Target oriented scaling pathways for CLCA initiatives for Bolivia and Mexico

COMPONENT 2: Development of a delivery system/participatory farmer-led extension system for accelerating of adoption

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Abstract

This report “Target oriented scaling pathways for CLCA initiatives for Bolivia and Mexico” is an output under *Component 2: Development of a delivery system/participatory farmer-led extension system to accelerate adoption*. The overall project goal is to sustainably increase production and enhance the climate resilience of small farmers’ communities and their crop-livestock production systems in drylands. Local challenges, such as the quinoa boom in Bolivia and soil erosion in Oaxaca, have displaced the livestock sector which has broken the balance between the livestock and agricultural production systems, resulting in unsustainable production systems. The innovations being piloted in this project, or CLCA practices, have to sustainably intensify the crop-livestock system as a whole, not just crops, or livestock but their combination. At the same time other multiple objectives of productivity, soil health and income need to be addressed. The following CLCA practices were selected that address multiple objectives and have potential to be used at large scale in Mexico were 1) Living barriers, 2) Controlled grazing of stubble and forage mixtures, 3) Relay cropping with fodders species, and in Bolivia 1) Improved fallow; 2) improved pastures; 3) windbreaks. We applied the USAID Agricultural Scalability Assessment Tool (ASAT) decision tree diagram to determine the appropriate scaling pathways for each one of the selected practices per country (). The scaling pathways identified were (i) Public sector, with donor support and/or capacity building; and (ii) Public-Private sector, with public or donor support. In year 4, it is suggested that the project team, partners, and stakeholders co-develop and test the business cases with the highest potential for scaling the impact of the selected practices.

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Introduction

Target oriented scaling pathways for CLCA initiatives for Bolivia and Mexico is an output under *Component 2: Development of a delivery system/participatory farmer-led extension system to accelerate adoption*.. Target oriented scaling pathways aim to contribute to foster solutions at scale to the needs of smallholders of integrated crop-livestock systems in the Mixteca Alta of Mexico and the Highlands of Bolivia. This component deals with the articulation of the innovation system model and a knowledge management (KM) strategy to ensure the design, development, and use of an effective delivery system for locally adapted CLCA[1] systems and practices.

Under Component 1 of the project, a variety of seeds, different combinations of rotations, intercropping and fallow, as well as manure and feeding management strategies are being tested in Bolivia and Mexico. Before entering year 4 of the project it is important to identify these CLCA practices (innovations) that perform well, not just technically but also by their potential to be adopted and disseminated by interested local parties, and their cultural, commercial, political fit. Therefore, it is important that these are tangible solutions that address the problem and where the CLCA team has the expertise and credible evidence to convince others that this CLCA practices has the potential to scale.

> We define a **"scaling pathway"** as the **route** to follow to increase the reach of an innovation through different partnerships and approaches. The starting point is a promising innovation and the end point is determined by the vision of change to be achieved. The road may take multiple years and may involve a sequence of interventions. Scaling pathways may vary depending on who drives the scaling process (i.e. private, public, PPP, donor-driven) and how direct ("we replicate X in environment Y") or indirect ("we strengthen the enabling environment for others to scale their innovations") one intervenes. The institutional structures, stakeholders, natural assets and the relationships among them, determine what scaling pathways are possible in a given context.

Our aim was to explore the diversity of innovations of the CLCA project with potential to scale in both countries and asses the possibilities for scaling pathways of selected innovations. This document is divided into four sections. The first section describes the case studies and their problem definition. The second section illustrates the materials and methods. The third section explores target-oriented scaling pathways

[1] Conservation agriculture in crop-livestock systems

for CLCA initiatives for Bolivia and Mexico. And finally, the fourth section gathers the conclusions and recommendations.

1.1 Case studies

CIMMYT is one of the leading institutes for research and development on conservation agriculture (CA) for smallholder farmers (Baudron et al., 2012; Jat et al., 2018). In areas where people mix livestock with crop production, a major challenge for CA is the competing needs for biomass for fodder and mulching for soil improvements. It was found in North Africa that CLCA systems can be profitable if proper strategies for incorporation of forage crops and balanced management of biomass are developed and applied (adjusted to local specificities of farming and agro-ecological systems). The current CLCA projects build on this to expand to dryland areas in Latin America, expand collaborations and link stronger to ongoing development and research projects in Mexico and Bolivia.

