



# USE OF CONSERVATION AGRICULTURE IN CROP-LIVESTOCK SYSTEMS (CLCA) IN THE DRYLANDS

FOR ENHANCED WATER USE EFFICIENCY, SOIL  
FERTILITY AND PRODUCTIVITY IN NEN AND LAC  
COUNTRIES

# Progress Highlights: YEAR II - APRIL 2019 TO MARCH 2020

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**USE OF CONSERVATION AGRICULTURE IN CROP-LIVESTOCK SYSTEMS (CLCA) IN THE DRYLANDS FOR ENHANCED WATER USE EFFICIENCY, SOIL FERTILITY AND PRODUCTIVITY IN NEN AND LAC COUNTRIES**

## GRANT NUMBER

2000001630

**International Center for Agricultural Research in the Dry Areas**

*Cover page figure caption. Adoption of Mixtures by women champions to increase forage production, diversify rotation systems and enhance soil fertility in Oued Sbayhia, Zaghouan – North East Tunisia (Credit: ICARDA)  
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## General Overview

In North Africa, Year-II of the CLCA Project was marked by the rapid expansion of the scaling road maps for Tunisia and Algeria. These road maps were co-developed with national partners at the end of year-I. Most of the content of this executive summary will reflect on the progress made from this perspective.

In LAC the development of the project has been slower due to the change in site from Nicaragua to Mexico and the recent political disruptions in Bolivia. However, through partnership with our collaborators in Mexico and Bolivia, activities were carried out somehow normally and the road map for the whole project co-developed.

### Stakeholder engagement and rapid appraisal

The 2<sup>nd</sup> year of CLCA project was successful in further engaging with national public and private partners. In Algeria, the Technical Institute of Field Crops – ITGC (CLCA project coordinator institution) has signed an agreement with the National Company of Agricultural Equipment Production & Trading – PMAT <http://pmat.dz/entreprise> which is one of the largest companies in Algeria for machinery construction. The agreement stipulates that ITGC (in the framework of the CLCA project), provides technical assistance to PMAT for further promoting zero-tillage seeder. The seeder, called Boudour, is now included as part of the commercial strategy of the company and ITGC continues to provide assistance to farmers who are willing to acquire it. This will give a strong push to CLCA in the coming two (2) years, especially in terms of expansion of No-till areas.

In Tunisia, the National Institute of Agronomic Research of Tunisia – INRAT (CLCA Project coordinator institution) continues to successfully cooperate and engage with COTUGRAIN, a private seeds production and commercialization company <https://www.cotugrain.com/en/>. The partnership is set around the commercialization of some forage crop seeds, in addition to some forage mixtures (Vetch-Oat, Vetch-Triticale, Meslin<sup>1</sup>), pre-defined and advised by the CLCA research team. The expansion of the collaboration this year refers to the largest amounts of seeds produced by the COTUGRAIN company based on the recommendation of the CLCA team (oat 100 tons, fenugreek 150 tons, faba beans 30 tons) in addition to the inclusion of new types of forage mixtures (more than 30 tons of forage mixture seeds were launched in the market). It also refers to higher number of farmers engaged by the COTUGRAIN company and technically supported by CLCA team members, to successfully produce these seeds for the company. More than twenty (20) multiplier contracts (Forage seeds multiplier farmers) were established with an area of 300 ha in the different target sites of CLCA Project.

Both Tunisia and Algeria CLCA coordination units also expanded their partnerships towards inclusion of farmers groups and additional public extension systems. In Tunisia, successful discussions have been undertaken with the National Extension Agency - AVFA, to cooperate around integrating some CLCA trainings in their relevant “training centers/regions”. Other workshops were also organized in Tunisia for a number of cooperatives (SMSA) and farmers’ groups (GDA) who were interested to engage in integrated crop-livestock systems agriculture; the objective of these workshops is to set a working framework with farmers’ organizations for

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<sup>1</sup> Combination of four (4) forage species (Vetch, Triticale, Oat, Fenugreek).

a more effective scaling up of CLCA technologies (Organization for scaling (O4S) approach). Compared to the first year of the project, five (5) SMSA-s farmers' organizations have been recruited in testing the CLCA packages and collaborate with the project. The Tunisia CLCA team is currently working to support farmers in Gboullat Site, new site of CLCA Project in North Western Region of Tunisia towards the creation of Farmers' Organization specializing in CLCA practices.

