provide a broad perspective of the transition from pork lard to lean meat and also about Embrapa's role in it. Moreover, the first author of this study has worked for Embrapa and headed socio-technical development projects in Brazilian pig production since 2000. This previous experience somehow reflects on study design and data interpretation. Thus, we critically self-reflected on our preconceptions, relationship dynamics, and analytic focus, following hints from previous work related to 'researcher bias' (Chenail, 2011; Galdas, 2017; Morse et al., 2002). Additionally, a researcher specialized in pig genetics issues in the Brazilian context reviewed and validated our findings.

## 4. Findings

This section discusses how Embrapa contributed to decontextualizing and recontextualizing the pyramid model and hybrid pigs in Brazilian pig production. In this section, we will present: 1) how the transformation from pork lard to lean meat took place in Brazil; 2) how the pyramid model was unpacked and repacked; 3) how hybrid pigs were unpacked and repacked; 4) which roles Embrapa played in both translation processes; and how roles played by Embrapa unfolded from a systemic point of view.

### 4.1. From pork lard to lean meat

Changes in the Brazilian economy and society, such as the popularization of domestic refrigerators and vegetable oils, influenced pig production to look in a new direction in the mid-1960s (Brabo et al., 2015; Brito, 2006). Gradually, pork lard ceased to be the pig market-leading product in Brazil and gave room for processed products aimed at urban fast-food consumption – e.g., sausages and ham (Spies, 2003). Since then, Brazilian pig production started turning to the increasing of lean meat availability, which is essential for this sort of market purpose (Souza et al., 2011). Pork lard replacement by lean meat in terms of market focus provoked varied shifts in Brazilian pig production. As expected, one related to pig genetics practices and technologies (ABCS, 2014).

Pig genetics went from a semi-professional setting (headed by pedigree farms up to the 1980s) to an industrial basis (dominated by pig industries and private genetic companies from the 1990s to date) in Brazil – see in Fig. 1 significant differences between previous and current pig genetics setting in Brazil. In this transformative process, two imported technologies played a decisive role: 1) the pyramid model implementation in the 1980s; and 2) the development of hybrid pigs in the mid-1990s. Embrapa took part in both translation processes.

### 4.2. Unpacking and repacking the pyramid model in the Brazilian context

The pyramid model was developed in the United Kingdom in the 1960s and adopted worldwide from the 1970s (Knox, 2016). Broadly, it structures pig genetic improvement programmes in three slices in the form of a pyramid (Brassley, 2007). At the top slice is the nucleus herd, where the genetic improvement of purebred pigs takes place through an intensive selection of economically essential characteristics. In the middle slice is the multiplier herd, which focus on boars and gilts[1] production to supply producers that provide the slaughtering animals.

[1] Boars are male pigs used for breeding after reaching the age of six months typically. In its turn, gilts are female pigs that has not produced a litter of piglets yet. Both are directed to farms focused on providing raw material used by the pork meat industry (Brassley, 2007).

