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A Model to Promote Sustainable Social Change Based on the Scaling up of a High-Impact Technical Innovation

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Abstract: The scaling up of the innovations concept has gained importance in recent years, underlining the importance of disseminating successful innovations on a large scale to increase their socio-economic impact, seeking to sustain broad rural development and promoting public policies that generate equal and sustainable results. However, few projects take advantage of the adoption of innovative technologies to promote social change. This paper reports on an intervention model that incorporates common elements, from the literature, of scaling up, and includes novel such as linking technological and social innovations, with an exit strategy to build sustainable processes and results. The model is based on a trans-disciplinary approach, and leadership, that involves local communities and stakeholders to establish synergies, to give coherence to the whole process, and to build an exit strategy involving territorial dynamics related to the innovation. The model includes a clear definition of the objects, and the process, that should be transformed, and the specific methodologies to involve local communities and stakeholders, to reach the final target user. The model was applied to develop the project, More Nutritious Potatoes, for scaling up new yellow potatoes varieties with improved agronomic and nutritional attributes. To implement the project, the research team, local communities, and stakeholders agreed on specific actions to improve food security and nutrition in a sustainable manner. The operational objectives were, the strengthening of capabilities for autonomy and governance in public policies, the entrepreneurship to build inclusive businesses, the valorization of agro-biodiversity, the acquisition of good food habits, and the promotion of social equity. The methodologies employed allowed building of social and scientific capabilities for Colombia.

Keywords: scaling up; social innovations; Potato Declared Seed System; Rural Entrepreneurs Nuclei; Family Farming Community Schools; food security and nutrition

1. Introduction

Innovations are change factors in all sectors of the economy and the society to overcome everyday challenges. Extension services were created to implement public policies for agricultural innovation, initially to modernize the sector and improve the productivity of agriculture and later to contribute to rural development [1]. In the rural sector, many of the innovations do not have the expected impact due to their low acceptance by producers, difficulties in marketing [2], or because interventions do not consider criteria of equality and sustainability [3]. The concept of scaling up innovations has pointed to the importance of spreading successful innovations from a small to a large scale of coverage to efficiently increase the socio-economic impact to support broad-based rural development [4].

In recent years, the successful scaling up of innovations has been a priority for agriculture policies, rural development, and nutrition [5,6]. Discussions around the theme conclude that in order to generate scaling up impact, it is crucial to consider the sustainability and adaptability of innovation and a broad conception of the concept beyond the simple increase in coverage [7]. However, scaling up is not a neutral process. Innovations usually lead to new environmental challenges, they could reduce the diversity and increase social and economic gaps [8]. The approaches to scaling up innovations have as goals growth, expansion, and maximizing profit, so new approaches are needed for social impact. Scaling innovations implies putting at risk non adopters and territories, and assessments of risk imply trade-offs. Scaling is more than resource allocation [9].

Implementing scaling up projects is a challenge [10], especially for innovations designed for small scale farmers and vulnerable populations, due to the difficulties derived from lack of knowledge, risk aversion, patriarchal and paternalistic cultures, financial and institutional difficulties and geographical conditions in rural sectors. The scaling up process is complex because technical factors of production are at stake with an intricate set of social relationships with different logics. This situation implies developing different activities in diverse environmental contexts besides generating political commitment and of flexible strategic management to scaling up [11].

The design of scaling up processes should start by sharpening the description of the product, service, approach, or intervention to be scaled up and the scope of the ambition in terms of numbers and geographical distribution of the intended beneficiaries [12]. Planners should screen innovations for scaling through features they believe are essential to their success (i.e., its economic advantages, the perception of it by potential users, the impact of this perception on social relations, and the compatibility with cultural uses and public policies).

Different authors have proposed models for scaling up innovations, there is, for instance, an operative model for effective scaling up which follows three steps: Step 1: Develop a scaling up plan to define what is going to be scaled up, how will scaling up be accomplished and who performs the key functions; define where and for whom does scaling up occur; assess scalability by analyzing the organizational and social context; fill information gaps and prepare a scaling up plan. Step 2: Establish the pre-conditions for scaling up, legitimize change, build a constituency, realign and mobilize resources. Step 3: Implement the scaling up process, focused on modifying organizational structures; coordinating actions; adapting strategy and maintaining the momentum [13].

Based on both a review of scaling up literature and practice, it exists a framework developed for the key dynamics that allow the scaling up process to happen, that is: to identify a promising innovation or intervention for scaling up; to identify those elements that are context-specific and those that are universal; to assure that the universal elements are applied, but leaving room for local adaptation; and to evaluate, learn, and change the approach as scaling up proceeds [14], these authors assume that real world is highly differentiated and disorderly, so they conclude that scaling up strategies have to adapt to specific environments, recognizing that the scaling up is a political and organizational leadership process concerning vision, values, and mindset, and about incentives and accountability—all oriented to make scaling up of a central element of development efforts.

Other authors highlight the important dynamics of social structures, cultural appropriations, and events that might or might not facilitate that innovation is widely accepted and used by society [15]. Similarly, institutional missions, policies to regulate, promote or limit the adoption, and how the local and regional economy works, may determine that potential adopters agree to participate. In this context, “scaling of innovations has tended to be an unpredictable and complex process, depending on the interaction between the ‘DNA’ (interpreting DNA as the essence) of the innovation and the context within which it is taking place” [16]. People, their groups, and communities, as well as, institutions work in changing environments providing opportunities for progress and threats to sustainability. The emphasis in successful scaling up of new technologies in rural development requires analyses of organizational, social, financial, and normative elements [12,17]. Regarding the objectives of scaling up agricultural innovations, it is accepted that they may seek to reduce costs, improve productivity,

and increase incomes. However, the objectives of the scaling projects, together with scaling up technological innovation, should seek positive environmental and social impacts. The objectives, beyond the economic impact, must seek significant and sustainable changes in the conditions of a good life of the people, their families and communities in a territory and nation. This complexity means that clear strategies should be set to different stakeholders.

Constant evaluation and continuous supervision facilitate the timely introduction of modifications that lead to achieve the previously set goals and meet both internal and external demands [18].