An extended partnership in Algeria has been established by including new farmers associations such as the Cereal and Seed Producers Association – Prodec, the Irrigators association and the Common interest groups – GIC and additional public/development partners (Agricultural Service and Supply Cooperative of Setif – CASAP, Interprofessional Council of Agricultural Sector- CWIF, Cereals/Legumes Interprofessional Council – CIC & CIL). Stakeholder meetings, field days, workshops were held in an intensive pace to pave the road towards exposing all stakeholders to the concept of sustainable integrated crop-livestock systems.

It is also important to mention that CLCA teams in Tunisia and Algeria are now coordinating and synergizing in full partnership their ongoing activities with other ICARDA projects in the same sites such as Food Security Project, ICT2scale, Consortium Research Program (CRP) on Livestock activities (Feeds and Forage Flagship), and/or national programs operating in the same project areas (INGC<sup>2</sup> & OEP<sup>3</sup>/Tunisia, ITELV<sup>4</sup>/Algeria).

In LAC countries, stakeholder engagement and collaborations have been successfully maintained and increased. In Bolivia, our main partner PROINPA has been engaged in deploying actions on the ground and ensuring that different stakeholders (including NGOs and farmers organizations) participate in the project activities. A new collaboration is being built up with the Postgraduate School of Development of the Universidad Mayor de San Andres (CIDES-UMSA) (<http://www.cides.edu.bo/webcides2/>) one of the most prestigious universities in Bolivia in relation to rural development and agriculture. Initial activities with CIDES-UMSA is the organization of a systems analysis course open to a wide range of participants (that needed to be postponed due to the current pandemic) and the application of systems analysis tools by students in the Altiplano Sur and Centro of Bolivia.

In Mexico, collaborations have been formalised with the Department of Crop and Animal Production of the Universidad Autonoma Metropolitana-Xochimilco (UAM-X) (<http://www2.xoc.uam.mx/oferta-educativa/divisiones/cbs/departamentos/paa/>) to test and assess the performance of the current and alternative crop and livestock management systems for improved the sustainability of mixed crop systems. Collaborations with the National Institute of Forestry, Agriculture, Fisheries and Livestock Research (INIFAP) have been defined as well as with four (4) local NGO's in order to test, implement and share alternatives for improved CLCA systems. Through semi-structured interviews a stakeholder mapping was done for the Mixteca Alta in Oaxaca and a workshop with over forty-six (46) stakeholders was organised in February to share the project objectives and structure, identify the main issues related to sustainability of CLCA systems and the main bottlenecks and opportunities for scaling CLCA alternatives (Scaling scan).

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<sup>2</sup> National Institute of Field Crops,

<sup>3</sup> Office of Livestock & Pasture,

<sup>4</sup> Technical Institute of Livestock.

### *Linkages to IFAD investment portfolio*

In Tunisia, discussions with PMU of PROFITS project (Siliana Territorial Development Value Chain Promotion) are very advanced. CLCA team met with IFAD focal point in Tunisia since the start of the project to discuss the collaboration between CLCA project and PROFITS project. CLCA and PROFITS teams met several times to discuss potential collaborations and the terms of an agreement that can be signed between them. Concretization of such an agreement lies within the priorities of CLCA team in 2020.

CLCA project continues to work in the same intervention area of the PROFITS project (Siliana Governorate/Makthar & Bargou Sites). Some of the farmers groups we are supporting are also benefiting from the support of PROFITS project. A mobile seed cleaning and treatment unit and a local feed grinder have been delivered and distributed to farmers' association having 350 members. Out of this number, at least 40% are young farmers (age <35 years). The seed treatment and cleaning machine is helping the farmer association to improve their farm seeds and forage production and consequently promoting forage seeds multiplication. We have also quantified the very encouraging higher integration of forage crops into farm rotations in the target site as a pillar of a sustainable crop-livestock integration under conservation agriculture.

Further to this and to quantify impact on natural resources, the CLCA project has established at the landscape level, where PROFITS projects has its interventions, a measurement network of erosion. This is happening with Chouarnia farmers' association where CLCA packages have been in place for several consecutive agricultural campaigns.

