Progress Highlights

YEAR IV – APRIL 2021 TO MARCH 2022

CLCA Project

GRANT NUMBER 2000001630

IFAD Investing in rural people
ICARDA Science for resilient livelihoods in dry areas
CIMMYT International Maize and Wheat Improvement Center

Acknowledgment

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Algeria

- Technical Institute of Field Crops **I** ITGC
- Technical Institute of Livestock **I** ITELV
- National Institute of Soils, Irrigation and Drainage **I** INSID
- "Trait d'Union" Association for Modern Agriculture **I** ATU-PAM
- Directorate of Agricultural Services (Setif, Oum El Bouaghi, M'Sila) **I** DSA
- National Company of Agricultural Equipment Production & Trading **I** PMAT
- Setif - "Farhat Abbes" University

Bolivia

- Fundación para la Promoción e Investigación de Productos Andinos **I** PROINPA

Mexico

- Universidad Autonoma Metropolotana-Xochimilco **I** UAM-X

Tunisia

- Institution of Agricultural Research and Higher Education **I** IRESA
- National Institute of Agronomic Research of Tunisia **I** INRAT
- National Institute of Field Crops **I** INGC
- Agency of Livestock & Pasture **I** OEP
- Regional Department for Agricultural Development (Beja, Jendouba, Kef, Seliana, Zaghouan) **I** CRDA

This document is the Progress Highlights Report for the fourth Year (April 2021 – March 2022) of the project titled "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." It provides information on the various activities undertaken during the mentioned period.

Cover page figure caption. Photos from different CLCA sites in NA countries. (Credit: ICARDA/Zied Idoudi)

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Background

The project goal is to sustainably increase production and enhance climate resilience of small farmers' communities and their crop-livestock production systems in drylands. To develop in participation with smallholder crop-livestock producers contextually relevant and gender sensitive processes for enhancing the broad uptake of Conservation Agriculture (CA) within integrated crop-livestock systems in drylands in LAC (Andean drylands, Central American dry corridor and the northern South American savannah) and NEN (Near East and North Africa) regions. The expected outcomes are: i) 3,000 smallholder farmers reached (at least 40% women and 20% youth below 35 years) and 2,100 have directly adopted CLCA farming systems [in four (4) target countries] with increased production and improved cost-benefits optimized by filling research and development gaps; ii) At least six (6) NARES, in addition to decision makers, NGOs and IFAD loan project partners in the four (4) target countries have adopted tools and methodologies for reliable decision making and guide investments on contextually appropriate CLCA system; and iii) At least four (4) effective agricultural innovation systems – one (1) in each implementation area of the four (4) target countries - are coalesced in order to foster broad uptake of CA practices within integrated dryland crop-livestock production systems.

General Overview

In North Africa, Year (IV) of the CLCA project comprised the harvest of the field trials and demonstration plots of the 3rd cropping season as well as the establishment of the 4th cropping season during the fall season of 2021. Although the project closes officially in June 2022, we took the strategic decision to put in place a 4th cropping season in Algeria and Tunisia, hence increasing the number of repetitions across time, and allowing a larger set of data to assess changes/modifications at the system level. This decision also meets one of the recommendations of the mid-term evaluation to expand the planting area under CLCA technologies, and to include more producers. Year (IV) was also marked by a strengthening of the establishment of the scaling and knowledge hubs which became an important relay mechanism for the sustainability of the project innovations after its closure.

In LAC the development of the project has continued to be challenged by the travel restrictions and large events organization. However, thanks to local partnerships, further testing of alternatives for crop-livestock integration and scaling has been possible. More farmers and area under alternative cropping systems have been included in our activities in Bolivia and Mexico and alternative communication strategies have been put in place such as WhatsApp groups, video, and social media posts. Over 2,000 farmers, students and local actors have been exposed and trained on the different alternatives and the demand for capacity building, collaboration and implementation is increasing.

Stakeholder engagement and rapid appraisal

Year (IV) of the project was very active in strengthening of the Knowledge hubs in Algeria and Tunisia was done through additional capacity development and networking activities aiming at connecting these hubs with wider local and regional, research and development stakeholders including agri-processing industries with a converging mission and interest. We have been successful in establishing functional 04 knowledge hubs (KH) in Algeria related to CA, livestock, forage, and mechanization & establishment of 02 additional KHs in Tunisia in the fields of livestock and CA. The most striking example of such KHs is the forage hub which we started establishing in Year (II) of the project and which has reached unexpected level of

maturity in linking women farmers with a large network of public and private actors. In Algeria, the CLCA project has further strengthened its support mission to the national strategy on Canola development.

CLCA project, particularly in Tunisia, continues to synergize with other ICARDA and IRESA projects targeting sustainable use of natural resources. In this respect, one of the new OneCGIAR initiatives on agroecology has selected the “home” transect of the CLCA project between the districts of Kef and Siliana for the implementation of its activities. CIMMYT and ICARDA researchers contributed to the development of the Sustainable Intensification of Mixed Farming Systems (SI-MFS) OneCGIAR initiative based on the learnings produced from CLCA and, although the target countries for the first three-year cycle of this initiative are concentrated in Asia and Sub-Saharan Africa, in the second cycle CLCA countries are to be included.