This article reports the key elements of a model to promote social change along with the scaling up of technological innovations. The model is a result of thinking on the design and development of a project that linked agriculture, education, and nutrition because a high proportion of the Colombian population suffers from food insecurity and micronutrient deficiencies [19]. This model may be useful for organizations, institutions, and academics fostering sustainable innovations, since it engages different stakeholders and promotes synergies to reach end-users with a broad cover, keeping the sustainable social change as a principal objective. The model was built as an advanced project that improved nutritional status of the population and small-scale potato producers' income to induce sustainable social and environmental changes (families' and communities' autonomy, entrepreneurship, governance, gender equity, diversity preservation, and environment protection). The project named the More Nutritious Potatoes, was a project led by Universidad Nacional de Colombia and McGill University to scale up the production and consumption of three yellow potatoes cultivars with better nutritional contents and better agronomic traits. The model emphasized: (i) the importance of developing and sharing an exit scenario, from the beginning to build sustainability of results, an exit scenario is the study of possible future events in society, how they might affect an organization, and the action of planning to prepare for them [20]; (ii) the definition of possible, comprehensive, and ambitious project objectives; (iii) the development of an integral and analytical approach to the problem to achieve the objectives; (iv) the design of appropriate strategies to involve different stakeholders and reach large populations; (v) the way in which each discipline, in a trans-disciplinary effort, contributes to achieving comprehensive objectives; and (vi) the definition of relevant and measurable results and the use of a continuous evaluation and an exit strategy.

2. Methodology

2.1. Design of the Scaling up Model

The word model in this paper is used as a simplified description of a system or process that serves as a reference for all those who design projects of the same nature.

A model for scaling up was constructed in the framework of the More Nutritious Potatoes project. The project scaled up three new potato varieties considered as an innovation. The project integrated a team with researchers from different disciplines: Agronomy, Plant Breeding and Genetics, Food Security and Nutrition, Food Chemistry, Social Work and Gender, Rural Development, Entrepreneurship, and Extension Education. This team worked in an open-minded atmosphere and with a trans-disciplinary approach that allowed all participants to fully understand the problem, design the project and create synergies among different disciplines. To design the scaling up model, the requirements of a call from International Development Research Center (IDRC) from Canada, were important inputs as well as a review of the literature.

2.2. The Case More Nutritious Potatoes Project

The project More Nutritious Potatoes was implemented to expand the consumption of three new cultivars of yellow potatoes. This project intervened in the availability in the market of these varieties and their consumption in Colombia. The project promoted social change, taking advantage of the scaling up of the technological innovation. The project stressed sustainability of results and methodologies, once the project is over. This project mobilized resources from Universidad Nacional

de Colombia and McGill University of Canada and built synergies with communities and public and private institutions. In the development of the project, useful social innovations to enhance sustainability were created and adapted. The project was designed following the scheme presented in Figure 1. This scheme highlights the shared vision of the project, a comprehensive approach of the key aspects of the project, the strategies to engage stakeholders, the technical components and measurable results connected with the exit strategy and with the evaluation. This scheme shows the coherence between the vision of the project and its implementation in field.

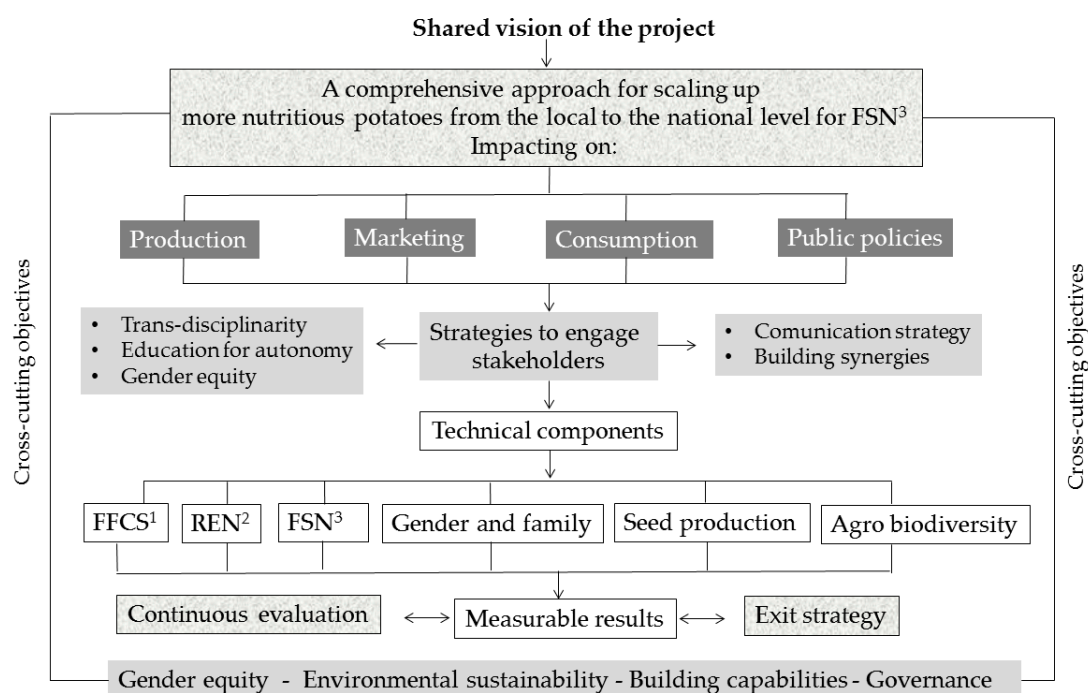


Figure 1. Scheme of More Nutritious Potatoes: Project for scaling up a technological innovation. It shows at the top the relevance of the shared vision project, for designing a comprehensive approach for scaling up. In the dark boxes, in the third line, are the aspects in which the project impacts. In the gray boxes, are presented the strategies to involve the stakeholders. In White boxes are the technical components, and how their results are subject to permanent evaluation and are key to the exit strategy. At the bottom are the cross cutting objectives integrated in the whole project. FFCS¹: Family Farming Community Schools; REN²: Rural Entrepreneurs Nuclei; FSN³: Food Security and Nutrition.

2.2.1. Research Territories for Implementing the Model

The territories selected for this research were four departments in Colombia: Nariño, Cundinamarca, Boyacá, Santander, and the rural area of Bogotá (capital city). These territories are important potato producing regions and the farmers are especially small-scale producers with peasant and communitarian economy.

2.2.2. Technological Innovation

The technological innovation was a set of three proven yellow potatoes varieties named: Criolla Dorada, Criolla Ocarina, and Criolla Sua Pa. They present better traits than the more consumed varieties in Colombia. The yield of these varieties in average is 30 t/ha and the potential to increase farmer's income is 18% and they present higher resistance to late blight [21,22]. This disease is the most devastating disease in potato [23–25] and the novelty is their better nutritional contents especially iron and zinc [26], protein [27], and antioxidants compounds [28].

2.2.3. Social Innovations

The project developed Family Farming Community Schools (FFCS) [29] and adapted Rural Entrepreneurs Nuclei (REN) [30] and Schools of Leaders Managers in Sovereignty and Food Security and Nutrition. These social innovations are based in educative processes to build autonomy and capabilities in agriculture, nutrition, entrepreneurship and social leadership to construct social fabric [31].

3. Results

The scaling up model and the More Nutritious Potato project were closely linked. The model emerges from the project, but in its progress the model is used to guide the project. The results present first the key elements of the model and second the application of those key elements in the project More Nutritious Potatoes.