CLCA team also consulted with PRODESUD – Tataouine “Agropastoral Development and Local Initiatives Promotion Programme for the South-East” to define groups of farmers who can benefit from feed grinders for more efficient feeding systems of small ruminants. Tataouine is not an area for cropping but this is a spillover effect to IFAD-investment projects particularly in the area of livestock. More than 100 farmers, members of an Agricultural Development Group – GDA supported by PRODESUD are now benefiting from this equipment & related training. This farmer's association is operating in an irrigated area of Tataouine governorate (extreme South and Arid region) where they are cultivating forage crops for their livestock in complementarity with rangeland grazing and the feedlot system. More quantified data on the use of the feed grinders and its impact on livestock feeding is being collected.

In Bolivia. The CLCA team has used the baseline survey of ProCamelidos to develop a typology of farming systems for five municipalities. These typologies were shared and discussed with ProCamelidos agents and gave their positive feedback on the usefulness of these kind of studies to better target their interventions. Further collaboration was planned where we cross these typologies with agroecological mapping developed by the ProCamelidos team but with the political situation in Bolivia the program got into stand stall and reorganization and it has been impossible to re-connect. ProCamelidos agents were registered to follow the course on systems analysis but it was postponed. Such course can become an important opportunity to intensify the dialog between the CLCA project and the ProCamelidos program.

In Mexico project activities should seek alignments with the program Sustainable Development Project for the Rural Communities of Semi-arid. Zones (PRODEZSA). PRODEZSA has a focus on non-timber forest products for rural livelihoods and, taking into account the important pressure on forest and community pasture for livestock production,

there are some opportunities for collaboration. We are currently planning more landscape approaches which include the forest as well as detailed tracking of herd management to identify where the livestock spends time and what they graze. PRODEZSA agent have unfortunately not being reactive to e-mails.

### **Developing integrated improved crop management systems including reduction of erosion and improvement of water use efficiency**

In Mexico site, erosion due to runoff in slope land is a major threat to the sustainability of the natural resources. Also, foraging in communal pastures is a key activity for livestock production and might also threat such sustainability. Halting erosion by protecting strong slopes with forage shrubs and trees is a key opportunity identified within the project. Forage living barriers for erosion control identified for Oaxaca are, among others, *Rupanea juergensenii*, *Buddleia* sp., *Eupatorium semialutum* (Chate), *Ostrya uirginiana* (Ts'utuj te') and *Luecaena* spp.. This species will be examined in terms of their reproduction and establishment as well as forage quality in year-III.

In Bolivia site, strong winds and almost no vegetation are important causes of erosion and soil water losses. In year-I, a series of species of grasses and bushes were identified for protection soil and water in agricultural fields: tola, qawachi, lampaya and perennial grasses such as pasto paja (*Stipa ichu*), pasto llorón (*Eragrostis curvula*) and alcar (*Agropyron elongatum*) and 2,500 seedlings were produced and installed in farmers' fields. For the second year, over 5,000 seedlings were produced with further production in Year-III accompanied with the training of ten (10) farmers in the production of such seedlings. Decentralizing the production of seedlings for wind barriers (i.e. by individual farmers rather than in a nursery run by the collaborating NGO) represents an opportunity for sustainable impact.

Experimental work on agronomy trials including forage trials, weeding management and soil health measurement (SOM, erosion, water retention, WUE) continues in Algeria and Tunisia as planned in the annual workplan. A detailed description of the main results of the 2018/19 trials and the establishment of the 2019/20 trials will be reported with full details in the 2<sup>nd</sup> year progress report.

In Tunisia, CLCA directly implemented with 92 farmers 1,450 ha between October and December 2019 in the different sites of the project. Twenty-two (22) women farmers (Influencers) have been involved in on-farm trials and demonstration plots under CLCA systems. In addition to the districts of Siliana, Beja, Zaghouan (focus of Year-I), the project activities were extended to the districts of Jendouba, Kef, and Kasserine. This is almost a 3.5-fold increase compared to what has been directly achieved in the first year of the project (440 ha by 70 farmers).

- ✓ Beja: 406 ha implemented by 23 farmers;
- ✓ Zaghouan: 435 ha implemented by 31 farmers;
- ✓ Siliana: 486 ha implemented by 20 farmers;
- ✓ Kef: 75 ha implemented by 11 farmers;
- ✓ Jendouba: 42 ha implemented by 06 farmers;
- ✓ Kasserine: 6 ha implemented by 03 farmers.