During Year (IV) we intensified conducting multi-actor national meeting in Algeria and Tunisia. In Bolivia and Mexico more than 2000 farmers, technicians, students, and local actors were reached through field days, presential and virtual courses and events and by the distribution of knowledge products for the promotion and scaling of CLCA innovations. Consultation with local actors in both sites led to narrowing most promising options for improvement of the system’s performance and business models are under construction to ensure their scaling and sustainability.

Main achievements during Year (IV)

The table below summarizes the main achievements during Year (IV) of the project related to some key activities in the project annual work plan and budget for the same year. We deliberately oriented our choice towards the activities which can be easily quantified and that are more indicative of the progress along the scaling pathway and the landscape-piloting stage in North Africa and Latin America and the Caribbean, respectively.

Year (IV) – Main Achievements

Activity	Planned in AWPB	Achieved	Observation
Developing integrated improved crop management systems	Disseminating of integrated improved crop-livestock management packages to 4,000 mixed, smallholder farmers in Algeria and Tunisia covering at least 6,000 hectares in both NA countries	▪ 3,000 ha in Tunisia under various CLCA rotations were established by 150 farmers. ▪ Seeds cleaning machines distributed by the project to four farmers associations in Tunisia were used to clean and treat about 900 tons of cereal and forage seeds (90% are cereal seeds), which is equivalent to 7,500 hectares of land where seeds of good quality were used. ▪ The local manufacturer of the mobile seed cleaning unit "Société Arfaoui Taher" (facilitated and engaged by the CLCA project) has sold over 50 units since 2019, some of them exported to neighboring Algeria. It is important to note that early conception and testing of the machine was supported by the CLCA project. ▪ More than 42 field and extension days have been organized by the CLCA team in Algeria on various CLCA topics, thus reaching more than 1,194 direct beneficiaries. ▪ 7 PhDs, 12 master's degree, and 12 graduated students have been supported by the project and conducted their research in CLCA-related topics. ▪ 10 Agricultural platforms located in 10 provinces of Algeria were targeted and benefited from the CLCA project interventions, thus reaching a total number of 723 beneficiary farmers in the country (38 of them are women farmers). ▪ 2,335 ha of land in Algeria directly benefited from the project intervention (including agronomic and animal feeding/forage) with remarkable increase of the areas cultivated under minimum & Zero tillage. ▪ 39 zero tillage seeders have been mobilized by the project team and partnering service providers during the cropping season 2021/2022 in Algeria to respond to the growing demand of farmers for this technology. Based on the assumption that 1 0-till seeder is enough for 200 ha per cropping season, nearly 8,000 ha should have been indirectly influenced by a CLCA-developed technology.	We compiled here some key quantitative achievements to depict progress in scaling (NA countries) and in landscape-piloting (LAC countries) CLCA activities and innovations

Year (IV) – Main Achievements (Cont'd)

Activity	Planned in AWPB	Achieved	Observation
Developing integrated improved crop management systems **(Cont'd)**	Disseminating of integrated improved crop-livestock management packages to 4,000 mixed, smallholder farmers in Algeria and Tunisia covering at least 6,000 hectares in both NA countries **(Cont'd)**	▪ 750 farmers in Tunisia received 50 SMS each (one on a weekly basis) . The text messages conveyed mobile-designed extension messages in the pillar areas of a CLCA system (CA, forage production, small ruminant management and health and farmers cooperatives and organizations). 13 radio spots per topic (each lasting 1 minute) were designed and recorded and then broadcasted by the national radio station. ▪ During this fourth year, the CLCA project continues to contribute to the "national program for promoting the cultivation of Canola in Algeria". Almost 180 ha of canola have been planted with zero-till seeders [compared to 80 ha in Year (III)]. ▪ In Bolivia 50 kg of wild Lupinus seeds were collected and established 8 ha of lupinus quinoa-relay cropping with 14 farmers who were also trained in collection of seeds and establishment of lupinus. 72 farmers were technically supported to improve their quinoa production through manure application, living barriers, quality seed and pest management, covering 100 ha with a yield increase of 30%.	-
	Scaling out of new forage mixtures and enhanced forage varieties under CLCA farming systems with almost 700 smallholder farmers in both NA countries covering at least 3,400 hectares in Algeria (2,250 ha) and Tunisia (1,150 ha)	▪ More than 1,000 ha of forage mixtures were implemented in Tunisia in different project sites under cereal-forage rotations. ▪ In Mexico, 250 farmers have established forage mixtures covering around 70 Ha. Seed availability was identified as an issue and we have been able to produce and distribute 90 kg of sunflower, 350 kg of oats, 100 kg of vetch and 200 kg of forage pea. In Bolivia 4,500 seedling of grasses and 6,000 of bushes for forage availability increased were produced and distributed to farmers while additional 48,000 seedling were distributed to the IFAD Pro-Camélidos program. 88 farmers were trained on the production of such seedlings in five communities.	The project activities across the 2 regions (NA and LAC) revealed that forage production and feed-based activities are an important entry point for the establishment of more complex CLCA options.
Fine-tuning crop residue use in different geographies and socioeconomic environments	Assess current and alternative feeding strategies for intensification of the livestock component within CLCA systems in Mexico and Bolivia	▪ In Bolivia, nutrition quality of different grasses and bushes was evaluated as well as for Quinoa husk (jipi) and training to ProCamelidos technicians on the use of Quinoa husk for supplementary feeding was carried out. In Mexico, supplementary feeding blocks had good acceptance from farmers and capture wider interest with several	-