3.1. Key Elements for the Scaling up Model

The analytical model includes the basic concepts that can be applied to projects that pretend to scale different innovations in diverse contexts (Figure 2).

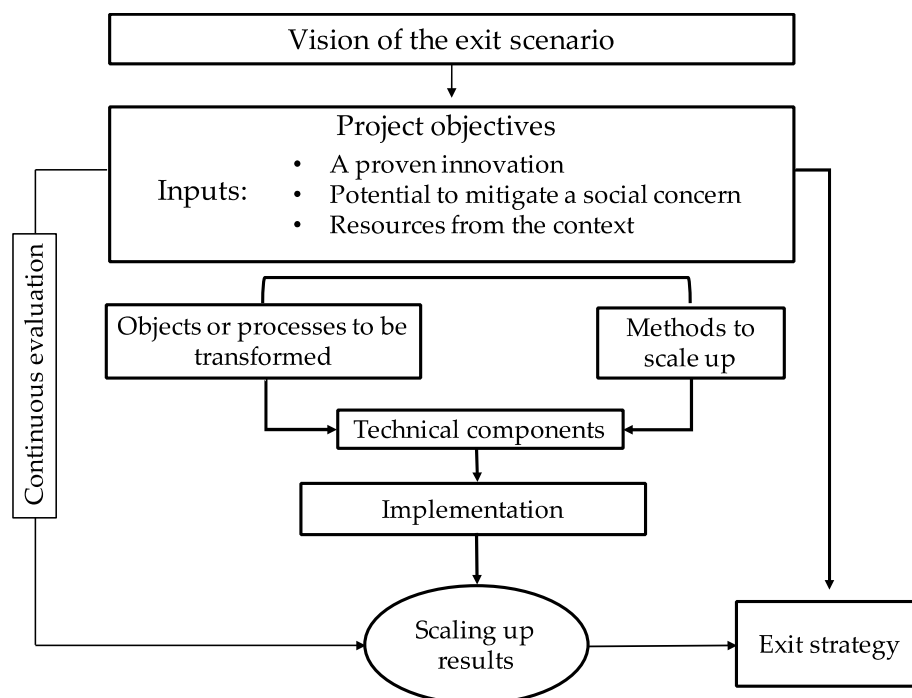


Figure 2. Scheme of the conceptual model for scaling up an innovation.

3.1.1. A Vision of the Exit Scenario

An exit scenario was constructed considering a preliminary vision of the context and the possible effects of the intervention and it required: (a) precision of interests and the recognition of the culture of the project's leading institution and the stakeholders; (b) a preliminary assessment of the characteristics of the innovation within scaling contexts; and (c) the first analysis of available time, resources, and ethical parameters.

3.1.2. Clear Scaling up Objectives

The objectives of the model intended to cope with the key changes to be attained—social and technological changes. In this project, the scale was to reach 1.5 million consumers by the end of

the project, however the final result shows 6.5 million consumers reached with more nutritious potatoes. Social changes were referred to nutritional education, social and gender equity, leadership, entrepreneurship, and governance.

3.1.3. Coherence among Objectives, Processes, and Situations to Be Transformed

The model established as critical points “what must be changed to achieve the objectives”.

The prioritization of the critical points was based on the complexity of the scaling plan and included the most critical elements to work on. Practical considerations, such as the availability of resources, number of intervention areas, and their size are an important decision. For increasing the impact of the scale, the project expanded the number of areas and increased the number of organizations.

3.1.4. Methods for Scaling up and Strategies to Involve Stakeholders

Strategies to involve stakeholders included: (i) educational methodologies to contribute to strengthening and increase individual, social, and organizational capabilities; (ii) building agreements with different stakeholders with specific commitments; (iii) linking women as a strategic agent of change, and social development; (iv) combining communication media for scaling up, in which beneficiaries received quality information and the project reached the maximum of users, customers, and potential beneficiaries; and (v) a trans-disciplinary approach.

3.1.5. Technical Components

In the model they are referred to specialties, disciplines or groups of study that develop the guidelines to solve a meaningful part of the scaling up problem, with attitude and capability to create synergies with other components to achieve the scaling up objectives. Together, the technical components and the synergies amongst them must cover the problem in its entirety. According to the levels of technical and methodological complexity, specialties define sets of activities to achieve common goals in established spaces and times. These sets conform technical units for management and administration.

3.1.6. Trans-Disciplinary Implementation

In building this model, it was found that the trans-disciplinary approach is fundamental. After planning the scaling up project, the project team started its implementation. It meant to coordinate and manage project resources to meet its objectives. The project recruited specialized personnel to develop the specific activities. They were trained for a trans-disciplinary work and to follow the fundamental criteria of the model, what should be transformed and methodologies to involve stakeholders.

Personnel selection and recruitment took into account building local capabilities. It was desirable for the staff to know in depth the territory, its actors, institutions, and relationships.

3.1.7. Exit Strategy

The model integrated the different elements (objectives, methodologies, and activities) for the scaling up. The elements constituted an important part of the exit strategy from the design phase of the project.

3.1.8. Continuous Evaluation

The model established the continuous evaluation as a process for monitoring and adjusting the scaling up implementation based on objectives, goals, and indicators. The model recommends an external and continuous evaluation with a strong communication between evaluator and the team.

3.2. Key Elements in Scaling up the More Nutritious Potatoes Project

The project scaled up a proven technological innovation in Colombia to impact food security and nutrition at two levels. First, with the indigenous and peasant population and the organizations involved directly in this project, and second with the Colombian consumers that in general are affected by deficiency of micronutrients [19].

The project, in two years, empowered seven organizations for production of good quality seed potato tubers with small and medium-scale farmers. More than six million consumers were reached. In the territories, the project enhanced governance in the territories, women reached decision-making positions and the small-scale potato producers' families increased their income. The project fostered home and community gardens linked to seed custody networks [22].