In Algeria and similarly to Tunisia, the project activities expanded from the target districts of M'Sila, Setif and Oum El Bouaghi in first year to new districts mainly Constantine, Batna and

Bordj Bou Arreridj. During the second cropping season in Algeria, the CLCA project directly facilitated establishment of 982 ha by almost 241 smallholder farmers (compared to only 316.5 ha and 35 farmers in Year-I).

In Tunisia, the CLCA team has installed four (4) paired Wischmeyer plots in two (2) sites of water basins in which CLCA project is intervening (El Krib and Chouarnia Sites). These protocols aim at measuring and quantifying erosions under CA and conventional systems at the landscape level. They will also serve for additional modeling tasks.

The Tunisian CLCA team also succeeded to publish in this second year a prospective paper about long term CA scope and impact in Tunisia from an agronomic and environmental perspectives. This publication was partly supported by CLCA Project. Main conclusion of this work is the importance of crop modelling approach as a tool to help policy makers in decision making. The study shows how CA based on Zero tillage and soil residue retention vs Conventional Tillage over 260,000 ha contributes to make wheat production more resilient to climate change in Tunisia through: i) Enhancing wheat yield (15%), ii) Improvement of water use efficiency (13% to 18%), iii) Increase organic carbon accumulation (0.13 t ha<sup>-1</sup> year<sup>-1</sup> to 0.18 t ha<sup>-1</sup> year<sup>-1</sup>), iv) Reduction of soil loss caused by soil water erosion (1.7 t ha<sup>-1</sup> year<sup>-1</sup> to 4.6 t ha<sup>-1</sup> year<sup>-1</sup> of soil loss).

The paper also demonstrates the importance of residue retention on the soil surface as a mulch to achieve the benefits of CA. <https://hdl.handle.net/20.500.11766/10157> .

For Bolivia, specific scaling interventions have been identified (e.g. the production of wind break seedlings by farmers or the collection, treatment and establishment of Lupinus seeds for improved fallows) and shared with local NGO's and farmers organizations, as well as with the technical team of ProCamelidos and the scaling pathways within a framework for improved advisory systems is being put in place so as to make the best use of the scaling potential of such partners.

In Oaxaca, from stakeholder consultation it was identified that water scarcity and soil degradation are recognized as major threats to smallholder livelihoods and that there are promising opportunities from a range of sectors to move to a more sustainable production system. The scaling scan was applied and it showed that main bottlenecks to scale CA in crop-livestock systems in the Mixteca Alta are the lack of clarity on business model, limited support by public sector, and scattered leadership and management.

There is no specific agricultural extension service in Mexico and farmers get their technical assistance partly from the Ministry of Agriculture in specific sectorial programs but other institutions, NGO's or private companies play a crucial role. Research, extension and development on small ruminants and maize based systems are hardly combined in Mexico. However, different NGO's have developed and implemented integral projects based on participatory approaches that integrate both components. Large potential is identified in improved communication and collaboration between development and research actors, the government and the private sector as, up to now, interventions are often implemented in isolation leading to unsustainable and short-lived piecemeal innovations.

### **Fine-tuning crop residue use in different geographies and socioeconomic environments**

To enhance the experimental work on fine-tuning stubble use at scale, to improve the efficiency of the feedlot systems and to improve livestock productivity in the different sites in

North Africa, a travelling workshop, held in Tunisia from 1<sup>st</sup> to 4<sup>th</sup> July, targeting participants from Algeria, Tunisia, and Morocco, explored best practices, frameworks and tools related to crop–livestock system under conservation agriculture (CLCA). The workshop assessed the effectiveness and potential of rational summer grazing, residual stubble mulch, and feedlot systems. Additional objectives of the workshop aimed at i) developing quick and reliable field tools to estimate stubble biomass, biomass intake, residual biomass, grazing intensity and to harmonize the methods between teams in target North African countries, ii) selecting the most suitable and flexible practices of forage integration in livestock feeding calendars, which can also fit with CA pillars and contribute to enhanced crop rotation, iii) approaching the livestock feeding systems from the on-farm and landscape point of views, iv) monitor feedlot systems for better efficiency, and v) overseeing flock and health management aspects that may hinder overall flock performance and overall profitability of crop-livestock systems.