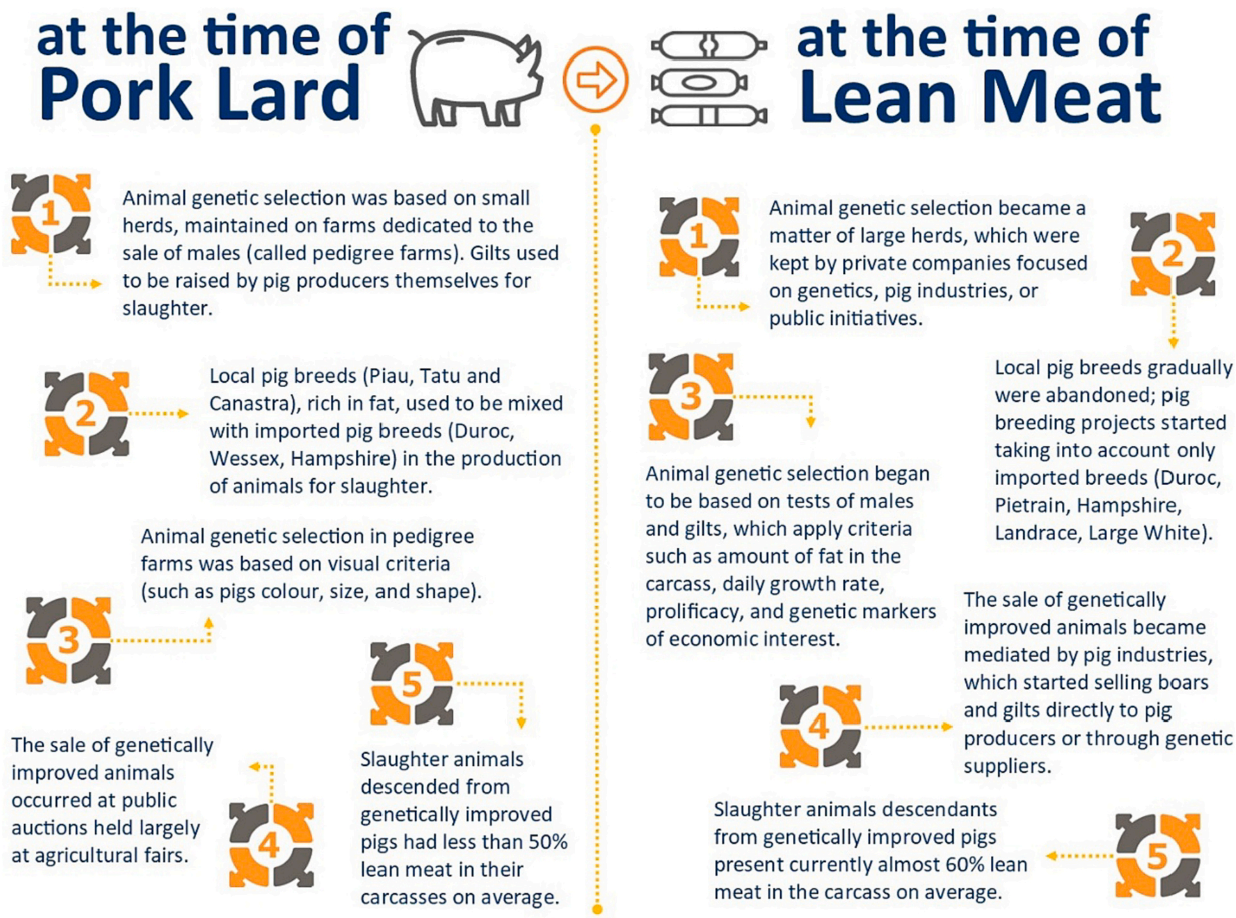



**Fig. 1.** Major differences between Brazil's pig genetics linked to pork lard and lean meat – based on researchers' own data, ABCS (2014), and Fávero et al. (2011).

At the base of the pyramid is the so-called large commercial herd, composed of animals that descend from improved pigs of upper slices and are bred by pig producers to provide the raw material for pig industries (Harris, 2000).

The pyramid model focuses on selecting pigs genetically in the nucleus herd by employing measurable testing criteria (see item three of Fig. 1) to identify the carriers of the searched genes and then scatter them within the commercial herd to reach market objectives (Knox, 2016). The lack of a model such as the pyramid used to be the major weakness of the Brazilian pig genetic structure based on pedigree farms when lean meat became the focus. Pedigree farms had small herds and could refine pig characteristics following visual criteria at the time (see item three of Fig. 1), a method that provided little genetic progress in the traits of interest (Fávero et al., 2011). In the late 1970s, pig industries, producer associations, research institutions, universities, consultants, producers, and state and federal governments strengthened their ties to bring from Europe a new pig genetic structure (Sebrae and ABCS, 2016).

As a result, organizations and individuals started collaborating to deploy the pyramid model in the Brazilian context. According to our fieldwork interviews, Embrapa was, at the time, the primary reference to agricultural research and innovation in Brazil. Its unit specialized in pig research was created in 1975, and the genetic improvement research group was one of the first teams set up at Embrapa. Therefore, in the early 1980s, Embrapa became a central actor in the innovation network (composed of producers' associations, local and state public organs linked to agriculture, public universities, researchers, consultants, and pig industries) to adapt the pyramid model. It exerted technical and organizational leadership, guiding how the innovation network built up adjustments in the pyramid model and the local context through unpacking and repacking steps (see Embrapa's contributions in unpacking and repacking steps in Table 2).

Notably, Embrapa worked to recontextualize the pyramid model by keeping the importance of pedigree farms. It attempted to reconfigure the Brazilian pig genetics structure by deploying pig breeding projects in the five biggest Brazilian producer states (Santa Catarina, Rio Grande do Sul, Paraná, São Paulo, and Minas Gerais) between 1980 and 1990. They were called pig breeding state programmes and took place in partnership with producer associations, state governments, and the federal government. Those state programmes aimed to implement the pyramid model in each state territory, connecting pig herds as the following: 1) some pedigree farms (better organized and technologically more capable) composed the nucleus herd, applying testing and crossbreeding methods to put into practice an intensive genetic selection in purebred pigs; 2) other pedigree farms assumed the multiplier herd, becoming responsible for the production of boars and gilts genetically improved to slaughter producers; and 3) the commercial herd was established in the farms that got pigs genetically improved from the pyramid upper slices, produced piglets, fattened them, and then sold adult animals to slaughterhouses.

However, state pig breeding programs achieved the expected results just to a certain extent. The following quote illustrates why the pyramid model implementation through pig breeding state programmes succeed partially:

> Unfortunately, despite all efforts made by producer associations, Embrapa, and other public organs, it was not possible to organize the two upper slices of the pyramid efficiently. Pedigree farms had to collaborate truly to put into practice the intensive selection of economically important characteristics. Cultural, technological, and organizational differences between pedigree farms and the lack of

**Table 2**
The pyramid model translation process in Brazil and Embrapa's contributions – based on researchers' own data and Fávero and Figueiredo (2015).

| Steps in translation | |
|---|---|
| *Unpacking step: the view on the pyramid model in Brazil* | |
| Technical | • Production model based on complementary slices, in which pigs go through intensive characteristics selection. |
| Social-organizational | • High-specialized private sector composed of pig genetic producers and thecnicians capable of applying scientific methods. |
| Economic | • Large-scale production guided by market objectives. |
| Biophysical | • Spatially concentrated in pig breeding facilities, specific pig handling, and the introduction of pig breeds according to market objectives. |
| Embrapa's contributions | • Embrapa sent researchers abroad to learn pig genetic intensive selection procedures. |
| *Repacking step: adaptative innovation and local context adjustments* | |
| Technical | • The pyramid model kept its technical aspects when implemented in Brazil. |
| Social-organizational | • At first, a public-private partnership to implement pig breeding programmes in five Brazilian state producers. Later and in parallel, industries and genetics companies started private pig breeding projects. |
| Economic | • Large-scale production guided by a public-private partnership, at first, to fill market objectives. Later, agreements between pig genetic companies and pig industries replaced the public-private partnership. |
| Biophysical | • Spatially spread in five different Brazilian states; pig breeds adapted to the Brazilian climate; later, pig genetics became spatially concentrated in facilities of private companies. |
| Embrapa's contributions | • Embrapa learned and interpreted how to apply the pyramid model in Brazil; researched the different pig breeds used in Brazil at the time; and developed services (Pig Information System - SIS-Suínos). |

knowledge on how to work cooperatively undermined pig breeding state programmes as time went by. (A former Embrapa's pig genetic improvement researcher).