3.2.1. Guidelines for Scaling up the Innovation

The More Nutritious Potatoes project was designed following the guidelines of an international call from International Development Research Center (IDRC) of Canada in 2015 [32] and the knowledge of the project leaders:

1. Having a good solution: technology, method, or practice that has a strong science behind it. This is robust enough to perform in different conditions and can be easily adapted to local practices. In order to be able to develop such a good solution, local know-how needs to be incorporated. The research to be conducted is user-inspired. Focus on women instead of focusing on the number of women participating in the project, it is necessary to move to more qualitative indicators such as gender role, empowerment, decision making. The incorporation of the youth is also crucial.
2. Right business model for scaling up: in order for an innovation to reach a large number of farmers, men, and women, it has to be affordable and easy to implement without too intensive processes.
3. The right partners help to co-develop, together with the researcher and the farmer's effective and practical business model to work in the reality. Those key partners are policy actors that enable the environment for scaling up, civil organizations reaching the local population, non-traditional actors, such as the private sector, meaning individual entrepreneurs or small enterprises within the country of intervention, like food processors, seed distributors, farmer associations, and cooperatives. It is necessary to develop a common language and common tools to work with different actors. The involvement of students is important as they are the leaders of the future. Students who are excellent in their fields and know how to communicate with people in other disciplines and with non-academics must become actors as well.
4. Need to read/interpret the local context and to take advantage of the existing opportunities. Scaling up is not a straightforward process, it is needed to have the local conditions and factors. Very often scaling up depends on luck.
5. Importance of leadership in the long-term. Scaling up is not a process that requires long-term funding, but funding is not the key challenge. The most important and harder thing to get is the commitment over the long-term as it can take the innovation beyond time and geographical barriers of the project.

3.2.2. The Vision of the Exit Scenario of the Project More Nutritious Potatoes

The vision of the exit scenario for the project was designed according to both the requirements of the IDRC call and interests and possibilities of Universidad Nacional de Colombia and McGill University [33] (Figure 1).

The design of the project included, building and sharing a vision of the exit scenario: a population of 1.5 million people consuming regularly more nutritious potatoes to improve Colombians' nutritional status; a production and chain market system of potato seeds of declared quality based on small-holding farmers; strengthened national leadership capabilities to develop complex projects. Besides, to the technological innovation, to generate a sustainable social change.

3.2.3. Definition of the Scaling up Objectives

The bases to formulate objectives were the guidelines for scaling up, the context to promote nutrition-sensitive and environmentally responsible agriculture, the time for project implementation, the budget, the characteristics of the innovation, and its perception by potential users. To define the specific objectives, the project established what should change and how to involve different stakeholders to address the problem.

The context analysis was used by the team of the project developed and shared a general objective: Scale up an innovation to encourage the consumption of more nutritious potato varieties and promoting diversity in the diet and better feeding habits in vulnerable sectors; strengthening the capacity of small farmers to obtain benefits of innovation, thus, improving their food security and nutrition and promoting adoption of new varieties among medium and large farmers for widening impact on the consumer population and expand the use of good quality seeds. Based on the general objective it was possible to define objectives and develop a theory of change scheme. Figure 3 shows the Theory of Change followed in More Nutritious Potatoes project.

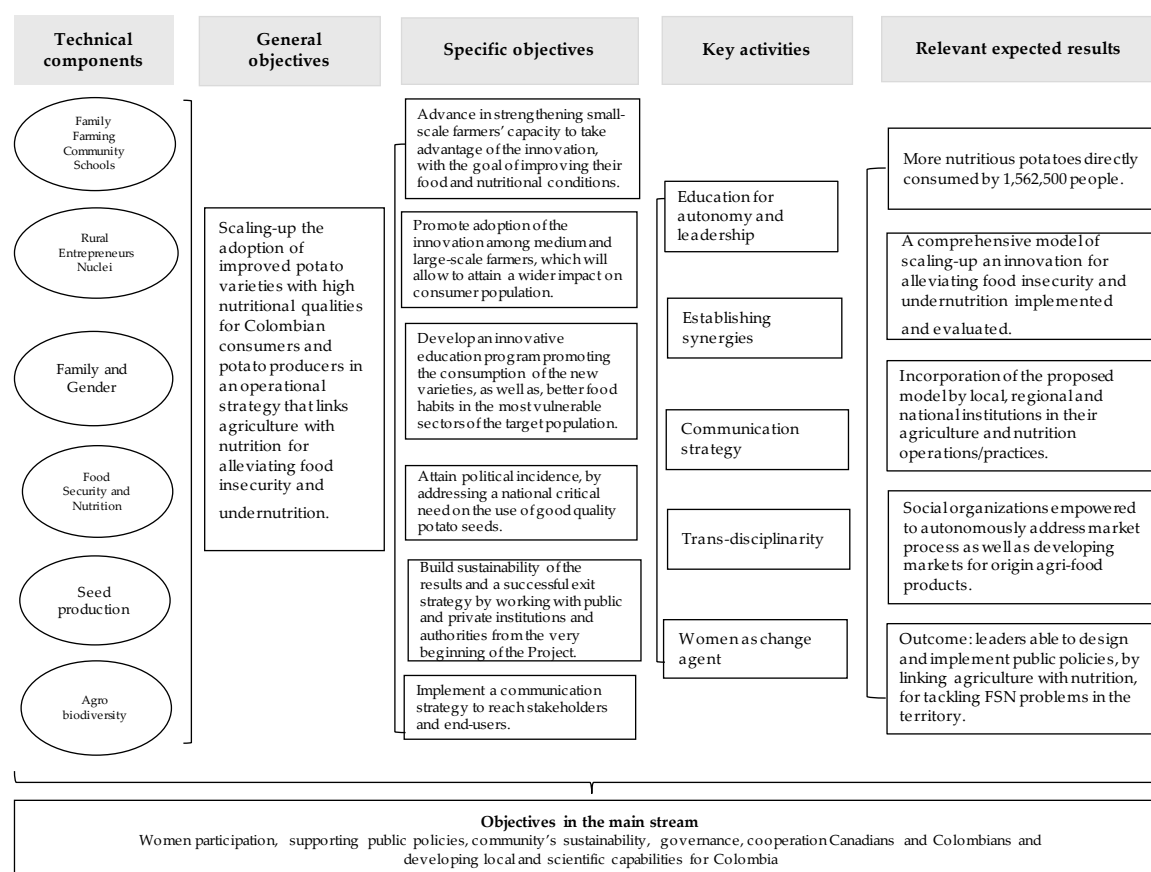


Figure 3. Theory of Change for More Nutritious Potatoes project shows a trans-disciplinary approach to achieve results. The chart shows the objectives of the project, the key activities for all technical components, as well as the relevant expected results. In the bottom, the objectives in the mainstream that are integrated into the entire project.

3.2.4. What Should Change: Comprehensive Approach for Scaling up

The approach for scaling up considered that the project should impact on: (i) the availability of food, focusing on potato production; (ii) access to food, focusing on marketing and increased income of small-scale potato producers; (iii) expansion of demand focusing on consumption and diversity of the diet; and (iv) public policy.

3.2.5. How to Involve Different Actors: Strategies to Engage Stakeholders

The project defined five strategies to engage stakeholders: trans-disciplinary approach; synergies; partnership; education to build autonomy; gender equity; and communication.

3.2.6. Technical Components

For scaling up innovation, different interventions were designed. These interventions were developed through the technical components of the project. The technical components and their synergies covered the problem in its entirety. The technical components were: (a) production of more nutritious potatoes; (b) Family Farming Community Schools; (c) Rural Entrepreneurs Nuclei; (d) food security and nutrition; (e) gender equity and family; and (f) valorization of agro-biodiversity (Figure 4).