1.1.1 Mixteca Alta of Mexico

The Mixteca Alta is mainly classified as a subtropical dry winter climate (Cwb) according to the Köppen-Geiger system, receiving most of the rainfall from June through September (Rogé et al., 2014). Temperatures are higher during April and May, and frosts are common from October through March. However, farmers tend to report an increase on drought and storm intensity, as well as changes on rainy season. The Mixtec people (or people of the rain - *Ñuu savi*) have farmed the semi-arid highlands of southern Mexico for centuries. The Mixteca Alta (Figure 1) is located midway between the Tehuacán Valley and Oaxaca Valley. During the prehispanic history of the territory, intensive hillside terracing was prominent. Afterwards, during the Spanish Conquest and subsequent colonial events, new production systems were introduced, including animal husbandry, wheat, and ox-drawn plow (Rogé et al., 2014).

Nowadays, agricultural systems in the Mixteca Alta are generally mixed agriculture-livestock where animals (i.e. goats and sheep) play a very important role in the livelihoods of farmers due to the generation of products for family consumption or sale, and as a means of saving system. Additionally, manure production serves to improve soil fertility. Rainfed agriculture—particularly maize, beans, and wheat—is widely practiced in the region. There are two types of rainfed maize (*Zea mays*) systems: *cajete* (long term) and seasonal (short term). Additionally, in the Nochixtlan valley is common to produce maize (*Zea mays*) using irrigation systems. The three maize systems differ significantly in their requirements for labor, technology, and social organization.

The CLCA project focuses on the continued and growing challenges of food security, climate change and land and natural resource degradation encountered by mixed smallholder farmers in dry areas of Mexico. Mixed crop-livestock smallholder farmers need to balance incomes, soil fertility and biomass from their livestock and their farm. In the Mixteca Alta, like many other arid and semi-arid areas, agricultural soils are prone to degradation with important consequences for crop productivity. Particularly, this region is marked by a history of severe soil erosion and degradation, as well as social marginalization (Boege & Carranza, 2009; Rogé & Astier, 2015). Moreover, this situation has been exacerbated by climate change effects, resulting in dramatic changes in local farming systems. Decreases in yield due to unsustainable farming practices, lower quality and quantity of farm labor, and limited access to appropriate extension services and technologies have decreased the productivity of the region. Increasing outmigration and an aging population in rural areas complements these challenges (Boege & Carranza, 2009; Rogé & Astier, 2015).

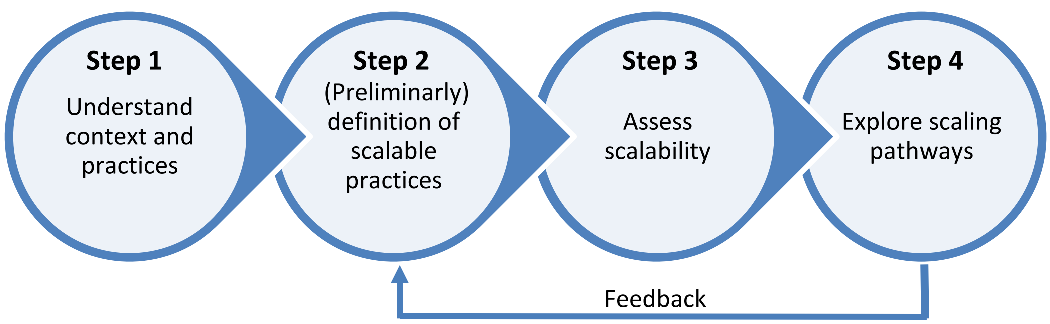
1.1.2 Central and South Highlands of Bolivia

The study concentrates in the Altiplano Central and South of Bolivia. The gradient north south has a decreasing rainfall (800mm-300mm) and increasing importance of Llama. There is a cold desert climate 3800-4600 m altitude with temperatures up to minus 15 degrees Celsius in the winter and annual average temperatures between 4 and 8°C. The rainfall occurs between November and March with a range of 200 to 800mm/year. Frosts occur throughout the year and hail by the end of the rainy period causing serious damage to the few crops and native grasslands in the area. The conditions include low water availability, high winds (16-30 km/h), soil salinity, high solar radiation and low nitrogen soils in Altiplano Sur. This region is origin and main area of Royal Quinoa, which it's characterized with large grain, better price and preferred for export.

The harsh environment of the highlands of Bolivia do not allow many crops or animals to survive. The traditional llama-quinoa system that consisted of about 10% land for quinoa and 90% grazing land for llamas has drastically changed. Currently, intensive monoculture of quinoa and llama production problems such as poor pasture management, water and animal health have decreased crop yields and livestock productivity. With low yields and their resources degraded, millions of livelihoods are threatened by poverty, hunger, resource degradation and forced migration.

Scaling pathways

Meaningful scaling goes beyond the semi-controlled environment of a project, and hast to integrate soft processes such as behavior change, power dynamics and relationships (Woltering et al., 2019). CIMMYT and its partners have a strong focus on impact at scale through coupling science and art of scaling with research for development. To outline potential scaling pathways for each of the cases the following steps guided this process.