According to fieldwork interviews,from state pig breeding programs weaknesses emerged actions headed by pig industries (such as Sadia and Seara) and pig genetics companies (such as Agroceres PIC) that made up an alternative innovation network, which structured parallel private pig breeding projects based on the pyramid model from the mid-1980s. They configured a second effort to recontextualize the pyramid model in Brazil, although they did not struggle or overlap the state pig breeding programmes initially. On the contrary, Embrapa took part in that parallel network by providing information services on pig genetics. As pig industries and pig genetic companies could successfully deliver what Brazilian pig production demanded at the time, nucleus herds and multiplier herds ended up practically restricted to them, forcing the vast majority of pedigree farms to focus on commercial herds or to leave pig production (Fávero and Figueiredo, 2015). In turn, Embrapa kept its research agenda linked to pig breeding, although not attached to state programmes anymore. Besides that, it carried on providing services such as the Pig Information System (SIS-Suínos) and scientific support to adapt genetic selection procedures to the Brazilian context, which proved essential to consolidating private breeding projects and research programs in general (Fávero et al., 2011).

### *4.3. Hybrid pigs: the unpacking-repacking steps through the 1990s*

In the early 1990s, after the consolidation of the local pig genetic structure based on the pyramid model, actors began to focus on embedding imported technologies that could enhance even more the availability of lean meat. This led to the development of crossbred pigs, replicating in the Brazilian context a technology developed in Europe and the United States in the 1980s (Fávero and Figueiredo, 2015). Crossbred pigs are animals from different breeds intentionally crossed to emphasize pursued characteristics. They have some advantages over purebred pigs because of a genetic phenomenon called heterosis, also known as hybrid vigor (ABCS, 2014). Heterosis gives crossbred pigs an improvement over the average of their parent purebreds in a chosen trait – e.g., lower level of carcass fat (Knol et al., 2016).

Furthermore, an organizational shift also influenced the embedding of crossbred pigs in the Brazilian context. In the early 1990s, most of the pig industries started paying a reward for pig producers according to carcass characteristics – i.e., after slaughter, each pig had its thickness fat and other items related to lean meat measured, which could mean an increase in the amount paid if the carcass presented the required features (Sebrae and ABCS, 2016). Linking part of the producers' remuneration to carcass characteristics caused a massive demand for boars and gilts genetically selected to produce more lean meat, which encouraged actors to invest heavily in crossbred pigs (Guimarães et al., 2017). In Brazil, these kinds of pigs became known as ‘hybrid pigs’. Often, they were developed by hybridizing three of these five different breeds: Large White, Landrace, Duroc, Pietrain, and Hampshire – all of them came from abroad and became adapted to Brazilian biophyisical conditions at the time (Fávero et al., 2011).

According to the narratives from the interviews collected in our fieldwork, the hybrid pigs' translation process relied on pig industries' leadership (Table 3 presents an in-depth description of the unpacking-repacking steps of hybrid pigs in Brazil). At the time, pig industries looked at how to deepen their control over the whole pork meat production process, which took them to broaden their actions related to pig genetics. This drove the pig industries to follow two directions. The biggest ones preferred to develop their own exclusive hybrid pigs, building up boars and gilts attached to their market interests. Others, which did not have enough financial resources to make it, established agreements with pig genetic companies and got non-exclusive hybrid boars and gilts. Nonetheless, both approaches reached similar results in the Brazilian context, playing a part in increasing pork lean meat

**Table 3**
The hybrid pigs translation process in the Brazilian context and contributions made by Embrapa – based on researchers' own data, Fávero et al. (2011), and Figueiredo (2016a).

| Steps in translation | |
|---|---|
| *Unpacking step: the view on hybrid pigs in Brazil* | |
| Technical | • Manipulation of different breeds crossing to reduce carcass fat and improve lean meat availability. |
| Social-organizational | • High-specialized sector marked by interactions between researchers and technicians from private pig genetic companies. |
| Economic | • Technology aimed to underpin large-scale pork meat production. |
| Biophysical | • Crossbred pigs, specific pig handling according to crossbreeding objectives, and intensive natural resources usage. |
| Embrapa's contributions | • Embrapa provided information about foreign pig breeds adapted to the Brazilian conditions. It also built a ‘public view’ of hybrid pigs. |
| *Repacking step: adaptative innovation and local context adjustments* | |
| Technical | • Hybrig pigs developed in Brazil combined the foreign breeds better adapted to the Brazilian climate. |
| Social-organizational | • Hybrid pigs were repacked in the Brazilian context through pig breeding programmes drove by large pig industries or for private genetic companies associated to regional pig industries. |
| Economic | • Technology aimed to underpin large-scale pork meat production and the improvement of lean meat availability. |
| Biophysical | • Crossbred pigs adapted to local climate, specific pig handling, and intensive natural resources usage. |
| Embrapa's contributions | • Embrapa provided data about imported breeds adapted to the Brazilian context and toot part in experiments to adjust genetic selection methods; developed a hybrid boar (called MS 58) in partnership with Aurora, which became a market cheaper option. |

availability, sharpening pig genetic improvement process, and boosting the pork meat production coordination.