Twenty-three (23) participants - technical advisors, coordinators and collaborators who were associated directly with this initiative and other IFAD funded Projects were trained to identify the best CLCA practices. The traveling workshop also enhanced synergies between IFAD-funded projects in the area (<https://mel.cgiar.org/projects/SKIM>) to support exchange on thematic areas and to identify best practices and knowledge products that can be disseminated at scale for better crop-livestock integration. One of the most important output of this traveling workshop was the validation of unified tools for the sustainable use of stubble consistent with CA package, the finalization of a field intervention approach to support the implementation of the scaling road maps of best CLCA packages for the North African countries, and the identification of an extension approach and knowledge management tools for the packages under consideration. <https://www.icarda.org/media/news/improving-integration-crop-livestock-systems-and-conservation-agriculture>

Three (3) journal papers about crop residue and CA & Livestock interaction are now submitted to ISI, impacted journals.

In Bolivia site, A series of alternatives for CLCA systems were identified in Year-I including, among others, improved fallows, rotations and pastures, improved manure management and agronomic practices for quinoa production. Fifty (50) kilograms of Lupinus seeds have been collected and 5,000 seedlings for living barriers. These alternatives have been implemented in forty (40) farmers' fields in the second year to i) assess their performance and ii) be used a discussion platform with farmers on their suitability for their agricultural systems.

In Mexico, the main identified CLCA alternatives are also related to the intensification of the cropping systems through diversification. Options for improved CLCA in the Mixteca Alta of Oaxaca include: Maize rotations and relay cropping with dolichus, sunflower, oats, common vetch, triticale, clover and canola. Their main features for CLCA are described in Year-II and Year-III will be used to assess their performance in already agreed network of forty (40) plots.

In both sites of LAC countries, description of current livestock management systems has been carried out and the bromatological analysis of the main CLCA alternatives is being conducted to assess their contribution to livestock intensification.

## Financially viable business models for No-Till and other agricultural machinery service provision enterprises

While the work on unlocking the constraint of Zero-till machines continues in Algeria and Tunisia (training, advocacy with policy makers and scaling), the CLCA team also engaged on generating business models for livestock-based small machinery. This is particularly in the area of forage seeds treatment and cleaning machines as well as the feed grinders. This was established in collaboration with other ongoing ICARDA projects (CRP Livestock <https://mel.cgiar.org/projects/237>). The demand exceeded expectations and the project financial capacity in Tunisia, and this is where we are seeking support from PROFITS project in the district of Siliana. The distribution of these machines served to enhance small businesses of the recipient farmers' cooperatives. These cooperatives started to rent them at a negotiated cost to their member farmers and generated additional income for the cooperatives. Four (4) mobile seed cleaning and treatment units have been delivered and distributed to farmers' associations having between 150 and 350 members each and are located in different CLCA target areas (North Western and Central regions of Tunisia) – globally, over 1,000 small-scale farmers will benefit directly from these units. Young farmers and women were considered among the beneficiaries and sex as well as age-disaggregated data will be provided in future reports. Besides the seed cleaning units, six (6) mobile grinders have been placed with young entrepreneurs and farmers associations engaged directly with CLCA project.

The grinders can chop and grind material like cactus cladodes and fruits, small olive branches and leaves, straw, hay, date kernels, cereals, faba beans etc which are ingredients of the small ruminants' diets. Low-cost feed supply is a major constraint for small scale livestock farmers, during summer. Through grinding of locally available feed, the intake will be increased, and productivity gained. Almost 1,080 beneficiaries (members of farmers associations) including young farmers and women are now benefiting from this equipment & related training. Recipient farmers associations were carefully selected based on their interest and need for the use of the machine to develop their feed and / or compost business. They either produce and sell the final product or they provide grinding services to farmers. It is an ideal tool for smallholder farmers to improve their incomes which represents an opportunity for improved livelihoods in traditional small-scale farming. These grinders can lead to reducing costs and thus increasing income. The use of these tools can reduce the labor time spent on feed-farming operations, hence enabling more time for small-scale farmers, especially for women farmers. Protocols on how women labour is eased off are being developed together with Gender specialists. The Project is also closely monitoring and coaching these associations to see how these small feed grinding machines are managed in an economically sustainable way.