Year (IV) – Main Achievements (Cont'd)

Activity	Planned in AWPB	Achieved	Observation
Fine-tuning crop residue use in different geographies and socioeconomic environments **(Cont'd)**	Assess current and alternative feeding strategies for intensification of the livestock component within CLCA systems in Mexico and Bolivia **(Cont'd)**	requests for the manuals and video developed. Live weight changes in sampled animals are continued.	-
Advocating alternative feeding systems and livestock enterprises	Establishing a knowledge hub related to the enhanced practices and management of dairy sheep in the district of Beja - Northwest Tunisia	▪ Early characterization of this hub capacity and need for handholding and capacity development was conducted late 2021; and were followed up by few farm and field trainings on relevant crop-livestock aspects. ▪ The hub encompasses now complementary innovations of the CLCA system and focused on a higher integration of livestock under CA and smart agronomic practices. Introduced innovations are forage mixtures; 0-till seeding; stubble grazing; promoting sheep milk quality and yields; farmers' training on rational health management practices. ▪ We recently extended the introduction of hand-held manual seeders to the farmers of the Hub to promote the seeding of forage mixtures of plots of small size and in rugged landscape.	The KH was implemented in collaboration with Farmers' association "GDA-Eleveurs Brebis du Nord" and the technical support of the regional office of Office de l'Elevage et des Pâturages/OEP (national technical center for the development of livestock and pastures).
	Community-level control of gastro-intestinal nematodes and enterotoxaemia as part of the rational management of animal health under CLCA practices in Tunisia	▪ 13,000 heads of sheep belonging to 185 CLCA farmers were vaccinated against enterotoxaemia and were drenched against gastro-intestinal nematodes in various project sites. This activity was coupled with the delivery by animal health experts of field days to increase awareness.	This activity was supervised and implemented by the regional animal health services in the different districts.
	Extending the Public Private Partnership in Tunisia between "Cotugrain" & "INRAT" to facilitate access of smallholder crop livestock farmers to forage seeds and establishment of seeds multiplication contracts with 40 Farmers adopting CLCA systems over a total area of 500 hectares	▪ 150 tons of forage mixtures were produced and marketed by COTUGRAIN. Seeds were produced in the framework of contracts with farmers in CLCA areas.	-
	Developing new PPP in Algeria for relevant topics to support the exit strategy of the project	▪ A PPP has been signed between the ITGC and a medium-sized private machinery manufacturer in Algeria (Setif) to co-assist each other in the design, manufacturing, and farmers' training on low-cost small machines relevant for the crop-livestock systems in place.	-

Year (IV) – Main Achievements (Cont'd)

Activity	Planned in AWPB	Achieved	Observation
Advocating alternative feeding systems and livestock enterprises **(Cont'd)**	Developing new PPP in Algeria for relevant topics to support the exit strategy of the project **(Cont'd)**	▪ 02 machines have been designed and manufactured, including a seeds cleaning and treatment machine, and a grinder for animal roughage feed. The CLCA project has purchased 4 seeds cleaning machines and 2 grinders to make them available to its beneficiaries and to use them for training. The manufacturer has sold 7 additional units to service providers in different regions.	-
Financially viable business models for no-till service provision enterprises	To develop "Business Model Development" and documenting cost-benefit evaluations of the small-scale mechanization promoted by the project, including forage seeds cleaning & treatment machine, pellet machine, and feed grinders	▪ Brief "Feed-pellets machinery for small-scale farmers livelihood programming: Cost-driven and sustainable solutions for Tunisian's dry land mixed crops-livestock farming systems" is drafted and pending final edits and layout. ▪ Feed pelleting was extended to IFAD loan projects in the south of Tunisia and benefited 65 livestock owners (20 female and 45 male) valorising local-available by-products. Find out more. ▪ 04 cooperatives in Tunisia developed their business models around seed sorting and cleaning machines and treated a total of 908 tons of seeds of cereals and forages (equivalent to sowing a total area of 7,500 ha). Read more. ▪ A financial analysis was conducted to build a business plan for five showcases where the CLCA project has distributed feed pellet machines and provided technical trainings about balance feed production using the machine. The business plan provides a set of economic and financial indicators showing the strong profitability of investing in these machines.	-
Reducing erosion in soils with steep slopes	Quantification of erosion at the landscape level	▪ The CLCA team has installed nine (9) Wischmeyer plots in Siliana site. These protocols aim at measuring and quantifying erosions under CA, minimum tillage, and conventional systems at the landscape level. They will also serve for additional modeling tasks. ▪ The CLCA team trained more than 25 extension agents in Tunisia on "soil-oriented sustainable intensification of cereal-based production systems". ▪ In Mexico and Bolivia, a scaling scan was performed for the different innovations and detailed business model is being carried out for one selected innovation per site.	After assessment of runoff and erosion at various field levels (see previous reports), this is the first time ever evaluation of soil erosion at a landscape level in areas under conservation agriculture (CLCA phases 1 and 2)