Embrapa helped pig industries and pig genetic companies to develop hybrid pigs by providing data about imported breeds adapted to the Brazilian context and taking part in experiments to adjust genetic selection methods. However, it also had the technical capacity and interest in developing hybrid pigs in the 1990s. It aimed to provide an alternative product, which would represent a cheaper option for producers neither associated with pig industries nor willing to pay what pig genetic companies charged for improved boars and gilts (see Embrapa's contributions to unpack and repack hybrid pigs in Table 3). Therein, Embrapa established an agreement with Aurora, a central cooperative and the fourth biggest pig industry in Brazil at the time, to build a hybrid boar focused on high carcass lean meat performance (the partnership between Embrapa and Aurora did not include the development of a hybrid gilt). Despite originating from an associated initiative to Aurora, Embrapa's hybrid pig, called MS 58, also became available for all Brazilian pig producers, as Embrapa used it as part of a public policy to disseminate crossbred boars at the time. Accordingly, Embrapa always applied a strategy of selling its hybrid pig for a lower price than that charged by private genetic companies in the Brazilian market. The two following quotes illustrate Embrapa's contribution to embedding hybrid pigs in the Brazilian context:

> Embrapa and Aurora adjusted an imported technology to a specific segment of Brazilian pig production in the 1990s. If Embrapa and Aurora had not worked to develop the MS 58, small cooperatives, local and regional pig industries, and independent pig producers would take much longer to acquire a hybrid pig that would give their offspring the capacity of producing more lean meat. (A pig industry executive).

> In the late 1980s, we had studies anticipating that the payment of a reward according to specific carcass characteristics would become a standard. We knew that there would be a demand for genetic material capable of meeting the interests of industries and producers. Thus, we focused our pig genetic research programme on developing hybrid pigs. At the end of the 1990s, we carried out an analysis and concluded that, per year, the segment benefited by MS 58 earned 3.2 million dollars more than it would have if it did not access a crossbred pig. Then, I guess what we did at the time was important for at least a specific sector of the Brazilian pig production. (A former Embrapa's pig genetic improvement researcher).

Embrapa launched three more hybrid pigs to date: MS 60 (in 2000, another partnership with Aurora), MS 115 (2008), and MO25C (in 2014, the first gilt developed within Embrapa's pig breeding programme). All of them updated imported knowledge on pig genetics improvement to keep a cheaper option in the Brazilian market for small cooperatives, local and regional pig industries, and independent pig producers (not associated with pig industries), reinforcing Embrapa's strategy of developing alternative hybrid pigs. In recent years, Embrapa also assumed a new position in the translation of imported innovation linked to pig genetics. It has taken part since 2010 in a partnership with BRF (the biggest pig industry in Brazil) to unpack and repack the pig genetic model based on genetic markers. Embrapa has used its structure to co-develop and validate a genomic selection process adjusted to the Brazilian context.

### 4.4. *Embrapa's translation roles in the unpacking-repacking steps of the pyramid model and hybrid pigs*

Embrapa played different roles to translate the pyramid model and hybrid pigs to the Brazilian context – Table 4 describes Embrapa's translation roles. One of these roles was cooperation-building. Embrapa supported cooperation when it facilitated communication and headed shared actions between producer associations, state governments, and the federal government to implement the pyramid model in the early 1980s through five pig breeding state programmes. Concerning hybrid pigs, Embrapa played a triple role. It performed as a cooperation-building entity by co-heading mobilization and communication actions that allowed the emergence of an alternative hybrid boar in the mid-1990s. Additionally, Embrapa also played roles as knowledge translator and technology broker in the unpacking-repacking steps related to hybrid pigs, as it developed boars and gilts adapted to the Brazilian context based on an imported innovation.

**Table 4**
Translation roles played by Embrapa to adjust the pyramid model and hybrid pigs.

| Roles played by Embrapa | What translation actions did Embrapa perform? | Imported innovation |
|---|---|---|
| Cooperation-building | • Learned the pyramid concept.<br>• Translated and adapted it in Brazil through five state pig breeding programmes. | The pyramid model |
| Knowledge Translator | • Provided information services and scientific support to genetic selection procedures. | |
| Capacity-building | • Capacitated pedigree farms to operationalize the pyramid model in the five pig breeding state programmes. | |
| Knowledge translator | • Provided data about imported breeds adapted to Brazil and took part in experiments to adjust genetic selection methods. | Hybrid pigs |
| Cooperation-building | • Mobilized partners and co-headed a parallel network to develop an alternative hybrid boar in the mid-1990s. | |
| Technology broker | • Developed an alternative hybrid boar (MS 58). | |

As demonstrated in Sections 4.2 and 4.3, Embrapa also operated as a knowledge translator to unpack and repack the pyramid model and hybrid pigs. In parallel to its efforts to implement the pig breeding state programmes, Embrapa participated in the network made up of pig industries and pig genetic companies to implement the pyramid model by providing translated scientific information and research services. Besides that, in the early 1990s, Embrapa collaborated with the network headed by pig industries and pig genetic companies to develop hybrid pigs. It transferred content translated from foreign databases on hybrid pigs (data about imported breeds and knowledge related to genetic selection methods). According to our fieldwork interviews, Embrapa performed steadily as a knowledge translator over time because this role is strongly linked to its original mission. The following quote illustrates it:

