



OPEN ACCESS

EDITED BY

Susana Arrechea,
New Sun Road, United States

REVIEWED BY

Jonathan Andre Morales Marroquin,
University of São Paulo, Brazil
Luis Reyes-Galindo,
Independent Scholar, Mexico City, Mexico

*CORRESPONDENCE

Iraima Lugo Montilla
✉ iraimalm@gmail.com

RECEIVED 15 October 2024

ACCEPTED 13 December 2024

PUBLISHED 14 January 2025

CITATION

Lugo Montilla I and Águas CLP (2025) Social technology and rescue of native seeds in the Venezuelan Andes Páramo. *Front. Polit. Sci.* 6:1511955. doi: 10.3389/fpos.2024.1511955

COPYRIGHT

© 2025 Lugo Montilla and Águas. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Social technology and rescue of native seeds in the Venezuelan Andes Páramo

Iraima Lugo Montilla^{1*} and Carla Ladeira Pimentel Águas²

¹Organization for Women in Science for the Developing World, Trieste, Italy, ²Laboratory of Technologies and Social Transformations, Department of Science and Technology Policy, Institute of Geosciences, State University of Campinas, Campinas, Brazil

This study analyzes the recovery and conservation of potato landraces in the Venezuelan Andes Páramo, specifically in the Mérida region. Smallholder potato farmers in the Venezuelan Andes have been actively creating knowledge, processes, and socio-technical artifacts necessary for the recovery of potato seeds and other types of plant genetic resources critical for food and agriculture. This effort has involved diverse socio-technical dynamics, engaging both human and non-human actors, with the support of universities, research institutions, local and national governments, etc. These initiatives counter historical trends, such as the erosion of complex genetic resource systems, genetic resources, the impacts of agricultural modernization, dependency on oil and imported agricultural technologies, and more recent challenges, such as food shortages. Using traditional techniques such as *Tinopós*—underground caves for seed storage—and social appropriation of technological processes, including genetic improvement, Andean smallholder farmers have successfully rescued ancient potato varieties while developing new ones. Fieldwork conducted in 2019 included a documentary review, thematic analysis, and a technology inventory. The findings reveal a close relationship between the diversity of Andean root and tuber crops, the unique biophysical and climatic conditions of the Páramo, and the traditional knowledge of peasant communities residing in these territories. The study underscores the importance of border relations and cultural translation between different knowledge systems in recovering and conserving native potato seeds. These efforts represent a locally driven initiative to construct social technologies for food sovereignty and sustainable local development.

KEYWORDS

social technology, production of knowledge, potato seeds, agroecology, agrobiodiversity, bottom-up public policy, scientific-peasant coalition, Venezuela

1 Introduction

The Andes highlands are recognized as the center of origin of potatoes (*Solanum tuberosum* L.). Countries such as Peru, Bolivia, Ecuador, Chile, and Colombia have the highest potato landraces and its wild varieties (De Haan and Rodriguez, 2016). The Andes highlands is particularly significant for producing local potato varieties due to specific factors such as soil quality and high altitudes. The soil is rich in minerals such as phosphorus, potassium, calcium, and magnesium, while high altitudes (Tapia and Fries, 2007) create a temperature range that is warm during the day and very cold at night. This temperature variation reduces the likelihood of pests and diseases. Additionally, the development of ancestral sustainable management techniques, such as “tinopós” or “andenes” play a crucial role in producing potato varieties. These practices help retain water and prevent soil erosion, forming a part of

traditional agricultural systems. The ancestral knowledge of Indigenous people and traditional communities has led to the creation of different types of systems over pre-Columbian times to preserve or protect potato seeds in complex environments (Forbes et al., 2020). In this study, we explore the experiences of potato smallholder farmers from the Venezuelan Andes and their local technologies for the rescue of native potato seeds. To reflect on innovative possibilities for public policies, we analyze the production of potato seeds in two communities in Rangel municipality. We discuss its processes of cultural translation, i.e., effective horizontality in contexts of interface between diverse cultures, as a source of innovation.