Year (IV) – Main Achievements (Cont'd)

Activity	Planned in AWPB	Achieved	Observation
Reducing erosion in soils with steep slopes (Cont'd)	Quantification of erosion at the landscape level (Cont'd)	▪ In Bolivia, 19 new living barriers were installed covering 2,930 meter in farmers' fields and additional 10,000 seedling were produced and distributed for future living barriers with forage aptitude. In Mexico a model for quantifying erosion under different land uses was parametrized and a scientific article published (see publications).	compared to control areas under conventional agricultural practices.
Developing comprehensive trade-off models	Use of the bioeconomic FarmDesign model in Zaghouan, Northeast Tunisia based on 100 surveys – for in depth analysis of production scenarios and their respective impacts on farms profits	▪ One paper on trade off modelling in mixed farming systems in Tunisia was published in an ISI journal with impact factor (IF: 3.044). The paper is entitled "Patterns of Use of Residue Biomass in Cereal–Sheep Production Systems of North Africa: Case of Tunisia". ▪ Another paper focusing on the modeling of crop livestock integration through forage rotations and CA practices using the farm design model in semiarid rainfed condition in north Africa, is nearly finished and provides detailed (biophysical and economic) impacts of different CLCA options once used into the mixed farming systems. The results were generated using a bioeconomic model (Farm design).	-
	Farm level models for multicriteria assessment used to assess indicators and trade-offs in mixed crop-livestock systems in Mexico and Bolivia	▪ A scientific article on the use of modelling and participatory methods to assess alternative from crop-livestock integration has been finalized, translated, and sent to the bilingual journal AgroCiencia. It is under revision.	-
Identify women's (both women-headed households and women in male headed households) decision-making constraints and develop opportunities for effective involvement in the adoption of CLCA systems	600 women in Tunisia and 320 in Algeria to be directly reached by the project through trainings, field days or exposed to the different KM products which are developed in the framework of the project	▪ Research in Tunisia addressed how digital extension can address gender inequality in rural areas in the context of the COVID-19 crisis by designing and evaluating the gendered impacts of a digital extension intervention delivered to 624 farmers (363 men and 261 women) which included phone distribution, radio, and SMS messages, and sharing of information prompts. ▪ Sixty (60) women farmers (Pioneers) have been involved in on-farm trials and demonstration plots under CLCA systems in Tunisia.	-
Testing of effective service delivery mechanisms for machinery, agronomic and livestock services	Promoting farmers' associations in Tunisia and Algeria (especially women-exclusive farmers' association) for effective scaling up CLCA systems	▪ The CLCA project team has invested to create a farmers' association devoted to promoting conservation agriculture, and particularly zero-tillage in the region of Gboullat (Beja). This region had strong potential in terms of CA adoption. A total of 15 farmers were engaged as a	CLCA project engaged an expert on farmer association to facilitate the creation of the SMSA. The general

Year (IV) – Main Achievements (Cont'd)

Activity	Planned in AWPB	Achieved	Observation
		starting nucleus to create a cooperative having in its agenda a strong focus on promoting soil conservation through CA, among others.	assembly of the SMSA is fixed on April 19, 2022.
Testing of effective service delivery mechanisms for machinery, agronomic and livestock services **(Cont'd)**	Promoting farmers' associations in Tunisia and Algeria (especially women-exclusive farmers' association) for effective scaling up CLCA systems **(Cont'd)**	▪ The CLCA Algeria team has organized a traveling workshop in December 2021, to all the project intervention areas, and met with about 140 local partners to strengthen their understanding and application of the Knowledge Hubs principle. ▪ A study exploring the level of mastery of the CLCA package was conducted with 31 extension agents in Tunisia, who were interviewed (through a structured interview guideline) about the definition of the CA concept, the knowledge of good CLCA agricultural practices, and the most relevant information they know about CA. the results shows that 81% of these are highly mastering knowledge on CA, and 51% of them have been directly involved in the extension about CA. ▪ The CLCA team in Algeria have created two additional knowledge hubs including: • KH on CA in Setif, which integrates CA with livestock production, • KH on forage crops in Ain M'lila which integrates forage crops with livestock production.	