Step 1. Understand context and practices.

The project CLCA in Latin America has one intervention in Bolivia and another one in Mexico. To understand the context of each of these interventions the project conditions are describe in the following table.

Table 1. Project (boundary) conditions

Case	Bolivia	Mexico
What?	Local adaptable soil conservation and water use efficiency technologies as well as forage crops and biomass management practices for different CLCA systems in the drylands using agroecological principles and participatory action research approaches	
Where?	Drylands of the highlands – South and Central Altiplano	Drylands of Oaxaca – The High Mixteca
For whom?	The project targets smallholder crop-livestock producers	
	Farmers with quinoa-llama production systems	Farmers with maize-small ruminants production systems
How many?	At least 50% women and 30% youth (below 35 years) small crop-livestock farmers	At least 50% women and 30% youth (below 35 years) small crop-livestock farmers
When	By June 2022	
With whom?	Fundación PROINPA (partner) Universidad Mayor de San Andrés - UMSA (Partner)	Universidad Autónoma de México- UAM (Partner) Fondo para la Paz (Partner)
Why?	To increase farm productivity and income while sustainably restoring land and water resources.	

During the first years of the project we facilitated a process for local stakeholders to define problem statements for what the CLCA innovations aim to solve in Bolivia and Mexico. These are:

- Bolivia: Soil degradation and low fertility due to lack of manure and shortened fallows for llama, as well as decreasing quinoa yields due to poor agronomic management.
- Mexico: Soil degradation and low fertility due to erosion and loss of organic matter and decreasing maize yields and small-ruminants (goat or sheep) productivity.

The target group of the CLCA project are crop-livestock smallholder farmers, which requires innovations according to their production system and context. Component 1 has technically evaluated a range of CLCA innovations for each country, these practices focus either on crop production (e.g. improved crop management), livestock (e.g. improved feed), or mainly on benefiting both (e.g. living fences of forage crops). Therefore, in this step, CIMMYT and local implementing partners in Bolivia (Fundación PROINPA) and Mexico (Metropolitan Autonomous University, UAM) developed a short list of practices per country that address the multiple objectives of the project and have a potential to scale. The multiple objectives of the project are 1) improved crop and livestock productivity, 2) soil and water conservation and 3) improved income of smallholder farmers. The CLCA innovations with a potential to scale are defined as those practices that 1) tangibly address the problem, 2) where the project team has the expertise and 3) credible evidence to convince others of the technical performance (Table 2).

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Table 2. Shortlist of CLCA practices and their description per country as defined by the implementing partners.

Country	Practice	Description
Bolivia	Optimal management of quinoa / *Manejo óptimo de quinua*	Agronomic management based on the use of quality seed, as well as organic pest management and soil fertility.
	Improved fallow / *Descansos mejorados*	Establishment of local legumes (e.g. *Lupinus spp*.) in relay with quinoa or in fallow plots.
	Management of llama manure / *Manejo de estiércol de llama*	Llama manure is collected from the corrals, composted and applied in sufficient quantity to the quinoa fields.
	Windbreaks with forage quality species. / *Barreras rompeviento con especies de calidad forrajera*	Multi-species barriers to protect agricultural plots from wind erosion and/or forage quality.
	Improved pastures / *Pasturas mejoradas o nativas*	Forage species are established - seed or seedling - in grazing areas.
	Food supplementation of llamas. / *Complementación alimenticia de llamas*	The feeding of llamas is supplemented with jipi and probiotics.
Mexico	Intercropping with fodder species. / *Cultivos intercalados con especies forrajeras*	Planting of intercrops with forage species. This planting occurs 10 to 40 days after maize planting, either in mixtures of forage crops or a specific crop between maize rows.
	Relay cropping with fodder species /*Cultivos en relevo.*	Relay cropping with species with forage potential and for soil fertility improvement. These crops are planted approximately 45 days after maize planting.
	Minimum tillage and soil cover with stubble. / Labranza minima y *cobertura de suelo con rastrojo*	Minimal soil movement either with machinery or manually, and if possible, stubble is left to protect the soil.
	Controlled grazing of stubble and forage mixtures. / *Pastoreo controlado de rastrojo y mezclas forrajeras*	Livestock grazing is controlled with mobile corrals where maize was harvested and/or plots where forage mixtures were established.
	Silage of stubble or forage mixtures. / *Ensilado de rastrojo o mezclas forrajeras*	Process of conservation of forage or by-products produced or native plants in order to generate more biomass and conserve it for a longer period of time, and thus feed animals.
	Feed supplementation with nutritional blocks / *Complementación de alimentación animal con bloques nutricionales*	Balanced feed supplement presented in solid form with a certain hardness as a product of a mixture of different ingredients. The grinding of the forage to be used in the region should be considered, as well as the use of molasses, urea and mineral sources.
	Living barriers with dual-purpose crops. / *Barreras vivas con doble propósito*	Planting leguminous species with forage potential on the edges of the plots to control erosion and provide animal feed availability.