Potato smallholder farmers from the Venezuelan Andes have carried out efforts to protect their native seeds and the social fabric, specifically in Mucuchíes, the capital of Rangel municipality in the state of Mérida. Like the rest of the Andes, mountain elevations exceed 3,000 meters, and the endemic vegetation, fauna, and a wide variety of crops have adapted to these climatic conditions. These small farmers have used hybrid systems involving social and ancient technologies, such as rescues of native potato seed and conventional genetic improvement. It made possible the development of local potato systems that have impacted regional and national potato seed systems (Romero, 2005). According to reports from the Ministry for Science and Technology -MINCYT, Spanish Acronym (2024), there are currently more than 200 groups of ancestral seed producers in Venezuela, impacting the increase in food production.

Since the 1960s, producers from the Rangel municipality have been participating in education programs, including technical assistance activities organized by governmental and non-governmental organizations at the local, regional, and national levels (Richer, 2005; Llambí, 2012). This process facilitated rebuilding a social fabric, where learning, adoption of practices and knowledge, and a specific capacity for resilience have been crucial in dealing with challenging circumstances such as the different socioeconomic crises of the country, as well as the socio-environmental conflict related to the uses of the Páramo (Richer, 2005; Romero, 2005). In 2003, the Productive Innovation Networks (Redes de Innovación Productiva-RIP, Spanish acronym) had an important role in the drive of social technology development. It was a public policy supported in the “Plan Nacional de Ciencia, Tecnología e Innovación. Construyendo un futuro sustentable Venezuela 2005–2030” (Ministry for Science and Technology, 2005) aimed at providing access to resources such as funding, marketing, training, and technical support to promote local development through innovative, productive activities, or grassroots innovations. For Mérida Andes Páramo, the Ministry encouraged the establishment of a specific innovation network to produce potato seeds (Red de Innovación Productiva de la Papa, RIP-SP, Spanish acronym), considering the region's tradition on potato production. Actors from diverse backgrounds participated in the RIP-SP, such as local farmers, local and national governments, universities, non-governmental organizations, community leaders, etc.

A long-standing debate recognizes the importance of technological appropriation or the development of appropriate technologies to solve socio-environmental issues in rural areas (Herrera, 1981). In recent decades, social technology (ST) has emerged as a specific category to identify initiatives, processes, and artifacts that originate from collective and democratic actions aimed at solving local problems or addressing rights violations stemming from socioeconomic, cultural, and symbolic exclusion (Tait, 2017;

Silva and Dias, 2020), contrasting with conventional technology models that prioritize profit and scalability (Dagnino, 2009). “The concept of Social Technology emerges as a critique of conventional technology (CT) and from a perception, not yet precisely formulated, of the need for a technological approach to the issue of what has been called social inclusion” (Novaes and De Brito Dias, 2010: 113). In this sense, “social” refers not only to interactions between people and between them and things but also to the protagonism of local communities to solve socio-environmental and economic issues. Tait (2017) describes some characteristics of ST in a rural productive context, such as establishing horizontal relationships within the domestic market, fostering the potential and creativity of both producers and consumers and supporting economically viable initiatives such as community cooperatives, incubators, and small enterprises. In practice, social technologies are increasingly adopted in the context of agroecological practices and as a platform for producing diverse knowledge to understand the functioning of complex agroecosystems and global environmental governance (Altieri, 1998; Foyer et al., 2014). For instance, initiatives such as community seed banks or native seed houses in different regions of Brazil exemplify how social technologies can address seed scarcity by integrating traditional practices with productive knowledge and broader networks (Alves et al., 2023). Those networks comprise a wider diversity of external agents, assuming complex relationships that benefit from intercultural translation processes. Ribeiro (2005) explains that the concept of translation has shifted from linguistics to cultural studies, which has broadened its meaning. From this broad perspective, translation is “a keyword of our contemporaneity, a central metaphor of our time. Potentially, any situation in which one seeks to make sense out of a relationship with difference can be described as a translatory situation” (Ribeiro, 2005: 79). Therefore, through translation, it is possible to identify, within a heterogeneous environment, “common concerns, complementary approaches and insurmountable conditions” (Santos, 2002: 34). It is possible to amplify experiences because instead of focusing on rival knowledge, its focus is on creating mutual intelligibility (Ribeiro, 2005).

The translation is challenging because the subjects are walking on completely new ground (Santos, 2002). If the frame of reference is debated and redefined, then power relations are also called into question (Ribeiro, 2005). We argue that rather than transferring technologies from a hierarchical and verticalized perspective, social technologies based on translatory processes have the potential to break down hegemonic power relations and create new responses from the border space between different epistemic paradigms. Specifically, we focus on the experience of Gavidia Base Nuclei (NuBaSe) and Association Integrated Producers of the Páramo (Proinpa), which can be understood as processes based on intercultural translation.