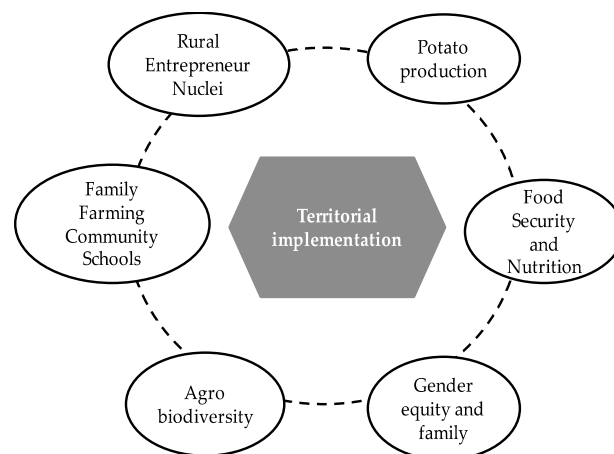


Figure 4. Technical components of the project More Nutritious Potatoes.

Specialties define sets of activities to achieve common goals into the established territories of intervention and time for the enforcement of the project. At the operative level, trans-disciplinary decisions and monitoring were basic for successful activities and achievements.

(a) Potato Production

To achieve the objective of having yellow potatoes available for consumption, four approaches were developed: (i) Rural Entrepreneurs Nuclei (REN) to accompany and empower solidary organizations to produce seed potato tubers of good quality; (ii) training and encouraging potato producers to promote short market circuits through the FFCS methodology; (iii) along with the associated project *Contributing to the Sustainability of Potato Farming: from Cundinamarca to Colombia*, the new varieties were registered for Cundinamarca and Boyacá as well as in processes of technological adjustment and diffusion of adoption; and (iv) together with producers of good quality seed, the production with quality seed was encouraged, orienting potato producers to the purchase of quality seed (from declared or certificated systems) in such a way that the proposed objectives were fulfilled by the first semester of 2018.

(b) Family Farming Community Schools (FFCS)

The FFCS is a social and educational innovation that links peasant and indigenous communities with institutions to build autonomy, dignity, gender equity, freedom, trust, and citizenship [29]. They developed processes to scale up more nutritious potatoes and social practices, improve food security, nutrition, and sovereignty, capabilities of management, and political incidence. The facilitators recognized each other's knowledge, accompanied by the valorization of local practices and knowledge and delivered relevant and pertinent information.

(c) Rural Entrepreneurs Nuclei (REN)

REN is a methodology underlying entrepreneurial and organizational training in groups formed to develop joint production or business market. Training processes emphasized building organizational autonomy and sustainability [34]. Seven organizations were accompanied to develop quality seed production system to produce seeds and develop short circuit markets based on trust. The quality seed production system and circuits have a territorial approach, generate higher income, and reduce phytosanitary and environmental problems. It allows small and medium-scale potato producers to access quality seed. It has been based on education, trust building, and communication strategy. To produce seed potato tubers of good quality, the project invited solidarity organizations of small- and medium-scale potato producers to create capabilities to produce good quality seed potato tubers with a focus on short market circuits. They were enabled with technical and organizational capabilities. The production started with basic seed to obtain good quality seed in the short-term, and for medium and long-term with mini-tubers produced by a private company. Its expansion to other territories was done through institutional synergies such as the Fondo Nacional de Fomento de la Papa (National Fund for Potato Development).

(d) Food Security and Nutrition (FSN)

This component includes aspects to promote the protection of the family through diet diversification and Schools of Leaders Managers in Sovereignty and Food Security and Nutrition. These Schools developed management processes and intervention in policy development, thus, enhancing governance. The schools promote food security and nutritional status of communities, adopting processes of local food sovereignty, promoting local leadership based on the existing capacities in the territory and promoting mechanisms based on dialogue and exchange of knowledge, so that public institutions perform effectively food and nutrition security in the region.

To promote food and diet diversity, a methodology called “*Shagras* for life” was developed. This methodology empowers the traditional *shagra* (indigenous home and community gardens) and the family garden in spaces that integrate a sensitive agriculture with nutrition and cultural and environmental partner processes that contribute to the right to food. This methodology focuses on three pillars: agro-ecological food production, rescue and conservation of native seeds to guarantee diversity of diet, and recovery of ancestral foods and recipes and their integration with better cooking practices for protecting the nutritional quality of food.

An integral homemade fortification strategy was implemented with the Ministry of Health and Social Protection, and the Departmental Health Institute to study ways to increase the adherence to the strategy.

(e) Gender Equity and Family

This component identified institutional weaknesses related to the implementation of policies and programs at the regional and local levels. The gender component contributes to the mainstreaming of the gender approach through the formation of the internal team and regional and local officers, as well as, the development of a strategy and its respective methodology, with the purpose of involving and strengthening the participation of women in each of the project’s components. For evaluating the model, three cross-cutting gender indicators were established: (i) proportion of women participating in the project; (ii) proportion of women who hold leadership positions; and (iii) recognition of women and their productive role as a result of the training process. The gender strategy in More Nutritious Potatoes project followed the RRR approach, presented by Nancy Fraser [35]. Where RRR means Recognition, Redistribution, and Representation. Building gender justice implies promoting Recognition, from daily life and cultural traditions. Redistribution not only of economic resources, but also redistribution of the traditional women roles, as time and care tasks. Representation, the participation of men and women in decision-making from daily life, organizations, and community.

(f) Valorization of Agro-Biodiversity

Native cultivars are at risk of being lost due to the phenomenon known as *genetic erosion* that usually occurs when farmers adopt the cultivation of new and more yielding varieties with advantageous agronomic traits for production and marketing and stop sowing traditional cultivars. Generating knowledge around these native materials encourages a sense of pride in the cultural heritage and propitiates a benign environment for the preservation of these cultivars. Likewise, working with local communities to develop activities aimed at identifying the use and exploitation of native crops, contributes to preserving the food traditions of the people and ensuring the possibilities of diversity in their diets.

3.2.7. Achieving Relevant and Measurable Results

For the project the indicators are specific measures, objectively verifiable, on the changes or results of an activity [36]. The indicators were constructed based on the objectives, results, and proposed actions to track changes in variables over time. In this project, an indicator was defined as an index to help determine whether a project meets its goals and objectives.

Monitoring and evaluation processes were permanent and continue from early stages of project implementation. Crucial indicators were established and used to take corrective measures and adjustments and they were employed by evaluators and funders.