Step 2. (Preliminary) definition of scalable innovations

Based on the previous list, a rapid survey on Google Forms was co-design with local team leaders of the project in order to preliminary identify practices with a high a potential of scalability. This process had purpose to assess the practices used in the CLCA project and then select the ones with perceived potential to scale in order to deepen their analysis for scaling. Practices were assessed according to their level of contribution to project objectives and their level of suitability. A selected group of panel of experts and stakeholders of each country participated (15 for Mexico and 6 for Bolivia). Participants scored the level of contribution (from 0- no contribution to 5 – very important contribution) of each practice to the each of the different project objectives (Table 3). It is important to recognize that some innovations are still under technical evaluation and we will have more evidence of their performance in the coming months

Table 3. Categorization of objectives

Category	Objective
Integrated productivity	Increase crop productivity
	Increase livestock productivity
Biophysical	Improve soil fertility
	Protect soil from erosion
	Improve water efficiency
Socioeconomic	Increase labor efficiency
	Generate income

The suitability/reach of innovations were assessed according to geographical focus (plains, hills, slope), type of unit of production (mixed system, mostly agriculture, mostly livestock), and purpose of unit of production (subsistence-commercia, mostly subsistence, mostly commercial). Additionally, for each practice participants had the option to describe perceived technical and scaling challenges.

The accumulated results were scored using the following system::

- 1 point for objective above 30 percentile of each innovation,
- 1 point for suitability/reach above 50 percentile of each innovation,
- 1 bonus point for dual productivity (livestock and crop),
- 1 bonus point for two or more biophysical objectives,
- 1 bonus point for dual socioeconomic benefits.

For Mexico, the practices were scored as shown in Figure 3, and the top innovations were:

1) Living barriers
2) Controlled grazing of stubble and forage mixtures
3) Relay cropping with fodders species.

For Bolivia, the practices were scored as shown in Figure X, and the top innovations were:

1) Improved fallow
2) Improved pastures
3) Windbreak

A validation workshop was organized with the partners and stakeholders who participated in the survey for selecting the top innovations to discuss the preliminary results and to gather feedback about scaling challenges of prioritized innovations. The innovations with the highest scores were selected for a deeper scaling analysis in each country.

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Focus	Objectives							Suitability/reach								
Cateogory	Productivity		Biophisical			Socioeconomic		Slope			System			Purpose		
Practice	Crop productivity	Livestock productivity	Soil fertility	Soil protection	Water efficienct	Labour	Income	Plains	Hills	Laderas	Crop-livestock	Mainly livestock	Mainly agricultural	Subsitence-commercial	Mainly subsistence	Mainly commercial
Living windbreaks	65	60	69	73	64	52	54	9	15	12	12	4	6	11	12	5
Relay crops with foddes species	61	59	65	70	65	53	58	14	13	12	8	13	2	10	9	11
Intercropping with fodder species	65	58	66	69	62	50	60	13	13	9	14	2	4	15	8	2
Minimum tillage and soil cover with stubble	64	51	66	71	63	55	59	10	12	9	14	3	3	10	10	2
Controlled grazing of stubble and forage mixtures	50	61	58	55	44	56	63	15	13	12	8	12	2	9	7	9
Silage of stubble or forage mixtures	38	73	38	36	37	60	65	15	11	10	8	2	14	12	9	8
Feed supplementation with nutritional blocks	30	71	29	30	32	57	67	14	13	9	11	7	5	11	7	7
Cut-off	**47.6**	**58.8**	**54**	**51.2**	**42.6**	**52.8**	**58.8**	**12.4**	**12.8**	**9**	**8**	**2.8**	**2.8**	**10**	**7.8**	**4.4**

Figure 1. Accumulate results by practice according to objectives and suitability/reach - Mexico.