2 Methods

We conducted a qualitative study, beginning with an exhaustive documentary review of local and regional literature to identify and analyze relevant cases and map social technologies. Subsequently, we collected empirical data through a visit to the Mucuchíes population center, the capital of the Rangel municipality, a community known for its potato seed production, and the location of Proinpa and

Gavidia Base Nuclei. We conducted 16 open conversations distributed to 5 women and 11 men. It followed a strategy of informal conversation, without adhering to traditional “subject/object” hierarchies, being selected randomly, and without responding to any statistical interest. These conversations took place as representatives of the organizations participated in arranging an event commemorating the twentieth anniversary of Proinpa in August 2019. All of them were farmers and producers of local potato seeds. Some were members of Proinpa, while others participated in the project to recover native seeds from the community of Gavidia.

Regarding the members of Proinpa, six identified themselves as founding members of the Association. Through these conversations, we explored the professional trajectories and their involvement in the Association’s activities. Other field records were made during the event. It was evidenced that meeting places such as a cultural feast are necessary for preserving the communitarian social fabric.

The information was transcribed and systematized in a matrix created for this research. The statements of participants were read alongside the contributions of the documentary review to understand the different moments that characterize the process of rescuing native seeds in the context of the páramo de Mérida, the actors involved, and the dynamics that have been part of this process. On the other hand, the already systematized data were questioned to open the space for the emergence of new explanations.

Every person spoken to was informed that this was an academic investigation and that the information would be treated according to ethical guarantees (voluntary participation, participant integrity, and preservation of personal data).

3 Results

The inventory of ST was built with input collected in the bibliographic review, in pre-field conversations, and from inputs provided by an associate who was initially contacted and who paved the way for the research to be carried out (Table 1).

Gavidia Base Nuclei (NuBaSe) and the Biotechnology Center for the Training and Production of Agamic Seeds (CEBISA) are ST because they are solutions for socio-cultural, economic, and environmental issues. In addition, they were built for local populations acting in networks with different sorts of actors, challenging the conventional technological system for agriculture, as we will see below.

3.1 Gavidia base nuclei (NuBaSe) and the EcoFestival of the native potato

Although the populations of Gavidia have carefully preserved some potato landraces for domestic consumption, the experience of recovering and producing on a larger scale is relatively recent. It occurs in the context of the development of research co-produced with research groups from the University of Los Andes (ULA) and RIP-SP. A long research process was launched in 1985 to study the ecological conditions of the agricultural system in the Venezuelan Andes, with Gavidia playing a crucial role. Since then, several research communities at ULA have been involved in developing studies to gain a comprehensive understanding of agroecosystem dynamics based on farmers’ sociocultural and economic practices.

In Gavidia, the Orchards, Caves, or ancient *Tinopós* continued to be a “source of new seed” of the Black Potato or Páramo Potato variety. These are considered native or ancestral potatoes stored in the farmers’ farms in cycles of up to 25 years (Romero, 2005). The management of these crops was evidenced by the absence of treatment or cure for pests or diseases, and yields were improved through fertilization with livestock manure. However, resting lands resulted in more notable harvests (Romero and Monasterio, 2005). Storage occurred in natural spaces within the field or in rudimentary structures built manually. Transport was conducted “by muleback to the nearest population centers with greater economic activity, such as Mucuchíes in the case of Gavidia” (Romero and Monasterio, 2005, p. 118). Other research began to advance the preservation of native potato seeds and encourage the growth of farming activities with minimal environmental impact. A researcher and the farmers started a project to create “seed areas.” These areas would represent local sociocultural practices and reflect the levels of agroecological specialization needed for a national potato seed system. The Seed Self-Management Nuclei (NuBaSe-Spanish acronym) project was developed to continue the native seed rescue.

According to the researcher from ULA, who co-led the development and implementation of the project, the overarching objective was to reconstruct the social and community fabric that has historically supported the preservation of native potato seeds for family consumption. To achieve this goal, the project aimed, among other initiatives, to revitalize oral traditions and promote the intergenerational transmission of knowledge from elders to younger generations. One of the key references that inspired this

TABLE 1 The stock of social technologies development in Venezuelan Andean Páramo for potato seed production.