> The Brazilian government established Embrapa to support pig sector development. As imported innovations have always been very important for the growth of pig production in Brazil, Embrapa naturally assumed in the 1980s the role of being the main bridge between knowledge coming from other countries and the pig sector. Later, private companies came up and started also working with pig genetics and other topics related to pig production. We could not properly answer all demands presented to us at the time, what is expected given the several complex issues tackled to develop the pig sector in Brazil in recent decades. However, Embrapa's importance concerning this type of support is acknowledged to date. (A former Embrapa's pig genetic improvement researcher).

Embrapa also contributed to unpacking and repacking the pyramid model by performing the capacity-building role. It manifested when Embrapa worked to become pedigree farms capable of taking part in the pyramid model implementation in Brazil. Pedigree farms received training from Embrapa to operationalize the different herds (nucleus, multiplier, and commercial) needed to put the pyramid model into practice in the pig breeding state programmes. We did not find evidence that Embrapa played the regulation-building role in the unpacking-repacking steps related to the pyramid model and hybrid pigs.

Embrapa's contributions also can be grasped from networks built with some degree of structuration (Dowd-Uribe, 2014), in order to unpack and repack both imported innovations. Regarding the pyramid model, Embrapa steered the unpacking and repacking steps, mobilized other actors around its interpretation, and assumed multiple tasks (such as the translation of knowledge and practices related to the pyramid model, the adaptation of them to the Brazilian context, the development of the Pig Information System, and pedigree farms training) in the translation network set up in Brazil in the early 1980s. Embrapa also drove how actors translated hybrid pigs to a particular sector in Brazil in the mid-1990s and again assumed multiple tasks within that translation network (such as the translation of content, practices, and experimental tests related to hybrid pigs and breeds selection to Brazilian biophysical conditions).

Sections 4.2 and 4.3 also uncovered that there were occasions when Embrapa just backed translation networks related to the implementation of the pyramid model and hybrid pigs in the Brazilian context. For instance, Embrapa provided only knowledge services (such as the Pig Information System - SIS-Suínos) and scientific support (to adapt genetic selection procedures to the Brazilian context) to the parallel initiative (headed by pig industries and genetics companies) to implement the pyramid model in Brazil. Another example is how Embrapa helped pig industries and genetics companies to introduce hybrid pigs in Brazil in the early 1990s. It supplied that translation network only with specific services, such as data on the adaptation capacity of imported pig breeds to Brazilian biophysical conditions and scientific support to improve pig genetics selection methods.

## 5. Discussion

### 5.1. Roles within translation ecosystems linked to the unpacking-repacking steps

According to findings presented in Section 4.4, Embrapa played different translation roles (cooperation-building, knowledge translator, capacity-building, and technology broker) while taking part in the pyramid model and hybrid pigs' implementation in the Brazilian context. Thus, our findings confirm previous literature on STS and agricultural innovation studies concerning how PRTIs help to translate innovations that flow from suppliers to receivers (Nelson, 2007; Spielman et al., 2010; Klerkx and Guimón, 2017; Iyabano et al., 2021). However, this work also uncovers that translation roles related to PRTIs have to do with actions they play into the unpacking-repacking steps that innovations go through when traveling to receiver contexts. From this point of view, we sharpen the understanding of translation roles related to PRTIs by infering that they also take place within particular translation networks that emerge to make imported innovations adjusted into receiver contexts.

Previous literature underlines that the unpacking-repacking steps rely on more than a single institution or individual to unfold (Dutrénit and Vera-Cruz, 2018; Hainzelin et al., 2016). There are collective efforts related to the translation of innovations, which often play out within specific networks with some degree of structuration (Dowd-Uribe, 2014). Drawing upon intermediaries literature (Kivimaa et al., 2019) as well as social innovation literature, in which ecosystems are sets of interconnected actors whose collective actions produce a particular outcome in a local system (Mair and Martí, 2006; de Vasconcelos Gomes et al., 2018; Liu and Stephens, 2019; Terstriep et al., 2022), we argue that such specific networks are dedicated 'translation ecosystems' for imported innovations. In so doing, we grasp that translation roles played by PRTIs do not depend on just skills they develop to interpret and adapt imported innovation. They also relate to how PRTIs engage translation ecosystems and find a status within them to participate in collective actions turned to translate innovations.

As findings from Sections 4.2 to 4.4 show, Embrapa did not develop or focus on a single translation skill over time. It assumed different roles fitted to every translation ecosystem it took part in to unpack and repack the pyramid model and hybrid pigs in the Brazilian context. For instance, Embrapa was a central actor in the first attempt to adapt the pyramid model to Brazil. This position influenced the translation ecosystem associated with it, where Embrapa found room to perform as a cooperation-building, knowledge translator, and capacity-building in the construction of five pig breeding state programmes. On the other hand, industries and pig genetics companies led the pyramid model implementation through private pig breeding projects from the mid-1980s. Embrapa found room to perform just as a knowledge translator in the translation ecosystem associated with this second effort to unpack and repack the pyramid model in Brazil.