Practice	Crop productivity	Livestock productivity	Dual productivity bonus	Soil fertility	Soil protection	Water efficienct	Multiple biophysc bonus	Labour	Income	Dual socioeconomic bonus	Slope	System	Purpose	Total
Living windbreaks	1	1	1	1	1	1	1	0	0	0	2	3	3	15
Relay crops with foddes species	1	1	1	1	1	1	1	1	0	0	3	1	2	14
Intercropping with fodder species	1	0	0	1	1	1	1	0	1	0	2	2	2	12
Minimum tillage and soil cover with stubble	1	0	0	1	1	1	1	1	1	1	0	3	1	12
Controlled grazing of stubble and forage mixtures	1	1	1	1	1	1	1	1	1	1	3	1	1	15
Silage of stubble or forage mixtures	0	1	0	0	0	0	0	1	1	1	2	1	3	10
Feed supplementation with nutritional blocks	0	1	0	0	0	0	0	1	1	1	2	3	2	11

Figure 2. Valorization of results by practice according to points for objectives and suitability/reach - Mexico.

Focus	Objectives							Suitability/reach								
Cateogory	Productivity		Biophisical			Socioeconomic		Slope			System			Purpose		
Practice	Crop productivity	Livestock productivity	Soil fertility	Soil protection	Water efficienct	Labour	Income	Plains	Hills	Laderas	Crop-livestock	Mainly livestock	Mainly agricultural	Subsitence-commercial	Mainly subsistence	Mainly commercial
Windbreaks	22	19	21	29	19	12	19	6		4	4	3		6		
Food supplementation	11	23	13	12	9	19	23	6	2	5	2	1	4	6		
Improved fallow	27	19	29	26	23	14	20	4	1	5	4	2		4	2	2
Management of llama manure	27	15	27	20	23	16	19	5	1	4	2	4	2	5	2	1
Optimal management of quinoa	26	17	22	23	19	20	26	4		3	3	4		6	2	1
Improved pastures	21	28	23	26	22	16	24	6	1	4	4	1	2	5	2	1
Cut-off	**22**	**18**	**22**	**22**	**19**	**15**	**20**	**22**	**19**	**15**	**20**	**5**	**1**	**4**	**3**	**2**

Figure 3. Accumulate results by practice according to objectives and suitability/reach - Bolivia

Practica	Crop productivity	Livestock productivity	Dual productivity bonus	Soil fertility	Soil protection	Water efficienct	Multiple biophysc bonus	Labour	Income	Dual socieconomic bonus	Slope	System	Purpose	Total
Windbreaks	1	1	1	0	1	0	0	0	0	0	2	1	1	8
Food supplementation	0	1	0	0	0	0	0	1	1	1	2	1	1	8
Improved fallow	1	1	1	1	1	1	1	0	1	0	2	1	1	12
Management of llama manure	1	0	0	1	0	1	1	1	0	0	2	1	1	9
Optimal management of quinoa	1	0	0	1	1	0	1	1	1	1	1	1	1	10
Improved pastures	0	1	0	1	1	1	1	1	1	1	2	1	1	12

Figure 4. Valorization of results by practice according to points for objectives and suitability/reach - Bolivia.

Step 3. Assess scalability

The scalability assessment relies on the 10 ingredients of the Scaling Scan (https://www.cimmyt.org/scaling-scan-a-simple-tool-for-big-impact/) which are used as framework to identify bottlenecks and opportunities of selected innovations. The key challenges shared optionally by participants per practice (collected in the Google Forms) were also categorized according to the 10 scaling ingredients (Jacobs et al., 2018). The following tables gather the key challenges mentioned by country.

Table 4. Scaling challenges per practice based on survey results of Mexico.

Ingredient	Practice(s)/challenge(s)
Technology/practice - An effective and efficient solution for the issue at stake	**Intercropping** - Technification of planting systems. - Impossibility of some other practices (weeding, hilling, herbicides). - Plots far from homes **Relay cropping** - Forage crops in dry season can absorb residual moisture. - Wildlife management (e.g., rabbits). **Minimum tillage** - Need for machinery and herbicide use. **Controlled grazing** - Consider making corrals and rotational animal rotation lots. - Measure trampling compaction - Farmer time to mobilize corral **Live barriers** - Reduction of arable area
Awareness and demand – wish and readiness for the consumer or producer to use the solution	**Intercropping** - Paradigm shift **Minimum tillage** - Changing approach to stubble use and benefit. **Controlled grazing** - Difficult for producers to invest in feedlots, they do not see it as a priority **Complementation** - Provide visible advantages for producers
Value chain – Effective links between actors to pursue their business cases	**Intercropping** - Seed access and availability. **Silage; supplementation** - Access to and availability of inputs. **Complementation** - Access to and availability of ingredients such as molasses, urea, mineral salts. **Controlled grazing** - Access to and availability of suitable materials for corrals **Live barriers**

	- Availability of labor
Finance – Effective financing options for users and other value chain actors	**Complementation** - Block cost
Knowledge and skills – Capacities at individual and institutional level to use, adapt and promote the innovation	**Intercropping; relay cropping** - Species knowledge for crop definition. **Intercropping** - Knowledge of planting densities and planting dates. **Silage; Complementation** - Producer training and consolidation of labor and technique. **Silage** - Knowledge of fermentation and fundamental requirements

Table 5. Scaling challenges per practice based on survey results of Bolivia.