Social technology	Description	Social demand attended	Outputs
Gavidia Base Nuclei (NuBaSe)	It is a communitarian network for potato seed production. It could be native or improvement. The main goal is to constitute “seed areas” for building a common agenda for a national potato seed system.	Access to native or local potato seed is needed for the mitigation of genetic erosion and biodiversity loss, improvement of	<ul style="list-style-type: none"> – Re-building of the social fabric and rescue of native potato seed. – <i>EcoFestival</i> of the Native Potato of Venezuela. – Expansion of NuBaSe at the national level (124).
Biotechnology Center for the Training and Production of Agamic Seeds (CEBISA)	It is a local germplasm bank that has adopted conventional genetic improvement processes without resorting to genetic modification through transgenesis.	the local crop capacity, and guarantee of food sovereignty, local and national.	<ul style="list-style-type: none"> – Re-building of the social fabric and rescue of native potato seed. – Production of improvement seeds as “<i>Angostureña</i>.” – Building of technological appropriation process.

Elaborated by ourselves. The categories were constructed since theoretical discussion and inspired by the systematization of “Fundação Banco do Brasil-Rede de Tecnologias Sociais.

methodological approach was the *Campeño a Campeño* movement, an agroecology production strategy rooted in the principles of sustainability and emphasizing the exchange of knowledge and experiences among farmers (Rosset and Val, 2018; Holt-Giménez, 2008). The main achievement was collective work and the design of an organizational route to manage the reconstruction of the seedbed social fabric in Gavidia. It was possible because of strategies such as participation and knowledge co-construction.

The centrality of the encounter between different epistemic paradigms to make the project viable points to the connections between the concept of intercultural translation and the innovative use of social technologies in border contexts. As we have seen, the border is an interstitial space for negotiating differences, from which new narratives are produced. According to Friedman (2001), in multicultural environments, the mosaic metaphor silences how difference is configured and reconfigured through continuous interaction. For this reason, she proposes the metaphor of twilight to characterize intercultural encounters. In other words, she describes the intermediary space as a place of constant migration and permanent back-and-forth movement. This twilight zone, which is constantly negotiating its position, is conducive to innovation. The translatory rationality that emerges from the border is cosmopolitan and open to articulation. The intelligibility between practices and knowledge that meet, clash, and interact allows ethical and political convergence (Ribeiro, 2005). Regarding social technologies implemented in contexts of cultural plurality, the concept of border space - or twilight, according to Friedman - is relevant because it breaks down epistemic hierarchies and proposes a real complementarity between different types of knowledge.

An outcome of the project that exemplifies the emergence of border spaces in that context was the creation of the *EcoFestival* of the Native Potato of Venezuela. This event aims to bring together seed guardians, share the progress of the rescue efforts, provide training to farmers, and help rebuild Gavidia's social and agroecological framework. The first *EcoFestival* was held in 2012 with various actors and institutions. The seventh festival in 2019 took on an itinerant format, visiting different locations in the *Páramo* and incorporating wheat as a twinned crop to the potato system. This festival was part of a broader project financed by the Small Grants Program of the Global Environment Facility - GEF-SGP (Global Environment Facility, 2024).

The 12th *Ecofestival* was celebrated in 2023. The Ministry of Science and Technology (MINCYT-Spanish acronym) and the Corporation for Scientific and Technological Development (Codecyt S.A.), a state-owned company attached to the Ministry, supported the event. The *Ecofestival* is a highlight because of its claims and its embodiment of a set of local practices and knowledge for solving local problems, but not only. The *Ecofestival* prioritizes social well-being and community empowerment, addressing issues such as environmental degradation, genetic erosion, and inequality.

Celebrations are more than the product of the practical conditions and purposes of collective work and go beyond the biological need for periodic rest (Bakhtin, 1987). According to Guarinello:

[A feast] is always a production of everyday life, a collective action that takes place in a defined and special time and place, involving the concentration of affections and emotions around an object that is celebrated and commemorated and whose main product is the symbolization of the unity of the participants in the sphere of

a particular identity. A feast is a point of confluence of social actions whose purpose is the active gathering of the participants (Guarinello, 2001: 972 [free translation]).