Hybrid pigs' implementation provoked a similar phenomenon. Embrapa contributed as a knowledge translator in the translation ecosystem related to hybrid pigs' adaptation headed by pig industries and pig genetics companies. Nonetheless, Embrapa also took part in the collective effort to unpack and repack hybrid pigs as a cheaper option for those who were neither associated with pig industries nor willing to pay what pig genetic companies charged for improved boars and gilts. It unfolded as a public-private partnership to make available a new technology for small cooperatives, local and regional pig industries, and independent pig producers in Brazil. From this initiative emerged a particular translation ecosystem, in which Embrapa assumed a different and broader status - i.e., it played roles as cooperation-building, knowledge translator, and technology broker in that translation ecosystem.

### 5.2. PRTIs translation roles: multiple, complementary, and coevolved

Embrapas' engagement in different 'translation ecosystems' related to the pyramid model and hybrid pigs' implementation also refines the understanding of translation roles related to PRTIs by demonstrating that they may play multiple roles in the same translation process. Previous literature emphasizes that translation processes rely on diverse actors to come through because they are about adapting imported innovations to local contexts and vice versa - i.e., they unfold as a too complex task for a single actor (Biscola et al., 2017; Friederichsen et al., 2013; Kruss, 2019; Sheth et al., 2019; Lazaro-Mojica and Fernandez, 2021). This study adds to extant work by uncovering that translation processes may also demand from actors that they will perform more than a single translation role simultaneously within different translation ecosystems.

Looking at Embrapa and its contributions to adapting the pyramid model and hybrid pigs, we infer that such translation flexibility fits PRTIs particularly. PRTIs such as Embrapa are set up to move between public and private interests (Souza et al., 2011; Goyal and Nash, 2017; Reardon et al., 2019; Turner et al., 2023). It means that PRTIs also tend to move between 'different translation interests' to fulfil public goals (such as inclusive development) and private needs (such as support for business growth). For example, Embrapa focused on business growth by performing as a knwoleged translator in the translation ecosystem associated with the second, and mostly private, effort to unpack and repack the pyramid model in Brazil. On the other hand, it fostered inclusion when it played translation roles in public-private partnerships to implement the pyramid model through pig breeding state programmes and offer a cheaper hybrid pig for cooperatives, small industries, and independent producers. In this sense, Embrapa contributed to making the agricultural innovation system more inclusive of different groups, and foster diversity in development pathways, which has been noted as important in recent work on agricultural innovation systems (Cholez et al., 2023; Kok and Klerkx, 2023).

Moreover, Embrapas' case helps to extend the comprehension of synergies, struggles, and overlaps experienced by PRTIs involved with translation processes (Glover et al., 2016; Glover et al., 2017), as it further sheds light on how translation roles take place in practice. We observed that Embrapas' roles played within the same 'translation ecosystem' unfolded synergically, complementing each other to some extent. For instance, Embrapa performed as a knowledge translator and cooperation-building in the ecosystem linked to adapting the pyramid model to Brazil through pig breeding state programmes. These roles, which allowed the pyramid model comprehension in Brazil and guided collaboration among institutions and individuals, legitimated Embrapas' performance as capacity-building in the same 'translation ecosystem' – i. e., Embrapa developed actions to become pedigree farms capable of operationalizing herds needed to put the pyramid model into practice in pig breeding state programmes.

Additionally, the different translation roles played by Embrapa, and the 'translation flexibility' capacity it was able to develop, also suggest that PRTIs translation skills coevolve with innovation dynamics in receiver contexts. Every translation of innovation at stake presents particular demands (Dowd-Uribe, 2014), which establishes innovation dynamics and fosters specific translation ecosystems. To some extent, Embrapa went through an evolutionary learning process by adapting its capabilities to each translation ecosystem emerged throughout the implementation of the pyramid model and hybrid pigs in the Brazilina setting. In practice, it meant that Embrapa grasped how to fluctuate from one translation role to another according to changes in innovation dynamics provoked by adapting its human and structural resources overtime (i.e., Embrapa provided data about imported breeds adapted to Brazil and took part in experiments to adjust genetic selection methods in the translation ecosystem headed by pig industries and genetics companies to developed hybrid pigs; it also mobilized researchers and structure to develop an alternative hybrid boar for for cooperatives, small industries, and independent producers). Such translation skills coevolution helped Embrapa to keep moving between public and private interests.

Findings did not provide evidence that the translation roles played by Embrapa presented struggles or overlaps between them. However, the translation ecosystems in which they unfolded to a certain degree represented divergent interests in comparison to other parallel translation efforts they were involved in. An example of this is the translation ecosystem linked to pig industries and genetic companies that translated hybrid pigs firstly to the Brazilian context and the 'translation ecosystem' where Embrapa performed as a technology broker to offer an alternative hybrid boar. Both did not defy one another directly but unfolded as parallel translation efforts with some degree of opposition and overlapping.

### 5.3. *Orchestrator and supporter: two main positions from Embrapa within translation ecosystems*

In connection with the insights presented in Section 5.1 and 5.2, we propose to refine the description of translation roles played by PRTIs in agricultural innovation processes by focusing on how they operate within translation ecosystems and what main position they take. We argue that higlighting such position taken further elucidates how PRTIs contribute to interpreting and adapting imported innovations, and is relevant in debates on scaling also (Sartas et al., 2020; Schut et al., 2020). We observed that Embrapa 1) played a role related to the ecosystems' governance, and 2) played a role related to the ecosystems' backing. Table 5 summarizes the refined translation roles, and we will now further discuss these.