Ingredient	Practice(s)/challenge(s)
Technology/practice- An effective and efficient solution for the issue at stake	**Improve pastures** - It implies forbidding grazing for at least one year, that reduces the area available for grazing. - Consideration should be given to the establishment of improved or native perennial or semi-perennial pastures, so that they really have the desired effect on natural resources and are highly supportive to counteract the adverse effects of climate change within the framework of carbon management. - There is a need to have forages of good nutritional quality, as well as in quantities required by livestock. **Optimal management of quinoa** - Availability of manure in quantities equivalent to the area of quinoa. - Implementation of conservation agriculture with its bases for the generation of plant cover, minimum tillage and crop rotation in the northern and central highlands of the country. **Manure management** - The manure is in areas far from the agricultural area, there are no easy access roads to farm fields. - The small amount of llama manure that is obtained in the Altiplano vs the quantity required for quinoa constitutes a limitation.
Awareness and demand – wish and readiness for the consumer or producer to use the solution	**Improve fallows** - The great challenge is the incorporation of the conservation agriculture methodology with the farmers considering that the process can take a long time.
Value chain – Effective links between actors to pursue their business cases	**Improve fallows** - There is not enough seed or species for every context in the highlands. - The main limitation is seed reproduction.
Finance – Effective financing options for users and other value chain actors	**Wind barriers** - Implementation at the start is a resource-intensive task.
Knowledge and skills – Capacities at individual	**Manure management** - The modalities and timing of application must be adjusted.

Ingredient	Practice(s)/challenge(s)
and institutional level to use, adapt and promote the innovation	
Evidence and learning– Evidence and facts underpin and help gain support for the scaling ambition	**Optimal management of quinoa** - The technological proposal must be based on local evidence in the different contexts of both subsistence and commercial. **Wind barriers** - Soil studies are required in terms of fertility and the requirements for the cultivation of quinoa and others (prior to the use of fertilizers).

The above results were discussed and validated in a seminar with all the consultation participants. The key messages from these discussions are listed below for each country.

➢ Mexico

- All 7 practices are relevant to the project given their particular focus on agricultural systems. Significant progress has been made in the agricultural area, but the implementation and data collection of the silage and nutritional blocks practices planned for this year is still pending.

- To deepen the analysis of the scaling ingredients, we will start with the analysis of living barriers, relay cropping and controlled grazing in mixed systems.

- For future analysis, the indicators/targets should adequately and fairly represent the livestock component.

- The analysis of combinations of practices is of interest to give clarity on complementarity or conflict between practices (related systems analysis of Component 1 of the project)

- We should recognize in the analysis efficiency at the production unit level and between production units at landscape level (e.g. mainly livestock units are organized with mainly agricultural or mixed units to provide fertilizer and food (stubble)).

- For scaling impact, market access is key, as well as supply chains for seeds, materials, etc. and environmental conditions (the 10 ingredients).

- As we go deeper into the analysis of scaling, we should broaden the discussion to other actors, including producers.

- Remains to discuss with the MEL team how to recognize implemented practices recognized in Table 2 (e.g. in Agrology).

- Further research is there is needed to assess a package or "menu" of innovations that consists of core and complementary technologies for crop-livestock systems.

➢ Bolivia

- All 6 practices are relevant to the project given their focus on agricultural systems. Significant progress has been made in the agricultural area, but there is no data of the forage proportion required for the ingestion for the llama, depending on the type of forage.

- Improve fallows could be a strategic option for the area because these grazing areas could regenerate and regain their productive capacity. It is recommended that these large or small spaces be synchronized with the grazing of the animals using mobile electric fences for example, so that the largest number of animals is concentrated in confined spaces, and they are rotated according to function. In the southern highlands, there is little plant cover but if you manage to establish grasses and shrubs from nurseries, and gradually replant and reforest the place and add regenerative livestock, you could see results.

- PROINPA colleagues have been working with kela-kela, and natela grass, which both have good protein. It would seem that we already found the adequate species that adapt to the area and that have a good amount of protein. Now in terms of management, there is normally a controlled grazing at the community level. Therefore, innovations might work better at the community level, and not only at the individual level because farmers don't own big properties.