3.2.8. Sustainability: Exit Strategy

The project's methodological approaches in building sustainability and the exit strategy were: (i) the educational approach, seeking the construction of autonomy of families and communities; (ii) participation of communities and institutions and local authorities from the beginning of the project; (iii) systematic promotion of dialogue among authorities, institutions, and communities; (iv) entrepreneurial and organizational training with a zero subsidies approach; (v) public policy proposals on the production of certified seed, integration of agriculture, education, and health sectors in the operation of food security and nutrition, and gender equity; (vi) training of new talent at the professional level; and (vii) valorization of agro-biodiversity, local know-how and culinary identity.

3.2.9. Continuous Evaluation

The project followed the principles of the Theory of Change [37,38] for the implementation and for the evaluation. The Theory of Change visually represented the articulation among objectives, inputs, outputs, results, and impacts (Figure 3). Indicators were constructed to measure the achievement of the general and specific objectives throughout the project cycle.

4. Discussion

This paper presents a model for scaling up of a technological innovation successfully scaled up in Colombia. The technological proven innovation was scaled up through the More Nutritious Potatoes project. The model of scaling up and the project were linked and it was a challenge to de-link the conceptual model from the project execution.

4.1. The Scaling up Model Responds to a Complex Problem

The model included different elements considered in scaling up models [12,13,17,39] and outlined aspects that are usually overlooked in project's approaches, such as the relevance of designing an exit scenario by consensus to reach sustainability and, the key aspects to be transformed and the methodologies to guarantee involvement of different stakeholders in scaling up.

4.1.1. The Exit Scenario a Powerful Tool

A powerful tool to plan a sustainable scaling up project is to construct an exit scenario considering a preliminary vision of the context and the possible effects of the intervention. The devoted participation of the project leaders in this exercise facilitates the definition of the project objectives and paths for their sustainable achievement, and especially, open their minds for trans-disciplinary work.

The exit scenario facilitates common thinking around the project, gives the process coherence and guides appropriate choice of methodologies to involve the different stakeholders to generate sustainability.

4.1.2. Clear Scaling up Objectives Requires the Expertise of the Team Members

To define the specific objectives, it is convenient to identify the minimum strategic aspects needed to transform the current situation and to define who and how they should be involved to reach the general objective and sustainability of the results.

A clear definition of objectives (general and specifics) requires the expertise of the team members to determine their feasibility. Scaling general objective should be set from the vision of the exit scenario, and requires to contemplate scaling context, innovation characteristics, and limitations derived from the availability of time, budget, and institutional capabilities.

The model recommends to select critical points to be transformed in order to achieve the objectives. The model allowed to specify “what must be changed to achieve the objectives”.

The prioritization of the critical points and the impact of the scale requires a flexible approach. This process requires a thorough consideration and understanding of the significance and implications of the scaling up process. The contribution of different specialists in this complex analysis is decisive for success.

4.1.3. Each Stakeholder Requires Special Treatment for Their Participation

When designing the structure for executing a project, is relevant to contemplate specific conditions: (a) targeted communities and stakeholders and (b) the territories for which the project seeks higher-quality benefits or from which some support is expected. Each beneficiary (direct or indirect) and each stakeholder requires an appropriate treatment for their involvement. Building social networks within beneficiaries is relevant for their decision-making around the adoption of innovations.

Educational methodologies may consider approaches to develop autonomy and governance, taking into consideration patriarchal and paternalistic cultures in communities and institutions.

Establishing synergies between the project team and the stakeholders is an important input to scale up innovations. A diagnostic of possible stakeholders with territorial importance is a criterion when selecting them. Their interests, values, objectives, and activities in the territory should be established for dialoguing to build synergies. Dialogue is a fundamental input since it soughs that all the participants contribute, learn, and benefit.

This model highlights the importance of team members who implement the project as stakeholders. The team members require special attention in order to achieve the scaling up goals, as well as, they must benefit in the process. In the design of the model, and in the project implementation the team members must benefit from learning in a multidisciplinary environment. This is especially relevant in the training of the young scientists who learn to tackle complex challenges with a trans-disciplinary approach.

4.1.4. Trans-Disciplinary Implementation through Technical Components

Trans-disciplinary decisions and monitoring are basic for successful leadership of the technical components. Special relevance is that the support from each discipline participating be rigorous to generate robust results with solid scientific knowledge behind that can be taken for decision-makers and contribute to develop synergies for the scaling up.

Staff training of the personnel must include trans-disciplinary work and approximations to the local culture and social change.

Gender equity should be a permanent focal point. For a successful implementation, both team autonomy and confidence in the team members are basic. Timely administrative support is critical in the implementation. The research administration requires trust in the researcher's ideas, their budgets, and a comprehensive flexibility.

4.1.5. Exit Strategy Is Built from the Beginning of the Project

Non-governmental organizations and organizations for rural development are often trapped into indefinite support for the grassroots organizations [40] and many project outcomes are lost after these organizations leave. This model stresses the importance of an exit strategy as a vehicle to guarantee the sustainability of change once the project is over.

The model integrated the different elements for the scaling up in a logical and coherent structure. The exit scenario guided the methodologies to promote and facilitate the appropriation of results by adopters, potential beneficiaries, clients, and friends of the project and to effectively contribute to its implementation and sustainability.

4.1.6. Continuous Evaluation a Strategy to Keep a Unified Whole

Assessing progress and results and a feedback mechanism contribute to making decisions about the necessary changes. The evaluation should be implied in each of the actions of the project, while maintaining a view of the unified whole it is a technical process that contributed to improve and strengthen the achievement of objectives and goals. It is crucial that all team members participate in the construction of goals and indicators for strengthening the trans-disciplinary approach.

4.2. *The More Nutritious Potatoes Project Integrates Successfully a Technological Innovation with Social Change*

The project links agriculture with nutrition supported by social innovations, FFCS and *Shagras for the life*. The project reaches 6.5 million consumers of more nutritious potatoes in Colombia and establishes a system to produce quality declared seed. These results are important because they respond to a global challenge that is linking agriculture with nutrition [41,42].

4.2.1. Basic Guidelines for Scaling up Projects

In relation to the guidelines of an IDRC call, a leader of More Nutritious Potatoes project underlines scaling up innovations (and research results) can be defined as the process of increasing the reach, breadth, scope, and sustainability of the changes, benefits, and solutions that innovations bring to people. Scaling up means sustainability and therefore: (i) Innovations can self-perpetuate or replicate after finishing the project. (ii) Partnerships are essential: Civil Society, as well as public sector organizations, may also be included in scaling up partnerships. (iii) Innovations should be particularly beneficial to poor rural populations, particularly women and smallholder farmers, (iv) New and creative ways to empower women at all levels and stage of the research need to be built into scale-up initiatives. (v) Scaling up initiatives deliver meaningful development outcomes through the effective deployment of scaling up models, mechanisms, and approaches. (vi) Scaling up may occur when an innovation is used by an increasing number of people in different geographical areas, countries or even continents. It may also occur when innovations provoke meaningful changes in livelihoods, in organizations and businesses, in market relations, and in policy configurations [43].