According to findings in Section 4.4, Embrapa's translation efforts sometimes steered and sometimes backed the networks with some degree of structuration (which we argue in Section 5.1 to be seen as translation ecosystems), built to unpack and repack the pyramid model and hybrids pigs in the Brazilian context. When Embrapa influenced the translation ecosystem's governance, there was a clear engagement with what STS and innovation literature describes as orchestration actions (Batterink et al., 2010; Naouri et al., 2020; Torres-Avila et al., 2022).

**Table 5**
Main positions of Empbrapa in translation ecosystems related to the implementation of the pyramid model and hybrid pigs in Brazil.

| Translation ecosystem | Translation roles played by Embrapa | Main position taken in the translation ecosystem | What is about? |
|---|---|---|---|
| The pyramid model implementation in the early 1980s | • Knowledge and practices translation, Pig Information System development, pedigree farms training, five pig breeding state programmes. | Orchestrator | Steering the unpacking and repacking steps, mobilizing other actors, assuming multiple tasks. |
| Alternative hybrid pigs in the mid-1990s | • Knowledge and practices translation, experimental tests related to hybrid pigs, breeds selection to Brazilian biophysical conditions, development of an alternative boar (MS 58). | | |
| The alternative pyramid model implementation in the mid-1980s | • Knowledge translation (Pig Information System - SIS-Suínos) and scientific support (genetic selection procedures). | Supporter | Providing specific support for unpacking-repacking steps (knowledge, data, structures, testing, and experimentation). |
| Industry's hybrid pigs in the early 1990s | • Knowledge translation (data on the adaptation capacity of imported pig breeds to the Brazilian agroecological conditions) and scientific support (genetic selection procedures). | | |

This sort of engagement relates to actors who assume a set of activities aimed at the innovation networks development and functioning – i.e., finding aligments between members, resolving tensions that may arise, and facilitating resources and interactions (Venot et al., 2014). Thus, based on Embrapa's case, we suggest that when PRTIs influence translation ecosystems' governance, they take the position of an 'orchestrator'.

A different sort of engagement occurred when Embrapa acted to back the translation ecosystems related to unpacking and repacking the pyramid model and hybrid pigs. Embrapa performed what STS and innovation literature considers innovation support actions – i.e., availability of data, laboratories, testing, experimentation, certification, office space, and other services linked to providing general support for entrepreneurs (Venot et al., 2014; Ingram et al., 2018; Faure et al., 2019). Thus, we infer that when Embrapa acted to back translation ecosystems, it was taking on a 'supporter role'. The finding suggests that orchestration roles and backing roles are complementary, for example testing, certification and experimentation can support orchestration activities such as finding alignment and faciliting resources, as they provide evidence on effectiveness of imported innovations. Beyond playing these roles in translation ecosystems, PRTIs may fulfil them more broadly in agricultural innovation systems, also supporting other sorts of innovation and scaling processes following Spoelstra (2013) and Turner et al. (2023).

## 6. Conclusion

This study contributes to the literature in STS and agricultural innovation systems in particular, by sharpening the understanding of roles played by PRTIs in translation processes related to embedding in local contexts innovations conceived in other contexts. The analysis linked to the pyramid model and hybrid pig's introduction in the Brazilian context adds three insights to extant literature. First, we show that PRTIs get involved with translation ecosystems while helping to interpret and adapt imported innovations. Second, we uncover that PRTIs may present a ‘translation flexibility’ and perform more than a single translation role simultaneously within translation ecosystems. Third, we propose two main positions (orchestrator and supporter) of PRTIs in such translation ecosystems, by observing how Embrapa contributed to translation ecosystems functioning.

Our understanding of translation roles played by PRTIs sharpens insights on which kind of contributions are needed from PRTIs in dealing with global flows of knowledge and the traveling of innovations in processes of scaling (e.g., the case of drip irrigation in sub-Saharan African countries, but also other innovations which are developed in one place and then implemented in other places), and hence contributes to the ‘science of scaling’ and ‘scaling readiness’ (Garb and Friedlander, 2014; Ankrah and Freeman, 2021; Valerio et al., 2022; Schut et al., 2020). Beyond a better understanding of how scaling (or diffusion) of innovations unfolds through unpacking and repacking, the study shows that the contributions of PRTIs also should be considered in terms of how to approach imported innovations in view of justice implications and the ‘politics of scaling’ (see also Kok and Klerkx, 2023; Pfotenhauer et al., 2021; Wigboldus and Brouwers, 2016), as they may assist actors who become marginalized by innovations coming from abroad, by adapting innovations to local contexts and make sure it fits different sorts of farmers and other agrifood actors. The Brazilian case showed that Embrapa's translation efforts were crucial to offer a cheaper hybrid pigs' option for small cooperatives, local and regional pig industries, and independent pig producers (not associated with pig industries).

Given the generalizability limitations of our explorative case, future work would be needed to substantiate our findings as whether the translation roles played by Embrapa would apply to other PRTIs involved in unpacking and repacking innovations in distinct agri-food receiver contexts. Moreover, further studies could verify if our insight about translation roles related to PRTIs could also be observed in other receiver contexts. It would also be interesting to investigate more deeply how roles described here (orchestrator and supporter) complement each other, and whether complementarities between them are required for translations to succeed in translation ecosystems. Additionally, it would also be valuable to investigate if the translation ecosystems functioning relies on a broader spectrum of translation roles, beyond those identified from the Brazilian case analysis.