- Improve pasture is a critical practice to be scaled. The Altiplano has been seriously affected by the climatological issue, initially with the issue of drought and recently in February with hail. There are certain studies of how many llamas should be had to supply a certain surface of quinoa so that they take advantage of the space, and there it is seen that the issue is lack of forage. In the long run, the fences are going to be needed because there are no people to herd the llamas, for example here we have 30 llamas and we don't have a shepherd, so we only rotate fences. Although there are problems with the environment, since there is a concern for wildlife (like vicuñas), but those also accommodate. It is also necessary to manage the animal load and that the producers understand the optimal number of llamas. Producers have to understand that sometimes it is necessary to reduce their stocks through training or convince them, and make them notice that they can gain more in survival of offspring, or gain in weight, or others.

- Key stakeholders: on the topic of quinoa seeds is the INIAF; Bio-inputs with PROINPA; quinoa seed growers is with private companies of Uyuni or Batacamaya; and for the work that includes training seeds with producers in the same communities with the producers with whom FAO has been working (but they are not in the central-south of the Highlands). In the case of machinery for conservation agriculture, FAO has a machinery from Brazil which has been modifying. Suppliers of fences are local to each community. Camelids program has currently a low presence in the region according to participants.

- FAO Bolivia is also interested in the protection of the *bofedales*, which is why some type of fence has been made

- Participants recognized that work at field level has been difficult due to the pandemic and political constrains.

- Generally, farmers do not have an awareness that their lands no longer produce the same, they are moving after 3 years, and the soils are salinizing. The living barriers are interesting because it is seen that erosion is decreasing, and the visual demonstration of the people who live in the area is much more lacking. It is also necessary to recognize opportunities such as the amount of seed… the mesofauna of the soil is also necessary.

- In the southern highlands, people are aware that they are buying on manure 3hrs away from their communities. They are even willing to pay transportation because they know what is needed.

Step 4. Explore scaling pathways

Scaling pathways usually relies a lot on public and private sector leadership. For this step, we apply the decision tree diagram (Figure 5) of the ASAT tool (Kohl & Foy, 2018) for determining the appropriate scaling pathways for each one of the selected practices per country (Table 6). The decision tree allows the team to determine the best overall pathway for scaling (i.e., public, private, or donor-driven) as well as the general roles the other stakeholders can play in the scaling process. After determining the potential pathway, it is suggested that the project team and partners co-develop and test the business cases with the highest potential.