4.2.2. The Vision of the Exit Scenario Invites Clarification of the Institutional Ethical Parameters

The exit scenario design involves ethical thoughts regarding aspects such as the highest ends of education, the role of external agents in social change, the importance of building governance and peace in the territories, the relevance of women as change agents, and the preservation of the environment.

The exit scenario in this project understood social change as those small changes in the life of individuals and communities that allow the development of equal opportunities for adequate access to resources, especially food, and to advance in values such as tolerance, solidarity, justice, non-violence, equity in the relationships of gender, the promotion of dialogue for the solution of conflicts, and the appreciation of respect, solidarity and trust for the construction of social fabric, as well as, stimulating the influence of civil society in local public policies.

4.2.3. Definition of the Scaling up Objectives

For defining the objectives, considers relevant aspects of the context: (1) that low levels of productivity and food insecurity are associated with poverty, and social inequality as was established by the National Planning Department, in 2008, in Colombia [44] and (2) the low impact of public policies [45]. It was useful to analyze the social, demographic and nutritional status of the Nariño population, as well as, public policies and organizational contexts regarding food security and nutrition and potato production and consumption [46].

The most prevalent nutritional problems in Colombia are anemia and deficiency of several micronutrients. A high percentage of pregnant women have a prevalence of iron deficiency anemia. Indigenous and afro-population showed the highest prevalence of malnutrition in children [19]. There are public policies related to guaranteeing a balanced diet for children and food security, adopting gender equity and environmental protection practices [34].

A major problem in scaling up of new potato varieties was the availability of sufficient seed potato tubers for the crop. This problem was very limiting because there were no producers of good quality seed potato tubers in Colombia. Medium- and small-scale potatoes producers did not use certified seed. Less than 5% of potato producers in Colombia had access to registered seed potato tubers [47] and small-scale farmers do not have access to good quality seed [48,49]. To include as an objective, the development of a system of good quality seed is crucial for the sustainable production of the new varieties. This objective also considered that the most important productivity barrier for small-scale potato farmers in Colombia is the bad quality of seed. As the potato multiplication is based on tubers, thus, the spread of diseases and pests is favored since tubers are a vehicle to contaminate soils and spread potato sanitary problems.

The size of the scale defined considered that tuber shape, color, size, and organoleptic properties of the new varieties do not affect consumption patterns of potato consumers, neither prices nor marketing channels. Besides, the government develops a national campaign to increase potato consumption and the Ministry of Agriculture and Rural Development promotes the distribution of certified seeds to improve production systems, especially for small-scale farmers [49].

Regarding the organizational context, the objectives take advantage that Universidad Nacional de Colombia and McGill University are academic prestigious universities with experience in execution of rural development projects in the Nariño context. These universities have expertise in different and complementary areas of knowledge (i.e., rural development, extension, gender, marketing, food security and nutrition, food chemistry, and plant breeding). The project setup includes technical components and project management with respect to budget and finance, personnel, and resources management. The technical components take advantage of methodologies developed by Universidad Nacional de Colombia in participatory research [22]: Rural Entrepreneurs Nuclei [30] and Schools of Leaders Managers in Sovereignty and Food Security and Nutrition [46].

4.2.4. “What Should Change” Requires a Comprehensive Approach for Scaling up

Decisions on what should change in improving the nutritional status of the population through innovative more nutritious potatoes are based on sound national policies. According to the Concejo Nacional de Política Económica y Social (National Council of Economic and Social Policy) Social 113 [44], National Food Security refers to: (i) the sufficient and stable availability of food; (ii) access; and (iii) timely and permanent consumption, thereof, in quantity, quality, and safety on the part of

all people under conditions that allow their proper biological use to lead to a healthy and active life. Besides, the Law 1355 of 2009 of obesity establishes the importance of promoting a balanced and healthy diet. On the other hand, the evaluation of the implementation of national plans for food and nutrition, states that the biggest problems stem from deficiencies in the integration between sectors and among national, regional, and local levels [45].

In order to have enough potatoes available in the market, it is necessary to secure enough seed for potato production. In the potato production system, there is no precise information on the cultivated area with yellow potatoes nationwide. Fedepapa—the union of potato growers—estimates that yellow potato sown area ranges from 12,200 to 13,863 hectares per year [44]. The average yield for yellow potatoes in Colombia is 12 t/ha. The main challenge, as was written earlier, is that there was no production of certified seed of yellow potatoes [47].

Regarding the availability of new potatoes in the market, the project considered that (i) yellow potatoes consumption is a part of the food and culinary culture of Colombians, especially in the Andean region. A national consumer survey showed that 99% of the households buy potatoes with some regularity [50]; (ii) that the new varieties of More Nutritious Potatoes project present to the consumer very similar characteristics to those of the varieties that are currently in the market but offer better conditions for producers and consumers, and (iii) that short market chains may be favorable for small and medium scale potato producers.

Access to diverse food and new yellow potatoes is increased through: (i) A better income of rural families: profitability of potato seed business, lower production costs, increases in the yield of new yellow potatoes, building, and training capacity for developing inclusive business around seed quality production; (ii) Importance of women in home decision making, as well as better handling of the domestic economy; and (iii) Promotion of home gardens.

To increase the consumption of new varieties, it is important to have that promotion through mass and social media, family education of consumers about the importance of a diverse diet and good eating habits, recognition of the value of the role of women to cope with the malnutrition and obesity double burden, and intervening population vulnerable to micronutrients deficiency. These complementary strategies to address the consume of new varieties allows to introduce the concept of responsible consumption as an axis to improve the nutrition.

Regarding public policies, it is necessary to impact the sectoral policies top-down, and to promote the inter-sectoral dialogue among agriculture, health, and education sectors at the national, regional, and local level. The implementation of scaling up at local level requires the promotion and strengthening of capabilities for local leadership to facilitate bottom-up dialogue to impact the design of public policy proposals.

4.2.5. Defining Strategies to Engage Stakeholders Is a Fundamental Task

A key strategy is to involve different actors with the project objectives to achieve and expand the results. Thus, identifying potential stakeholders and getting in touch with them, getting their commitment was a fundamental task in the implementation of the project.

Trans-disciplinary approach for linking agriculture with nutrition: to improve the availability, accessibility, and consumption of food it is important to link agriculture with nutrition. This strategy involves the achievement of goals requiring expertise from different disciplines in order to interpret the problem and promote solutions. Professionals from nutrition, social work, agronomy, rural extension, entrepreneurship, food chemistry, and plant breeding jointly analyzed and defined intervention activities.