An important output which is coming from Algeria is the commercial launch in Algeria of the 0-till seeder Boudour which is newly manufactured by the National Company of Agricultural Equipment Production & Trading (PMAT). PMAT decided to assign the twenty (20) available zero-till seeders they have in stock to their different sales points along the cereal-production belt in Algeria. PMAT is now in a position to issue proforma invoices and this has become possible because the seeder is now included in the official nomenclature list of the Algerian Ministry of Agriculture and the seeder is subjected to 30% subsidy when the seeder is purchased individually and 40% when it is purchased by a farmer association. The launch price is a bit over 13,000 USD. Farmers and local companies providing agricultural services

started to acquire such seeders and renting them to farmers in their respective regions. This process was all induced through the signed agreement between CLCA national coordinator (ITGC) and the PMAT signed in June 2018 immediately after the official start of the CLCA-II project, thus providing strong evidence and argument for the ministry to include this zero-till seeder in the subsidy nomenclatures.

In Bolivia, training of farmers in the production of seedlings for wind breaks and seeds for improved fallows is ongoing and such process will allow to break dependency to the project and generate potentially novel enterprises in the region. In Mexico, there is still a need to identify the effective delivery systems of the different CLCA alternatives identified. In Both cases, farming systems typologies have been developed so as to better target interventions and improve the effectiveness of the different delivery systems to be developed.

### **Developing comprehensive trade-off models**

CLCA team of ICARDA was coordinating a new data collection wave in the additional project sites of the project.

Additional analysis, based on data collected in CLCA I, was conducted to quantify and characterize the use of crop residues, including how much crop residues grazed, sold, and left on the soil to serve as much. This analysis was done for Tunisia (Siliana) and Algeria (Setif). A journal paper about this topic is now submitted to an ISI journal (Agricultural systems).

In relation to that, the team also implemented a Bayesian Belief Network model (BBN) to measure and assess the main drivers of crops residues patterns in the study areas. relevant information has been generated about specific production systems which are putting high pressure on the limited residue resources through grazing.

Two (2) master degrees titled "Assessment of trade-offs related to the use of cereal residues in mixed Crops-livestock production systems of Northern Tunisia" & "Analysis of options for enhancing the large-scale adoption of Conservation Agriculture practices in small mixed-farming systems of North Africa: Case of Tunisia" were successfully promoted under this activity by CLCA researchers at ICARDA.

The CLCA team established a cooperation with Wageningen university (WUR), to use the FarmDESIGN model (developed in WUR, Groot et al. 2012) for multi-criteria assessment and trade-offs quantification of crop residues in both Tunisia and Algeria. The objective is to use this model for the analysis of the new data which is being collected in the new sites of the project.

In each of the LAC sites (Bolivia and Mexico), based on a typology of farming systems, three (3) representative farms were selected with different degrees of integration between crops and livestock. Thorough information for these representative farms has been obtained and used to parametrize the FarmDESIGN Model, a bio-economic whole farm model developed for the multicriteria assessment and design of farming systems.

Multicriteria assessment of current mixed crop livestock systems will be reported and will serve, in Year-III, as the basis for i) further assessment of the impact of CLCA alternatives in relation to crop and livestock management and ii) analyze trade-offs between different indicators and identify optimum use of the resources available for improved sustainability of mixed crop-livestock systems as well as iii) discussion with farmers on the way forward. A

gender focus analysis was undertaken to describe the engagement of different family members in the different crop and livestock activities to take into account such division of tasks on the assessment of CLCA alternatives to empower women and youth.

### **Establishing appropriate monitoring and evaluation frameworks**

The Monitoring, Evaluation and Learning (MEL), Data Management and Geo-informatics Option by Context (GEOC) Learning Week took place in Tunisia 1-7 November 2019. The Learning seminars were led by the MEL Team and RALS Program. The main objectives were to: i) Conduct joint/participatory curation of datasets from Tunisia. This will use the datasets uploaded to MEL as a basis and also include data recorded by CLCA project. At the end of each curation session, a Communication Specialist/Officer shall collect information on the history of data collection and the process and generate a knowledge product, and ii) conduct training on mobile open data collection – Open Data Kit (ODK) for participants drawn from CLCA project and CRP Livestock. <https://www.icarda.org/media/events/monitoring-evaluation-and-learning-data-management-and-geo-informatics-option-context> The demo tool for ODK data collection training was based on the Module A of the CLCA-II project data collection tool. It was used to guide the training using both the ODK builder and ODK XLS approaches <https://hdl.handle.net/20.500.11766/10369>.