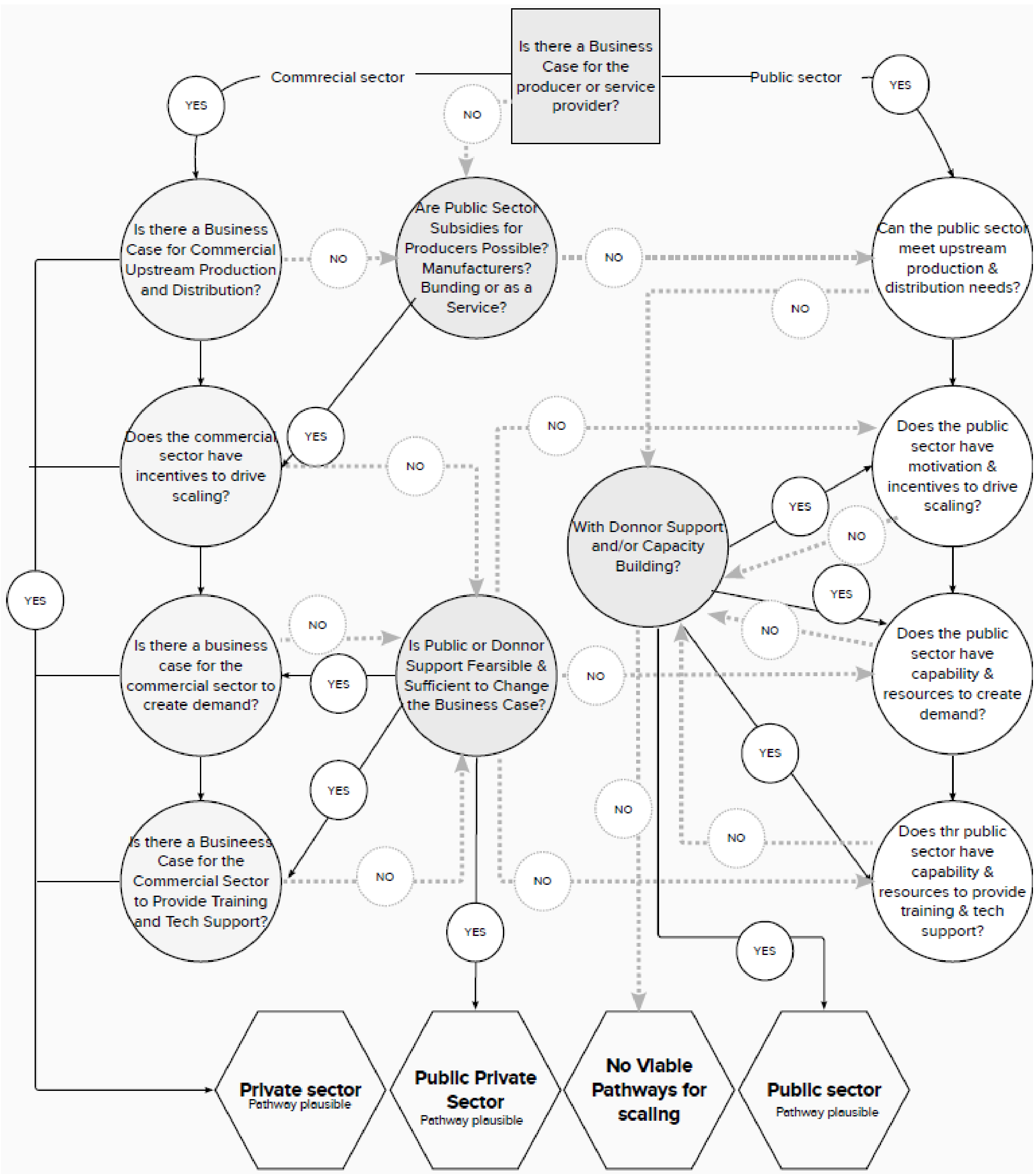

Figure 5. Decision tree diagram for exploring scaling pathways (Kohl & Foy, 2018).

Table 6. Plausible scaling pathways per practice

Country	Practice	Summarized diagram flow	Pathway
Mexico	Living barriers	Business case of seeds for living barriers → Public sector → Public sector can upstream production & distribution needs (*Sembrando Vida* Program) → With donor support and capacity building, public sector can have motivation & incentives to drive scaling → Public sector have the capability & resources to create demand	Public sector, with donor support and/or capacity building
	Controlled grazing of stubble and forage mixtures	Business case of mobile corrals → Public sector → Public sector can upstream production & distribution needs (*Sembrando Vida* Program) → With donor support and capacity building, public sector can have motivation & incentives to drive scaling → Public sector have the capability & resources to create demand	Public sector, with donor support and/or capacity building
	Relay cropping with fodders species	Business case of seeds for relay cropping → Public sector → Public sector can upstream production & distribution needs (*Sembrando Vida* Program) → With donor support and capacity building, public sector can have motivation & incentives to drive scaling → Public sector have the capability & resources to create demand	Public sector, with donor support and/or capacity building
Bolivia	Improved fallow	Business case of seeds of local legumes (e.g. *Lupinus spp*.) → Public sector subsidies → Llama commercial sector have incentives to drive scaling → There is a need to develop a business case for the commercial sector to create demand with public or donor feasible and sufficient support	Public-Private sector, with public or donor support
	Improved pastures	Business case of seeds (e.g. *Lupinus spp*.) → Public sector subsidies → Llama commercial sector have incentives to drive scaling → There is a need to develop a business case for the commercial sector to create demand with public or donor feasible and sufficient support	Public-Private sector, with public or donor support
	Windbreak with quality species.	Business case of seeds → Public sector subsidies → Llama and quinoa commercial sector have incentives to drive scaling → There is a need to develop a business case for the commercial sector to create demand with public or donor feasible and sufficient support	Public-Private sector, with public or donor support

Conclusions

The project goal is to sustainably increase production and enhance the climate resilience of small farmers' communities and their crop-livestock production systems in drylands. Local circumstances such as the quinoa boom in Bolivia and soil erosion in Oaxaca have displaced the livestock sector, but there is a balance between the livestock and agricultural production systems, and when it lags behind this, the whole production system is unsustainable. That is why the innovations piloted by the project, the CLCA practices, have a goal that rather than intensify each of the components of the system, rather intensify the crop-livestock system as a whole. After this analysis and discussions with the project team and partners, we were able to group the practices we had for each country (Mexico: Living barriers, Controlled grazing of stubble and forage mixtures, Relay cropping with fodders species; Bolivia: Improved fallow; improved pastures; windbreak). The practices are interrelated, but we defined them individually to deepen their scaling analysis. It is important to acknowledge, that some of the overall practices are still in their maturation process, and the evidence is in the process of being generated. Scaling pathways usually relies a lot on public and private sector leadership. The decision tree diagram of the ASAT tool helped us to determine the appropriate scaling pathways for each one of the selected practices per country. In year 4, it is suggested, that the project team, partners and stakeholders co-develop and test the business cases with the highest potential for the scaling the impact of the selected practices. However, this will be determined according to the current COVID-19 pandemic and local political circumstances (e.g. changes of governments).

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