Linkages to IFAD Investment Portfolio

In Tunisia, we have set a priority to conclude and agreement between CLCA project and IFAD-investment project PROFITS (Siliana Territorial Development Value Chain Promotion). In previous reports we have reported the continuous attempts since the start of the project of the CLCA national coordinator to establish contacts with PROFITS management team to discuss and formalize the collaboration between both IFAD projects and to discuss the possibility to sign an agreement for potential collaboration. Unfortunately, there was no feedback from focal point of PROFITS project. Nevertheless, CLCA project continues to work in the same intervention area of the PROFITS project (Siliana Governorate/Makther & Bargou Sites). Some of the farmers groups which CLCA is supporting are also benefiting from the support of PROFITS project. As an example, a mobile seed cleaning and treatment unit was established within the farmers' association in Chouarnia/Siliana and in the fourth year of the project, more than 500 tons of cereals and forage seeds were processed. These interventions are in line with the global orientation of PROFITS which aims at enhancing the livestock value chain in the region through better production and feeding techniques. The CLCA activities in Siliana allows farmers to improve their farm seeds and forage production and many of them are now contracted by private seeds companies to be forage seeds producers.

CLCA in Tunisia was also able to mainstream some spillover effects, concerning small machineries, to other IFAD projects operating in the south of the country. Although the area (because of its aridity) is not suitable for CLCA systems, the joint interest revolved around livestock and particularly the small machinery to promote collective feed production. Three farmers' associations targeted by IFAD project PRODESUD approached CLCA project to establish their business models around the activities of feed grinders and feed pelleting machines. PRODEFIL project has also distributed mobile grinders and pellet machines to young entrepreneurs in the governorate of Medenine to support local pastoral territorial development and alternative feeding resources. This type of small feeding machinery has a strong impact on lowering the grazing pressure on rangelands. One of the small projects created by a young entrepreneur and supported by the PRODEFIL has acquired a grinder and two pellet machines which have been earlier tested, validated, and disseminated by the CLCA project.

In Bolivia, an agreement has been signed between PROINPA and ProCamelidos to collaborate in the production and distribution of grass and shrub seedlings and more than 50 000 seedlings were provided to the ProCamelidos program as well as technical backstopping for the use of Quinoa husk for supplementary feeding of llamas (link). A joint virtual event was organized together with ProCamelidos around soil and water management in the context of climate change followed by 583 participants.

Year (IV) – Major Knowledge Management Products and Evidence (Including Publications and Scientific Papers)

Knowledge Product Title	Type	Brief description	Link	Target Country
Patterns of Use of Residue Biomass in Cereal–Sheep Production Systems of North Africa: Case of Tunisia	Journal Article	This paper analyzes the complex relationships of factors influencing residue biomass management in cereal–sheep production systems in semi-arid areas of Tunisia. The Bayesian belief network (BBN) methodology was applied to identify factors enabling the better management of crop residue (CR) at the farm level. Data were collected from 152 farms located in the governorate of Siliana in north-west Tunisia. After designing the complex interactions between different variables that have an influence on the allocation of CR, BBN was also applied as a predictive model by inserting evidence conditional probabilities on the quantity of CR left on the soil and simulating the incurrent changes in the probability state of the remaining network variables. The results show that around 70% of farmers in our sample retain an overall quantity of CR lower than 200 kg/ha. The share of livestock income, livestock herds, cost of livestock feed, and off-farm income are all factors that have a strong influence on residue biomass management.	Click	Tunisia
Effects of spatial resolution of terrain models on modelled discharge and soil loss in Oaxaca, Mexico	Journal Article	The effect of the spatial resolution of digital terrain models (DTMs) on topography and soil erosion modelling is well documented for low resolutions. Nowadays, the availability of high spatial resolution DTMs from unmanned aerial vehicles (UAVs) opens new horizons for detailed assessment of soil erosion with hydrological models, but the effects of DTM resolution on model outputs at this scale have not been systematically tested. This study combines plot-scale soil erosion measurements, UAV-derived DTMs, and spatially explicit soil erosion modelling to select an appropriate spatial resolution based on allowable loss of information. During 39 precipitation events, sediment and soil samples were collected on five bounded and unbounded plots and four land covers (forest, fallow, maize, bare land). Additional soil samples were collected across a 220-ha watershed to generate soil maps. Precipitation was collected by two rain gauges and vegetation was mapped. Two UAV campaigns over the watershed resulted in a 0.60 m spatial resolution DTM used for resampling to 1, 2, 4, 8, and 15 m; and a multispectral orthomosaic to generate a land use map. The OpenLISEM model was calibrated at plot level at 1 m resolution and then extended to the watershed level at the different DTM resolutions. Resampling the 1 m DTM to lower resolutions resulted in an overall reduction of slope. This reduction was driven by migration of pixels from higher to lower slope values; its magnitude was proportional to resolution. At the watershed outlet, 1 and 2 m resolution models exhibited the largest hydrograph and sedigraph peaks, total runoff, and soil loss; they proportionally decreased with resolution.	Click	Mexico