The More Nutritious Potatoes project promotes the production of yellow potatoes with higher nutritional contents and better agronomic characteristics and the production of good quality seed. These activities generate great interest among producers, as they positively affect their financial income and for this reason, it is a good way to motivate other changes, such as incorporating Good Agricultural

Practices, promoting home gardens, improving food security, diversifying the diet, and advancing in gender equity and landscape care.

4.2.6. Synergies Are Important Input

In this project, transparent agreements were meant among the different actors' objectives to achieve and expand results. Synergies were important for achieving objectives and sustainability of scaling up. This process includes clarifying one's own responsibilities, identifying potential stakeholders in different geographical areas, talks to assess their goals, interests, and resources in order to reach agreements on how to work jointly to develop management programs. Trust is basic for building sound relationships with stakeholders, including communities, local authorities, private organizations, and institutions at different levels.

In the project More Nutritious Potatoes initially the partnership was constituted by the academic sector, communities, and the private sector. This private sector was constituted by the social branches of two large companies. The partnership with the companies was not successful due to their orientation in the profits more than in the promotion of social change.

4.2.7. Education to Build Autonomy Is Basic for Social Change in Paternal Cultures

In scaling new varieties, it was intended for small-scale farmers to benefit with the new varieties. The intervention seeking social development and sustainability required building relationships based on enhanced capabilities and skills of individuals and organizations to make decisions supported by the knowledge and related to special circumstances. In this context, freedom of choice is fundamental and allows building trust. Education sought to provide elements for the construction of autonomy and trust among the different participants regarding their own situations. Congruent with this approach, the project developed joint ventures without subsidies with the farmers' organizations to produce seed potatoes in a sustainable way. This autonomy is evident in leadership of the organization to define its organizational architecture, responsibilities, and functions.

Members of the community autonomously designed and are still developing the Community Action Plans (CAP). The plan is an initiative of the project's participants in order for the project to have a larger scope and achieve a sustainable impact for their community. The participants had to work with local officers and CAP constituted an important methodology to build autonomy and dialogue culture.

4.2.8. RRR Strategy Increased Gender Equity

Reports on the development of projects highlight the importance of women to guarantee its success and sustainability. Women were important actors to achieve the objectives of this project and also benefit from its results [51]. The approach followed in the project was the RRR strategy (Recognition, Redistribution, and Representation). Increased women agency (capacities, skills, access to resources) looks for more equitable social and gender norms and relations at household, community, and legal frameworks inclusive and responsive to the needs of both men and women.

4.2.9. A Communication Strategy Should Consider Local and Regional Conditions

It is essential to generate interest and exchange information. This strategy involved identifying the different groups in terms of roles, major requirements, and main expectation of information: (i) Internal information: project staff, direction level, operational level, funding agencies, internal coordination, and direct beneficiaries; (ii) Information with synergetic organizations: local organizations and authorities at national, regional, and local levels; (iii) Information with others: policymakers, academic communities, Colombian consumers, and common potato producers. Communication involved various techniques and disciplines, and relationships with institutional policies. Universidad Nacional de Colombia has its own communication policies [52].

The diversity of beneficiaries of scaling up, their dispersion in the territory, and the different possibilities that they have to access the media, demanding a design of a comprehensive strategy, decentralized, flexible, and adaptable to local and regional conditions of the project.

4.2.10. Technical Components Are Based on Robust Specialties Sensible to the Scaling Project Objectives

The technical components cover the entire scaling up objective and thanks to the trans-disciplinary approach it is possible to go beyond specialties and face the complexity of problems. To work in the field in a trans-disciplinary way was easier than expected in the theoretical design. This is evident at the FFCS. This was possible thanks to the training that achieve the participant's commitment in relation to the strategies to involve stakeholders.

4.2.11. Monitoring Results Should Be Based on Trust and Commitment

The clear definition of the objectives and the methodologies to achieve them allow one to build a picture of the expected results and the way they will be measured.

The synergic work among the technical components implies that results from one component are inputs for the other component but at the same time problems that affect one component may affect the other component. Therefore, this is an important challenge for trans-disciplinary work. Establishing realistic schedules and regular monitoring of advances are crucial. The monitoring should be based on trust and commitment.

In this project, one objective of the planned scale was to reach 1.5 million consumers by the end of the project, however the final result shows 6.5 million consumers reached with more nutritious potatoes. This difference was due to the fact that other actors adopted the innovation thanks to the communication strategy around the novel varieties among the potato farmers and synergies with other institutions.

4.2.12. Involving Local Institutions Is Basic for Exit Strategy

It is important for projects to create conditions for the sustainability of their results over time and reduce the collateral damage caused by the scaling up.

Training technical personnel from the local institutions able to innovate and scale actions to other communities is important to generate sustainability because these institutions remain in the regions, once projects are over.

4.2.13. The Basis of Continuous Evaluation Are Indicators Defined by Technical Components

The Theory of Change facilitates the organization of the evaluation and the measurement of how a program works and what its impact is.

Evaluation incorporated as a continuous action helps to improve the technical feasibility of the project and facilitate the timely introduction of modifications that lead to the achievement of the goals. It is important that each technical component of the project be responsible for monitoring their activities and results. Therefore, the technical components must define variables and indicators and how to measure and record them.

5. Conclusions

The scale up model designed was the result of a long process of negotiation, analyses, agreements, and adjustments to realities to obtain a shared vision of the entire work and its implementation. The scaling up of the technological innovation associated with the scaling up of social innovations was fundamental to achieve social change and sustainability to benefit the target population and to reach users who traditionally do not access the products of scientific research and are marginalized. The model considers it important to stimulate other potential adopters to increase the scale and in this point the communication strategy is key to reach them in the right moment with the key messages.

The elements of the model discussed throughout this article deserves to be applied in different contexts to face complex challenges. The application of the model requires a collective learning environment, in such a way that each specialty contributes to its own responsibilities and reaches agreements with other disciplines to build synergies. The trans-disciplinary approach is relevant and this approach should be based on strong disciplinary knowledge.

The constitution of a partnership is crucial for the success of scaling up. The leading institution must consider the risks in the case of the withdrawal of any partners, especially in the case of private companies. The involvement of partners, as well as, stakeholders should be in the right moment according to the nature of them, their interests, and possibilities. In general, it is convenient to involve them from the beginning of each particular situation.

Building an exit scenario based on a preliminary view of the context, institutional ethical principles, and the possible effects of the short and long-term intervention is an important tool for planning, especially to open minds for the trans-disciplinary work. The exit scenario is also an important guide for selecting appropriate methodologies to promote sustainability of changes and results of the project.

Overcoming paternalism and patriarchy in traditional communities and institutions is a relevant way to generate sustainability of the expansion of innovations, so educating for autonomy turns to be a strategic key.

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