This definition of a festival is linked to a non-crystallized understanding of culture and identity, which are forces that move and articulate in the arena of power relations (Hall, 1996). Considering that the *Ecofestival* involves actors from various epistemic universes, it can be understood as a space for community empowerment and identity strengthening. It also offers an opportunity for convergence around potato rescue strategies, constituting a border space conducive to translatory processes.

3.2 Biotechnology center to produce agamic seeds – CEBISA: biotechnology “managed by people from the same field”

The Biotechnology Center for the Training and Production of Agamic Seeds (CEBISA-Spanish acronym) is a germplasm bank belonging to the Association Integrated Producers of the *Páramo* (Proinpa). Proinpa was born from the agreement of different perspectives on *páramo* agroecological management. On the one hand, the Tropical Andes Program (PAT-Spanish acronym) and, on the other, the interests of a heterogeneous group of farmers are differentiated by land ownership and their level of education, from incomplete high school to postgraduate.

PAT arrived in the *páramo* in 1996 to provide technical and social assistance to the region's communities, especially on topics such as tourism and sustainable agriculture. The program was part of a broader international cooperation project funded by international and national institutions. Some authors (Llambí, 2012; Richer, 2005) emphasize that PAT introduced agroecology as a reference for a new ecologically sustainable agricultural production pattern, more aligned with local cultures. Nevertheless, when PAT arrived in the Mérida *Páramo* mountains, Venezuela already had established expertise in ecological and environmental agricultural sciences (Velázquez, 2003; Hofstede et al., 2014), and discussions about conservation and agricultural production had already taken place.

Additionally, some of the founding members of Proinpa also participated in socio-organizational and agroecological activities in the *páramo* during the same period. Some of the founding members of Proinpa, small farmers with extensive experience or belonging to socio-economically differentiated families with a long farming tradition—owners of plots between 3 and 10 hectares or heirs of family-owned properties—had pursued careers directly related to agricultural activities in the region. Some managed to start technical careers, bachelor's degrees, or engineering in agronomy, agroforestry, and education, among others. In this process, the students/farmers showed their ability to translate different cultural and epistemic perspectives, acting as key players within the border space.

Upon obtaining the bachelor's degree and returning to the *páramo*, the farmers, along with PAT, recognized agroecology as one of the best responses to some socio-environmental conflicts in the region, like the expansion of the agricultural frontier (Romero and Romero, 2007). The proposal emerged to create an official public training program through a system of technical high schools focused on adult education to primarily address the environmental and

agroecological demands of the páramo. A technical degree in agroecology was created within the same municipality linked to the Nestor Contreras Toro High School, an institution oriented to educating young people and adults. Some conflicts arose in obtaining a working space, as well as the necessary agreements and permission from the Ministry of Education and the Ministry of Agriculture, among others. Finally, they succeeded in formalizing the technical grade in agroecology, and 150 graduates were trained.

After 4 years of collaboration with the Páramo producers, PAT ended the experimental project because of funding cuts from development agencies in 2002, and “the 25 producers who took part in the experimental project chose to establish a productive organization, which later became the Association of Integrated Producers of the Páramo (Proinpa)” (Llambí and Duarte, 2005).

We call the process of forming Proinpa the *founding stage*. This moment allowed the foundations of CEBISA to be laid. It began with the PAT partnership and continued until the formalization of the organization in 2002. Thenceforth, Proinpa achieved approval for small projects to produce locally improved seeds. In 2003, MINCYT funded the construction of a 500 m² greenhouse. It is situated in a cultivated Páramo area at 3,400 m above sea level in the *Sierra de la Culata*, specifically in the ‘*La Angostura*’ sector of the Rangel Municipality (Romero, 2005). The funds were allocated by the Productive Innovation Networks (RIP). Initially, the project was experimental, with the goal of producing certified potato seeds under agroecological conditions adapted to the local ecosystems’ biophysical conditions.

Additionally, it aimed to reduce the seed importation process (Llambí, 2012, p. 22). However, they soon began to have problems with the supply of seedlings, which led them to embark on a new project: the construction of a potato seed laboratory. Following the development of a project supported through partnerships with universities and agricultural researchers, Proinpa established a Biological Supplies Laboratory within a 40-square-meter classroom at Nestor Contreras Toro High School. Some graduates in the technical grade in agroecology started working in the laboratory, most of whom were women.