Another issue raised by this study concerns the dynamics behind translation ecosystems. One could analyze, for example, whether it is feasible to purposefully foster interactions between different translation ecosystems to optimize fit of innovations for different target groups, or convergely discourage translation ecosystems that are focused on a ‘one-size-fits-all’ solution, thereby improving inequalities in local contexts. In this vein, studies could focus on how translation roles played by PRTIs may perform as pivotal actions in overcoming marginalisation in agricultural sectors provoked by imported innovations. Lastly, it one might investigate how local conjunctures facilitate or hamper PRTIs of taking part in translation ecosystems focused on adpapting foreign innovations. All these further research efforts may enhance the contributions reached here, which improved knowledge on how PRTIs can better deal with the global flows of knowledge and traveling of innovation.

## CRediT authorship contribution statement

**Jean Vilas-Boas:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Laurens Klerkx:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Rico Lie:** Supervision, Writing – review & editing.

## Funding

This research was supported by a PhD studies grant for the first author from Embrapa.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

## Appendix 1. List of interviewees, 2017 and 2019

| Groups of Influential Actors | Interviewees | Position or expertise | State and region | Total |
|---|---|---|---|---|
| Industries | BRF SA representative | Sustainability, process management | Paraná - South | 5 |
| | Aurora Alimentos Central Cooperative representative | President | Santa Catarina - South | |
| | JBS Foods | Corporate director of livestock | Santa Catarina - South | |
| | Frimesa Central Cooperative | Executive director | Rio Grande do Sul - South | |
| | Pig Production Industries Association | President | Santa Catarina - South | |
| Producers | Brazilian Pig Producers Association | Executive director | Brasília - Central-West | 2 |
| | Santa Catarina Pig Producers Association | President | Santa Catarina - South | |
| Advisory Services | BRF SA representative | Executive director | Paraná - South | 4 |
| | Aurora Alimentos Central Cooperative representative | Executive director | Santa Catarina - South | |
| | Advisory service consultant | Innovation and animal welfare | Rio Grande do Sul - South | |
| | Advisory service consultant | Communication and animal welfare | São Paulo - Southeastern | |
| Science | Research governmental company | Pig genetics | Santa Catarina - South | 4 |
| | Research governmental company | Pig genetics and economics | Santa Catarina - South | |
| | University | Pig sector development | Rio Grande do Sul - South | |
| | University | Pig genetics | Paraná - South | |
| Non-governmental organizations | World Animal Protection Brazil | Executive director | São Paulo - Southeastern | 3 |
| | Santa Catarina Agriculture Association | President | Santa Catarina - South | |
| | Santa Catarina Animal Health Institute | Animal health, environment, and education | Santa Catarina - South | |

(*continued on next page*)

(*continued*)

| Groups of Influential Actors | Interviewees | Position or expertise | State and region | Total |
|---|---|---|---|---|
| Government/policymakers | Brazilian Ministry of Agriculture, Livestock, and Supply | Pig production director | Brasília - Central-West | 1 |
| Suppliers | Agroceres-Pic | Director | Minas Gerais - Southeastern | 2 |
| | Granja Bagdá | Owner | Santa Catarina - South | |
| Total | | | | 21 |

## Appendix 2. List of core and additional secondary data

| Type of secondary data | Core secondary data | Additional secondary data | Total |
|---|---|---|---|
| Books | The economics and organization of Brazilian agriculture – Fábio Chaddad (2016)<br>Mapping of Brazilian Pork Chain – SEBRAE and ABCS (2016)<br>Pig production: theory and practice – ABCS (2014)<br>Swine cooking in Brazil: quality from the field to the table – Arthur Bosísio, Raul Lody, Jean Vilas-Boas, Márcia Leitão, Humberto Medeiros (2003)<br>Sonho, desafio e tecnologia: 35 anos de contribuições da Embrapa Suínos e Aves – Jean Vilas-Boas, Dirceu Talamini, Gerson Scheuermann, Gilberto Schimidt (2011) | | |
| | Bem-estar dos suínos – Cleandro Pazinato Dias (2016)<br>Como as normas de bem-estar animal podem impactar na produção de suínos no Brasil – Cleandro Pazinato Dias (2018)<br>Pork consumption in Brazil: challenges and opportunities for the Brazilian pork production chain – Marcia Dutra de Barcellos (2011) | | 6 |
| Scientific papers | Bem-estar Animal na Produção de Suínos (Transporte) – Charli Ludtke, Osmar Dalla Costa, Stefan Rohr, Filipe Dalla Costa (2016) | | 3 |
| Policy briefs | Decree on Pig Production Animal Welfare Best Practices – Brazilian Ministry of Agriculture (final version, issued in 2020) | | 1 |
| Guides and official technical material in animal welfare | Animal Welfare in Brazil – Brazilian Ministry of Agriculture (2016)<br>STEPS Project: Guide to humane slaughter of pigs – WSPA (2010) | | 2 |
| Official public reports | | Censo Agropecuário Brasileiro – IBGE (2006) | 1 |
| | | Guia Gessulli da Suinocultura Industrial – Revista Suinocultura Industrial (2015) | 1 |
| | | ABPA Annual Report 2019 – ABPA (2020)<br>ABPA Annual Report 2020 – ABPA (2021)<br>Pig Production Magazine N° 14 – ABCS (2015) | |
| Media articles published in newspapers and magazines | | Pig Production Magazine N° 15 – ABCS (2015) | 4 |
| Total | | | 18 |

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