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Cont'd	-	Sedigraphs were more sensitive than hydrographs to spatial resolution, particularly at the highest resolutions. The highest resolution models exhibited a wider range of predicted soil loss due to their larger number of pixels and steeper slopes; soil loss proportionally decreased with resolution. The proposed evaluation method showed to be appropriate and transferable for soil erosion modelling studies, indicating that 4 m resolution (>5% loss of slope information) was sufficient for describing soil erosion variability at the study site.	-	-
Better Crop-Livestock Integration for Enhanced Agricultural System Resilience and Food Security in the Changing Climate: Case Study from Low-Rainfall Areas of North Africa	Book Chapter	During the 4th Year, the project team synthesized the research and development activities implemented in NA countries within CLCA project on options for the better integration of crop and livestock system in low rainfall areas in North Africa. System that integrates crops and livestock under CA are recognized as resilient smart and sustainable models for production in fragile and conflict -affected situations where critical inputs such as fertilizers and seeds become unavailable as local or international imports dry up or prices rocket. Key integrating factors for the sustainable intensification of crop-livestock systems include alternative grazing/feeding systems, crop diversification, integration of tree-crops and livestock, conservation agriculture (which balance the tradeoff between leaving residues as feed for livestock and leaving them as mulch for the soil), scale-appropriate mechanization, and herd health management. Combining all or a few of these components helps to improve overall farm incomes, crop productivity, soil quality, input use efficiency, and the provision of healthy protein in the human diet, and fodder for livestock consumption. Integrating livestock into cropland also provides the potential advantages of a sustainable intensification strategy. For wider adaptability innovations at farm level need to consider the following: (i) developing upscaling approaches and innovation hubs, as collective agricultural systems for crop-livestock integration; (ii) understanding and clarifying the different forms (complementarity, synergy, substitutions, etc.) of crop-livestock integration specially under a CA- based approach, assessing benefits (economic, social, etc.) and limitations, and identifying mechanisms to support these forms beyond the farming context; (iii) establishing and empowering public-private partnership development and coordination (e.g. for mechanical no till seeders, mobile seed cleaning and treatment machines, mobile feed grinders, forage seeds); and (iv) investing public funds in supporting forage-based crop-livestock farming and research, (including forage seed systems) rather than cereal monocropping or industrial-scale meat and milk production.	Click	Algeria Tunisia

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Tunisian Consumer Quality Perception and Preferences for Dairy Products: Do Health and Sustainability Matter?	Journal Article	Consumer awareness about dairy quality increased in the last years, specifically after recent food incidents worldwide (aflatoxin contamination in Europe, 2013, E. coli outbreak in the USA, 2015). In Tunisia, food security and sustainability are at the center of agricultural and food strategies. Therefore, data collected from a face-to-face survey of 214 participants in three cities of Tunisia were analyzed with the aim to identify the general trends of dairy consumption in Tunisia. A factor analysis was conducted to define the way consumers perceive the concept of dairy quality with regards to health and sustainability perceptions. Then, by means of cluster analysis we explore the existence of specific consumer types in relation to dairy quality perceptions, with clear-cut and statistically solid socio-demographic and behavioral profile. Three consumer types were highlighted to evaluate dairy quality, based on different quality dimensions, such as health and sustainability, experience, visible quality, brand name, price, and innovation. The results show the emergence of a specific segment of young and older consumers, more educated, and with health and sustainability concerns toward dairy quality.	Click	Tunisia
"Dear Brother Farmer": Gender-Responsive Digital Extension in Tunisia during the COVID-19 Pandemic	Journal Article	Providing farmers with essential agricultural information and training in the era of COVID-19 has been a challenge that has prompted a renewed interest in digital extension services. There is a distinct gender gap, however, between men's and women's access to, use of, and ability to benefit from information and communication technologies (ICTs). The overall purpose of this research is to examine how digital extension can address gender inequality in rural areas in the context of the COVID-19 crisis by designing and evaluating the gendered impacts of a digital extension intervention delivered to 624 farmers (363 men and 261 women) (which included phone distribution, radio and SMS messages, and sharing of information prompts) in northern Tunisia. In order to assess the effectiveness of gender-responsive digital extension that targets husband and wife pairs, as opposed to only men, we employed logistic regression and descriptive statistics to analyze a sample of 242 farmers (141 women and 141 men). We find that phone ownership facilitated women's access to their social network, as well as agricultural information and services, ultimately improving their participation in household decision making and agricultural production. We find that gender-responsive digital extension is effective for men and especially women in terms of usefulness, learning, and adoption. We identified education level and cooperative membership as important factors that determine the impact of digital extension services on farmers and demonstrate the positive impact of radio programming. We recommend strengthening phone access	Click	Tunisia