The Proinpa associates continued developing projects to build their own laboratory, and they were funded by an entity attached to the MINCYT. In 2015, CEBISA started operating in 167 square meters (167 m²) next to the greenhouse. CODECYT has played a crucial role in advancing the projects and objectives of the RIP-SP and PROINPA. This support has included financial backing, technical assistance, and close guidance in operational management. The center has an annual production capacity of 250,000 plants, potentially supplying 3,000 m² of greenhouse space and producing 5,000 tons of registered seed. This would substitute 50% of the national imports of this resource Patiño Villafaña (2015).

From the perspective of seed production techniques, CEBISA employs agamic propagation, also known as asexual propagation or plant cloning. Among its innovations, the “Angostureña” stands out as a new and highly relevant genetic material. According to an internal report from PROINPA, this clone demonstrated exceptional performance during various evaluations, with yields surpassing 45 tons per hectare. It also exhibited remarkable adaptability to medium and high altitudes (1,800–3,500 meters above sea level) within the potato-growing regions of the Venezuelan Andes. Additionally, the “Angostureña” achieved a 78% reduction in the use of chemical

products for controlling *Phytophthora infestans*, a significant pest in potato cultivation.

This process is closely tied to biotechnological expertise that goes beyond the techniques typically employed by local or family farmers. CEBISA does not intend to employ other techniques, such as transgenesis, in the foreseeable future. It maintains an active stance in defending anti-transgenesis practices in food resources and promoting the free circulation of seeds.

4 Discussion

The study by Cebisa and NuBaSe in the páramos of Venezuela shows that farmers in the region have developed a close relationship with potato landraces. Whether through the construction of dialogs between conventional technologies and social technologies, such as CEBISA, or through the reconstruction of ancestral social technologies, such as the *Ecofestival*. Although it’s still too early to identify a specific seed identity, there is a clear and strong socioeconomic focus on potato seeds. Even though some producers in Gavidia have a close working relationship with Proinpa and even collaborate with them, there are still differences in the production technology and economic organization between these two communities. These distinctions emphasize the position of producers who were later integrated into the commercial potato production system.

The NuBaSe and Cebisa can be considered social technologies because they were created to promote social inclusion, participatory processes, and culturally contextualized practices. These technologies embody principles of accessibility and empowerment (Dagnino, 2009), contributing to sustainable development goals by promoting autonomy and resilience within marginalized communities. They also reinforce the value of indigenous and local knowledge systems (Silva et al., 2020). In contexts such as the páramo of Mérida, a region susceptible to human activities such as industrial and agricultural production, social technologies assist in the conservation of genetic diversity, which, as in the case presented, has allowed the counting of more than 50 species of landrace and improved potatoes (Romero, 2005; González et al., 2016; PROINPA, 2019). On the other hand, the development of a medicinal plant production program under an organic scheme in crop association, using species such as *Allium sativum*, *Ruda Ruta graveolens*, *Caléndula*, *Ajenjo*, *Ortiga*, *Clavel de muerto*, among others, has shown positive results for the diversification of production and the rescue of other ancestral knowledge associated with health care (PROINPA, 2019).

We can consider the local potato seed production system in the Mérida Páramo as a common resource, in line with Ostrom’s (2000) concepts of self-organization and self-management within the communities and local agents that form the system, in contrast to external dynamics trying to be imposed on the system. Similar to other experiences of building social technologies in Latin America, including La Via Campesina and the Landless Rural Workers Movement, the efforts to rescue native seeds and produce local seeds in Venezuela through technological appropriation can contribute to the development of public policies in the region. The example discussed here reflects the relationship between the concepts of social technology and intercultural translation,

pointing to the importance of breaking down epistemic hierarchies to innovate on a multi-epistemic basis. To ensure effective public policy development, especially in contexts of cultural diversity, it is important to prioritize political participation, resource transfer, and culturally appropriate technical assistance following methods adapted to the context.