After this training, two (2) CLCA data collection forms were designed and operated in ODK tool for use in Algeria and Tunisia (<https://hdl.handle.net/20.500.11766/10570> & <https://hdl.handle.net/20.500.11766/10569>). The required data will be used to monitor and systematize the progress on the fields. Trials' and farmers' data describing the management of crops, yields, costs, dates and crop status will be captured through these tools. Data collectors will be local stakeholders and their extension agents who can work online and offline in the field, save submissions at any point and – once they are finished – send them to the project servers. ODK Collect uses the Android platform and supports a wide variety of question types: text, number, location, polygons, multimedia, and barcodes.

Different protocols and data collection tools have been developed and implemented to be used in Bolivia and Mexico in order to gather and organize data collected such as workshop participants, primary soil and crop information, land use classification). In each site, a network of forty (40) plots has been established where CLCA alternatives have been or will be implemented and used to assess the performance of the different alternatives and as support to discuss with farmers and generate capacities around the technologies developed and recommended.

### **Knowledge Management and Sharing**

To deepen the knowledge on CLCA packages, field days and trainings are organized. In Tunisia thirteen (13) capacity development (CapDev) events were implemented, where a total of 430 participants consisting of local farmers, extension staff, local authority, experts, researchers, policy-makers and students have been provided with skills and information concerning: i) CA practices including crop residue management, ii) direct seeder use, iii) best agricultural practices under CLCA systems, iv) best agroecological practices under CLCA package, v) forage crops & mixtures, vi) animal health for profitable integrated crop livestock systems and vi) the procedures and steps to organizing a smallholder Farmers' association (SMSA). From this total, at least 30% of the participants were women, achieving one of the targets of this project to promote gender inclusiveness.

In Algeria, fifteen (15) CapDev events on “stubble management”, “forage seed production”, “weed control”, “use of Boudour - direct seeder and calibration”, “best agricultural practices under CLCA system” and “stubble management under CLCA” took place with a total of 695 participants. Topics were repeated in the different intervention areas of the project.

In order to create more demand and awareness, SMS as an ICT tool has been introduced in both countries. Algeria has used Data SIM Application to send awareness SMS to 530 farmers (13% women) and invite them to CapDev events, whereas Tunisia developed in collaboration with other ongoing ICARDA project (ICT2scale) more than twenty-five (25) technical SMS messages related to CA, Livestock, forage and crop rotation reaching out to 700 farmers in the target areas of CLCA project. These tools are now being extensively used by the project teams in Algeria and Tunisia to keep momentum with the farmers during the lockdown periods and to collect some of the data that farmers themselves can measure or report.

In Bolivia, knowledge products have focused this 2<sup>nd</sup> year into technical documents describing the CLCA alternatives identified for Bolivia, the organization of field days to share the experiences with a larger group of farmers (ca. 40) as well as the participation in conferences presenting results from the field activities implemented. Partnership with local universities have been developed (UMSA in Bolivia and UAM and UNAM in Mexico) and it expected that in Y-III graduate and undergraduate students participate in CLCA project activities. A systems analysis course was designed and organized together with UMSA-Bolivia and UNAM-Mexico for Bolivian partners and graduate students to be carried out on the third week of march, but it had to be postponed due to the current situation. A similar course will be organized in Mexico in Y-III.

In Mexico, a workshop with forty-six (46) stakeholders was organized to present the project objectives and rationale and to discuss the main critical issues and potential solutions for sustainable CLCA systems.

### **Gender focus**

In Tunisia and during this second year, the project targeted an important site in Oued Sbaihya Region which is located in the North eastern regions of Zaghuan, approximately 4,500 ha in size, where livestock production (sheep and goats) is essential for the livelihood of the farming communities. Over seventy (70) households inhabit the area with an average of five (5) persons per family. The main income is generated through olive production and extensive small ruminant production. This extensive farming is dominated by ruminant livestock (especially small ruminants), which are mainly reared by women farmers. According to the Regional Commissariat for Agricultural Development (RCAD), the livestock number is about 3,030 sheep, 1,390 heads of cattle and 1,220 goats. Livestock is of the extensive type and herds are fed mainly from scrubland forest trails, fallow and stubble-residues of cereal crops without movement outside Oued Sbaihya-watershed. Moreover, according to the RCAD, forage resources cover only 60% of the needs of the livestock herds that are increasing the possibilities of overgrazing the rangelands. To increase forage and livestock production, diversify rotation systems and enhance soil fertility, fourteen (14) women farmers (influencers) (most of them are active farmers) were selected from this site and involved in on farm trials on CLCA systems, more precisely in the adoption of forage mixtures (Vetch-Oats). All of them are members of Women Farmers Association called “Women's group for Agricultural Development /Oued Sbaihya (Groupement Féminin de Développement Agricole - GFDA)”