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Cont'd	-	for women, targeting information (including through non-written ways) to both husbands and wives, using sharing prompts, and more rigorous extension for knowledge-intensive topics such as conservation agriculture and rural collectives.	-	-
Long Term Effects of Tillage–Crop Rotation Interaction on Soil Organic Carbon Pools and Microbial Activity on Wheat-Based System in Mediterranean Semi-Arid Region	Journal Article	Conservation agriculture based on no-tillage (NT) and crop rotation allows to enhance soil health. Based on data collected from long-term trials in a semi-arid region of Tunisia, results showed that NT increased significantly soil organic carbon stock (SOCS), soil microbial biomass carbon (SMBC), arbuscular mycorrhizal fungal (AMF) root colonization , and soil microbial respiration (CO_2) at 0–20 cm topsoil layer compared to conventional tillage (CT). Moreover, triennial rotation (TRI), based on annual succession of Faba Bean-Durum Wheat-Barley, and biennial rotation (BI), based on annual succession of Faba Bean-Durum wheat, increased significatively SMBC, AMF, and (CO_2). Likewise, a significant benefit of the two-way interactions Tillage × Rotation was observed. Furthermore, NT combined with TRI recorded the highest SOCS (2181 g C m^{-2}), SMBC (515 mg C kg^{-1} soil), AMF (14%), and CO_2 which is an indicator of soil microbial respiration (1071 mg CO_2 kg^{-1} soil). The current results highlight the benefit adoption of minimum or (NT) combined with crop diversification on soil health.	Accepted and will be online soon PDF Journal Article_Long Term Effects_CA.pdf	Tunisia Algeria
Stubble Quality of Wheat Grown Under No-Tillage and Conventional Tillage Systems, and Effects of Stubble on the Fermentation Profile of Grazing Ewes' Ruminal Fluid	Journal Article	Conservation practices that involve leaving mulch on the soil are known to increase soil fertility. However, mulch is an important source of feed for ruminant livestock. Accordingly, the trade-offs between mulching and stubble uptake by livestock are currently hot topics in the research field. In this study, a comparison between the quality of stubbles of wheat grown in no-tillage and conventional tillage fields and the rumen fermentation characteristics of Barbarine ewes grazing in the two fields was carried out. Samples were collected four times after wheat grain harvesting. Immediately after harvest, stubble biomass was slightly higher under no-tillage than conventional tillage. The ewes displayed different grazing behavior, with feeding at a higher rate on the conservative stubble than the conventional stubble. This feeding behavior seemed to be an adaptive strategy to offset the decline in the nutritional quality of stubbles from no-tillage-grown wheat. Indeed, dry matter, protein, fiber, and ash contents were lower in stubbles from no-tillage than conventional tillage at the second sampling time.	Accepted and will be online soon PDF Article_Rumen_Stubble_Conservation_Agri	Tunisia

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Cont'd	-	Consequently, the concentration of the volatile fatty acid, propionic acid, was lower in ewes grazing in the conservative plots. However, this feeding behavior did not cause any body weight impairment during the two-month experimental period. At the end of grazing, the no-tillage practice was found to be comparable to the conventional tillage system according to the amount of residue remaining on the soil surface. Therefore, no-tillage could not be used to solve the competition between crops and livestock for residues.	-	-
"Oh Brave ! Tunisian Women Farmers"	Movie	In Tunisia, three main fields of empowerment were carried out by the CLCA Project and conducted as part of the New Directions for Equitable Results (GENDER) Platform: 1. Empowerment in decision making about agricultural production and use of productive assets through enhancing women access to information and technology. 2. Enhancing women leadership in communities through i) improving the inclusiveness of the existing community-based organization by involving women farmers in the different trainings and other knowledge investment operations, and ii) supporting women farmers associations and leveraging their management and technical knowledge capacities. In some cases, the project even stimulates the creation of some of these WF associations, in a way they can be considered as knowledge hubs, inclusive of women problems and opportunities. 3. Acting on enhancing time allocation through enhancing women access to machinery, reduce workloads, and Encourage entrepreneurship for youth and women. "Oh Brave ! Tunisian Women Farmers" is a short movie documenting a series of testimonies on (i) the challenges women farmers are facing, (ii) the solutions brought by the CLCA project to face these challenges and (iii) the impact of these solutions on the livelihood of Tunisian women famers in the crop-livestock farming system.	Click	Tunisia
Mobile seed cleaning and treatment unit improves forage seed quality and quantity and presents a successful business model for farmer cooperatives	Brief	The business model described in this brief is part of a basket of solutions that can help support livestock producers to raise efficiencies and productivity. While there is opportunity for more research, the mobile seed cleaning and treatment machine can be considered a candidate model for scaling and be adapted into an integrated model for sustainable intensification of livestock production for smallholder farmers.	Click	Tunisia Algeria