There is plenty of evidence on the seed recovery process in the páramo de Mérida, mainly in the areas of ecology, agronomy, and economy. In this work, we seek to deepen our understanding of the processes of construction of social technologies undertaken by seed-producing communities to achieve the recovery and custody of native varieties and production in local systems. On the other hand, this study is part of a broader research project on the dynamics of knowledge production, not only among the guardians and producers of potato seeds but also between them and actors from other spheres of knowledge, such as researchers from universities in the region, local and national governments, civil society organizations, research centers, funding agencies, etc. Innovative results have been achieved through ST and the encounter between different epistemologies.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by University of Campinas - Unicamp. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

References

- Altieri, M. (1998). *Agroecología: a dinâmica produtiva da agricultura sustentável*. Porto Alegre: UFRGS.
- Alves, J. H., Sais, A. C., Fachini, C., and Forti, V. A. (2023). Mapeamento e análise da diversidade de sementes em casas de Sementes do Cariri Cearense / mapping and analysis of diversity in seed house in Cariri Cearense / Mapeo y análisis de la diversidad en casa de Semillas en Cariri Cearense. *Rev. NERA* 27:9864. doi: 10.47946/rnera.v27i1.9864
- Bakhtin, M. (1987). *A cultura popular na Idade Média e no Renascimento: o contexto de François Rabelais*. São Paulo: Editora Universidade de Brasília.
- Dagnino, R. (2009). *Tecnologia social: Ferramenta para construir outra sociedade*. Campinas: Editora da Unicamp.
- De Haan, S., and Rodriguez, F. (2016). "Potato origin and production" in *Advances in potato chemistry and technology*. eds. J. Singh and L. Kaur (San Diego: Academic Press), 1–32.
- Foyer, J., Jankowski, F., Blanc, J., Georges, I., and Kleiche-Dray, M. (2014). Saberes científicos y saberes tradicionales en la gobernanza ambiental: La agroecología como práctica híbrida. s.l.: ENGOV, 79 p. (ENGOV Working Paper Series, 14). Available online at: <https://agritrop.cirad.fr/577336/> (Accessed April, 2024).
- Forbes, G. A., Charkowski, A., Andrade-Piedra, J., Parker, M. L., and Schulte-Geldermann, E. (2020). "Potato seed systems" in *The potato crop*. eds. H. Campos and O. Ortiz (Cham: Springer).
- Friedman, S. (2001). O 'falar da fronteira', o hibridismo e a performatividade: teoria da cultura e identidade nos espaços intersticiais da diferença. *Rev. Críti. Ciên. Soc.* 61, 5–28.
- Global Environment Facility (2024). Consolidación de la Red de Semilleros y del Ecofestival de la Papa Nativa en Gavidia, estado Mérida. Available at: (<https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=27945>)
- González, L., Araujo, Y., Rosales, J. S., Lugo, Z., Gómez, D., Pichardo, J., et al. (2016). Variedades de papa Venezolana. Available at: <http://www.publicaciones.inia.gob.ve/index.php/iniadivulga/article/view/759> (Accessed August 15, 2024).
- Guarinello, N. L. (2001). "Festa, trabalho e cotidiano" in *Festa: Cultura e sociabilidade na América Portuguesa*. eds. I. Jancsó and I. Kantor (São Paulo: Edusp/Imprensa Oficial/Hucitec/Fapesp), 969–975.
- Hall, S. (1996). "Who needs 'identity'?" in *Questions of cultural identity*, ed. S. Hall and GayP. du (New Delhi: Sage Publications), 1–17.
- Herrera, A. O. (1981). The generation of technologies in rural areas. *World Dev.* 9, 21–35. doi: 10.1016/0305-750X(81)90074-7
- Hofstede, R. (2014). *Los Páramos Andinos ¿Qué sabemos? Estado de conocimiento sobre el impacto del cambio climático en el ecosistema páramo*. Quito, Ecuador: UICN.
- Holt-Giménez, E. (2008). *Campesino a campesino: Voces de Latinoamérica*. Movimiento Campesino para la Agricultura Sustentable. Managua: SIMAS.