which is now a new partner of CLCA project having about seventy-nine (79) permanent members.

A training on forage mixtures was organized for all the members of the women group (GFDA) in Oued Sbaihya. The objective of the training was to raise awareness, promote and educate women farmers on the benefits of planting this cereal-legume mixture. The training focused on Vetch-Oat mixture cultivation from soil preparation for sowing to mowing-hay and fodder conservation. Since the training was interactive, all women farmers were given an opportunity to share their knowledge on forage mixture with the trainer and the other participants.

The Women farmers in Oued Sbaihya had indigenous knowledge of forage crops cultivation and acknowledged that it is ideal for animal feeding (sheep, goat and cattle) as well as for, diversification of rotation systems and enhancing soil fertility. However, women farmers had no knowledge of its exploitation and its conservation. They stated that the obstacle they have encountered is the unavailability of vetch seeds in the market, which is causing the low cultivation of vetch and forage mixtures in the region. After the training, fourteen (14) women farmers wishing to cultivate forage mixtures received vetch-oat seeds from the GFDA for sowing areas varying between 0.5 ha and 1 ha.

As part of the capacity building activities and based on the global assessment of the major animal diseases/health issues hampering integration of crop and livestock in the different farming communities/project targets areas <https://hdl.handle.net/20.500.11766/10824> and to pave the road for extending the project activities in conformity with the scaling road map in Tunisia, an animal health training was executed on the 24<sup>th</sup> of February 2020 at Community Based Organization of Oued Sbaihya for their members. The purpose of this training was to initiate the “Community Conversation of Oued Sbaihya” in animal health where we identified animal health issues as a major constraint for profitable crop-livestock integration. The training was developed to provide women farmers and young farmers with evaluation methods, knowledge and specific technical skills to avoid the major animal diseases for better crop-livestock integration under CLCA systems. Animal health is here presented as a novel entry point for profitable crop-livestock integration systems.

Agricultural engineers from the national system in Algeria as well as the Rural Women Unit were trained on conducting women focus groups during the first year of the project. This second year, a focus group held with sixteen (16) women farmers in Setif to understand gender roles and needs in integrated livestock-crop production as well as understanding the impacts and costs of adopting CA and means to mitigate them. These women farmers will be directly integrated into CLCA component activities during the third year of the project.

Understanding the role of different family members in the functioning of mixed crop-livestock systems is essential to envisage the plausible impacts of different alternatives on the empowerment the most marginal and in need. In the two (2) LAC sites, a typology of farmhouse centered on issues related to gender and social inclusion was developed. These typologies were based on ProCamelidos baseline survey data for Bolivia and PROAGRO survey for Mexico. These typologies included, rather than only resource endowments, the social characteristics of the farm households. In Oaxaca, six types of farm household were identified being the marginal feminized farm household (18%), low resource mixed crop-livestock (28%) and agricultural labourers (34%) the most important types. For Bolivia, farm household with a diversified economy (18%), elderly low-income livestock farmers (21%) and

young livestock farmers with limited resources (33%) the most common types. These typologies might be a guiding principle to Tailor project activities and CLCA alternatives towards the most marginal and vulnerable far types.

At the farm household level, and in relation to possible adoption burdens or disempowerment of women and youth through the CLCA alternatives, a detailed description of the engagement of different family members in crop and livestock activities and their decision power was performed. In general women and elderly or kids are in charge of different livestock management practices and decision while men are more in charge in the commercialization of livestock products. Alternatives related to livestock management will need to consider these differences in decision making. In Year-III explicit participatory assessment of the different CLCA alternatives by men and women will be performed for their adjustment and increase their chances of success by properly targeting the communication and capacity building.