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Conservation Agriculture	E-Learning Module	Building on the CLCA Knowledge, three E-learning modules have been developed within the GIZ funded "SWC@Scale ProSol" Project (in French language) and made available on the e-learning platform of ICARDA. The modules cover three specific topics namely Agroecology, Conservation Agriculture, and Soil Health and they will be of interest to researchers, academics, students, development stakeholders, public and private sectors, and policy makers as well as pioneer Farmers.	Click	Tunisia Algeria
Agroécologie : Principes & Pratiques d'un Changement Incontournable			Click	
Adopter de Bonnes Pratiques Agricoles pour une Amélioration de la Santé des Sols Agricoles			Click	
User-Friendly seed spreader saves Tunisian female farmers time, Money, and efforts with significant yield increases	Blog	To help Tunisian female farmers, ICARDA rolled out a user-friendly and cost-effective innovation that saves time and reduces the amount of seeds needed. The Handheld Precision Spreader (HPS) comes with a container to hold seeds and an adjustable opening to control the volume of the material distributed. At the bottom, a spinning disk is operated by a spinner attached to its side. Because the HPS spreads seeds and fertilizers evenly, it results in 20 percent higher biomass yields in forage crops compared to hand broadcasting. The other advantage of this technique is that farmers can spray chemical fertilizers without their skin being in contact with the product, reducing health concerns. With national partners, ICARDA has imported and distributed low-cost spreaders and provided technical guidance to women farmers . Farmers reported that the machine is easy to handle, reduces labor, and slashes costs by 40% - saving time spent on broadcasting.	Click	Tunisia
Stubble Grazing Management- Model 30:30 (in French)	Leaflet	During Year IV, a set of flyers, technical leaflet and brochure were generated in Algeria and Tunisia related to CLCA topics including: i) two flyers on stubble grazing management- model 30:30 in French & Arabic languages, ii) one Bulletin on vetch in arabic language, and iii) one leaflet on feeding management for small ruminant in Arabic language – adopting a simplified text for a wide range of stakeholders. A brochure entitled "Valorization of by-products in small ruminant feeding" was also produced in Arabic language to increase awareness of CLCA farmers in Algeria about the incorporation of by-products and encourage them to reduce stubble grazing.	Click	Tunisia Algeria
Stubble Grazing Management- Model 30:30 (in Arabic)	Leaflet		Click	
Vetch Crop	Technical Bulletin		Click	
Feeding Management for Small Ruminant	Leaflet		Click	
Valorization of by-products in small ruminant feeding	Brochure		Click	

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Integrating Gender into the Use of Conservation Agriculture in Crop-Livestock Systems in Tunisia	Brief	The CLCA Project aims to develop context-specific processes to promote the large-scale adoption of conservation agriculture in integrated crop-livestock systems in the drylands. Conservation agriculture (CA) is built on a set of interlocking soil and water conservation practices. The core principles are no or limited tillage, permanent cover, and crop rotation and diversification (legume/cereal). CA involves new ways of working with the agricultural system and its interventions have impacts on labor needs and labor allocation, investment decisions on mechanization and herbicide use, crop selection, and residue management (Farnworth et al. 2016). The willingness to adopt CA and the perception of impacts differ according to gender because the expectations and concerns are not the same for both. In addition, we are used to seeing different agricultural tasks for women and men. For example, women are more likely to remove weeds and men are more likely to use mechanization. CLCA was conducted in four regions that are part of northern Tunisia: Beja, Kef, Siliana, and Zaghouan. Our current document analyzes the results of 14 focus groups and 5 interviews conducted in these regions and provides an overview of subsequent intervention in Tunisia.	Click (in English) Click (in French)	Tunisia
Gender-responsive digital extension in Tunisia during the COVID-19 pandemic (in English)	Policy Brief	Providing farmers with essential agricultural information and training in the era of COVID-19 has been a challenge that has prompted a renewed interest in digital extension services. There is a distinct gender gap however, between men's and women's access to, use of, and ability to benefit from information and communication technologies (ICTs), which is compounded by women's historical marginalization from traditional extension programs. These issues present a challenge to the inclusive delivery of digital extension services. To assess the impact of gender-responsive digital extension in Tunisia during the COVID-19 pandemic and accompanying isolation measures, digital extension services were delivered to 121 women and 121 men the Beja, Kef, Zaghouan and Siliana regions of Tunisia. The sample included individual men (N=40) and women (N=41) who were prompted to share the extension information with their spouses, as well as men (N=41) who were not prompted to share. A final group of 40 husband and wife pairs (N=80) both received the same extension information. A gender-responsive approach was implemented, providing select women with mobile phones and delivering the extension information using gender-sensitive language. To improve the accessibility of the information, radio communications were delivered in addition to SMS messages. After 8 months of digital extension, the effectiveness of the intervention was assessed by survey.	Click	Tunisia
Gender-responsive digital extension in Tunisia during the COVID-19 pandemic (in Arabic)			Click	

Year (IV) – Major Knowledge Management Products and Evidence (Cont'd)

Knowledge Product Title	Type	Brief description	Link	Target Country
Agricultura y ganadería en la Mixteca de Oaxaca	Blog	Based on CLCA project, the CIMMYT South Pacific Hub shows how it is possible to create positive synergies between Conservation Agriculture and livestock.	Click	Mexico
Rendimiento y análisis bromatológico de subproductos de trilla de cuatro variedades de quinua (Chenopodium quinoa Willd.) en Kiphakiphani, La Paz - Bolivia	Journal Article	The paper shows that quinoa is a multipurpose crop with good options to contribute positively to the quinoa-llama integration in the arid production systems.	Click	Bolivia
Manejo de pasturas para la crianza de llamas.	Brief	Pasture management for raising llamas.	Click	Bolivia
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