Author contributions

IL: Writing – original draft, Writing – review & editing. C.Á: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. The research is a result of a doctoral fellowship funded by the Brazilian governmental agency Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes). The fieldwork was also possible with complementary support from the Department of Technological and Scientific Policy at the Institute of Geosciences, University of Campinas.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

- Llambí, L. (2012). Procesos de transformación territorial y agendas de desarrollo rural: el municipio Rangel y la Asociación de Productores Integrales del Páramo (PROINPA) en los andes venezolanos. *Agroalimentaria*. Venezuela: Universidad de los Andes Mérida, 19–30.
- Llambí, L., and Duarte, M. (2005). Reformas de mercado, instituciones y costos de transacción: impacto de las reformas en los pequeños productores andinos de papa en Venezuela. *Agroalimentaria*. Venezuela: Universidad de los Andes Mérida, 57–79.
- Ministry for Science and Technology (2005). Plan Nacional de Ciencia, Tecnología e Innovación. Construyendo un futuro sustentable Venezuela 2005–2030. Venezuela: Ministry for Science and Technology.
- Ministry for Science and Technology -MINCYT, Spanish Acronym. (2024). Alianza Científico-Campesina contribuye a la recuperación de la producción alimentaria en Venezuela. Available at: (<https://telecom.gob.ve/alianza-cientifico-campesina-contribuye-a-la-recuperacion-de-la-produccion-alimentaria-en-venezuela/>)
- Novaes, H. T., and De Brito Dias, R. (2010). “Construção do Marco Analítico-Conceptual da Tecnologia Social” in *Tecnologia social: Ferramenta para construir outra sociedade*. eds. S. P. Komedi and R. Dagnino (Campinas: Komedi), 113–154.
- Ostrom, E. (2000). El gobierno de los bienes comunes. La evolución de las instituciones de la acción colectiva. Fondo de Cultura Económica. México, DF.
- Patino Villafañe, J. M. (2015). Movimientos Ambientalistas en Mucuchíes, Municipio Rangel Del Estado Mérida. Venezuela: Universidad de Los Andes.
- PROINPA (2019). Asociación de Productores Integrales del Páramo. Mérida: PROINPA.
- Ribeiro, A. S. (2005). “A tradução como metáfora da contemporaneidade. Pós-colonialismo, fronteiras e identidades” in *Colóquio de Outono: estudos de tradução*. eds. A. G. Macedo and M. E. Keating (Braga: Universidade do Minho), 77–87.
- Richer, M. (2005). Innovación social y desarrollo local en un municipio andino. *Rev. Venez. Econ. Soc.* 5:16.
- Romero, L. (2005). La estrategia de la semilla en el sistema papero de Los Andes de Mérida. Una visión desde la perspectiva agroecológica. Venezuela: Universidad de Los Andes.
- Romero, L., and Monasterio, M. (2005). Papas negras, papas de páramo Un pasivo socioambiental de la modernización agrícola en Los Andes de Venezuela. *Bolet. Antropol.* 23, 107–138.
- Romero, L., and Romero, R. (2007). Agroecología en Los Andes venezolanos. Available at: (<http://www.saber.ula.ve/bitstream/123456789/21456/2/articulo10.pdf>).
- Rosset, P. M., and Val, V. (2018). “The ‘Campesino a Campesino’ agroecology movement in Cuba” in *Routledge handbook of food as a commons*. eds. J. L. Vivero-Pol, T. Ferrando, O. Schutter and U. Mattei (London: Routledge).
- Santos, B. S. (2002). A crítica da razão indolente: Contra o desperdício da experiência. São Paulo: Cortez.
- Silva, L. C. R., and Dias, R. B. (2020). As tecnologias derivadas da matriz africana no Brasil: um estudo exploratório. *Linhas Críticas*. Vol. 26. Universidade de Brasília, Brasil.
- Silva, N. M. G. D., Addor, F., Lianza, S., and Pereira, H. D. S. (2020). O debate sobre a tecnologia social na Amazônia: a experiência do manejo participativo do pirarucu. *Revista Terceira Margem Amazônia*, 6, 79–91, doi: 10.36882/2525-4812.2020v6i14p79-91
- Tait, M. M. L. (2017). “Tecnologia social” in *Marco Referencial de Agroecologia*. Rede de Agroecologia da Unicamp. eds. G. G. Fagundes and A. M. Souza (Campinas: Biblioteca / Unicamp).
- Tapia, M. E., and Fries, A. M. (2007). Guía de campo de los cultivos andinos. Lima: FAO-ANPE.
- Velázquez, N. (2003). Ambiente Sociedad e Historia en Los Valles Altos Andinos de Venezuela (1930-1999). *Fermentum*. Revista Venezolana de Sociología y Antropología. vol. 13, núm. 36, enero - abril, 2003, pp. 38–54. Universidad de los Andes. Mérida, Venezuela. Available online at: <https://www.redalyc.org/pdf/705/70503605.pdf>