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

Completion Report - Appendix

Grunt Number 2000001630

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

This document is the appendix of the Completion Report (CR) of the IFAD Funded "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". The CR covers the entire period of the project implementation, from April 2018 to June2022.

Sheep grazing stubble in the site of Fernana – Northwest Tunisia (Photo: Zied Idoudi, ICARDA)

Tables

Table A. Details of the Different Actions Carried out for Stakeholders' Engagement and Rapid Appraisal in Bolivia and Mexico

Year	Type of Event (Country)	Stakeholders Targeted	Major Output
Year-I	Stakeholders mapping (Bolivia)	Stakeholders involved in Quinoa-Llama systems	▪ Assessment of stakeholder's motivations and limitations ▪ Identification of key stakeholders from governments, universities NGO's and international organisations
Year-II	Maintaining and increasing stakeholder engagement (Bolivia)	PROINPA foundation and other relevant stakeholders	▪ PROINPA engaged as the main CLCA project partner in deploying actions on the ground and ensuring that different stakeholders (including NGOs and farmers organizations) participate in the project activities
Year-II	Development of competences (Mexico)	Postgraduate School of Development of the Universidad Mayor de San Andres (CIDES-UMSA)	▪ A course on systems analysis was organized ▪ The systems analysis tools were applied by students in the Altiplano Sur and Centro of Bolivia
Year-II	Testing and assessing the performance of the current and alternative maize based mixed crop-livestock management systems for improved sustainability (Mexico)	Department of Crop and Animal Production of the Universidad Autonoma Metropolotana-Xochimilco (UAM-X)	▪ Sixty (60) participants in the workshop, from a wide range of organizations including farmers, NGO's, academic institutions
Year-II	Testing, implementation and sharing alternatives for improved CLCA maize based mixed crop-livestock systems. (Mexico)	National Institute of Forestry, Agriculture, Fisheries and Livestock Research (INIFAP); Four local NGOs	▪ Participatory trials with farmers and adoption of CLCA packages
Year-II	Stakeholder mapping (Mixteca Alta in Oaxaca, Mexico) + Assessment of innovation capacity for scaling solutions in the CLCA system and their contextual structural conditions	Different organizations including farmers, NGO's, academic institutions, etc. Cereals/Legumes Interprofessional Council – CIC & CIL).	▪ Stakeholders mapped ▪ Innovation capacity for scaling solutions assessed and contextualized ▪ In year 4, 271 farmers and technicians were trained on improvement of the quinoa-llama systems through CLCA alternatives and 329 high school and university students from 6 different education centers were rained on practices of sustainable soil management and the importance of vegetation cover
Year-III	Inclusive partnership for scaling pathways (Bolivia and Mexico)	Farmer development groups, NGOs, and additional public extension & research institutions	▪ Co-developed interventions through the consolidated CLCA partnership established in both countries during Year-I and Year-II. ▪ Business cases with the highest potential for scaling the impact of the selected CLCA packages analyzed in both countries.
Year-III	Webinar Cycle on Management of soil, water, and vegetation cover in the context of Climate Change for the Sector camelid Event organized together with ProCamelidos (MDRyT).	Producers, technicians, university students	▪ 583 participants

Table B. Details of the Different Actions Carried Out in Tunisia and Algeria for Stakeholders' Engagement and Rapid Appraisal

Year	Type of event (country)	Stakeholders targeted	Major output
Year-I & Year-II	National, regional, and local workshops, field and information days, survey and focus groups, meetings: 12 events in total (Tunisia)	**1st Year:** Stakeholders from cereals -forage-livestock system (national and local government and NGOs actors, rural actors, farmers) **2nd Year:** Farmers cooperatives (SMSA) and farmers' development groups (GDA) willing to engage in integrated crop-livestock agricultural systems	▪ **1st Year:** i/ Presentation of the CLCA concepts and packages to the different stakeholders including policy makers; ii/ Scaling approach presented to extension actors; iii/ A total of 1179 participants reached; iii/ Lead farmers for CLCA packages identified through stakeholder consultation meetings ▪ **2nd Year:** i/ working framework set-up with farmers' organizations for a more effective scaling up of CLCA technologies; ii/ Five SMSA-s farmers' organizations recruited for testing the CLCA packages; iii/ Support for the creation of a Farmers' Organization specialized in CA practices in Gboullat
Year-I	National, regional, and local workshops, field, and information days (Algeria)	Stakeholders involved in cereals -forage-livestock system: national and local government and NGOs actors, rural actors, farmers	▪ Scaling implementation approach for CLCA system identified and extension actions for adoption of CA assessed. ▪ Presentation of CLCA technical packages to local stakeholders including farmers
Year-I	Advanced training session on scaling of CLCA technologies and practices (Tunisia)	Regional extension services and policy makers in the regional directorates of MAHRF in the CLCA project regions	▪ Buying in from Technical regional extension staff and policy makers to support scaling of CLCA system
Year-II	Meetings, workshops, and field days (Tunisia and Algeria)	Stakeholders of different professional horizons including policy makers	▪ Six and eight events organized respectively in Algeria and Tunisia. ▪ A total of 690 and 850 stakeholders of different professional horizons reached respectively in Algeria and Tunisia.
Year-II	Extending the engagement of new stakeholders for scaling (Algeria)	Cereal and Seed Producers Association – Prodec; Irrigators association; Common interest groups – GIC; Public/development partners (Agricultural Service and Supply Cooperative of Setif – CASAP; Interprofessional Council of Agricultural Sector-CWIF, Cereals/Legumes Interprofessional Council – CIC & CIL)	▪ Partnering for scaling with new stakeholders
Year-II & Year-IV	Development of partnership for extension	**1st Year:** National Extension Agency – AVFA (Tunisia) **4th Year:** National Extension Agency – AVFA with Extensionist s from different regions (Tunisia) **4th Year:** Integration of agricultural technicians who work in the extension services at the level of the wilaya of Sétif for continuous training	▪ **1st Year:** integration of some CLCA trainings in the relevant AVFA "training centres/regions" (Tunisia) ▪ **4th Year:** - 33 extensionists trained on forage crops and forage mixtures for enhancing crop diversification and animal feeding (Tunisia) - 13 technicians trained in Algeria
Year-II to Year-IV	Agreement between ITGC and an industrial company for the production of No Tillage seeder (Algeria)	National Company of Agricultural Equipment Production & Trading (PMAT) one of the largest companies in Algeria for machinery marketing	▪ A No Tillage seeder called Boudour was locally produced with the technical assistance/ e of ITGC and made available to farmers. ▪ Farmers willing to acquire the No Tillage seeder are benefiting from the technical support of INGC. ▪ Cost subsidized by the state.
Year-II to Year-IV	Agreement between INRAT and a private seed production and commercialization company	COTUGRAIN	▪ **2nd Year:** i/ Forage crop seeds, as well as specific ready to uses forage mixtures (Vetch- Oat, Vetch-Triticale, Meslin1), tested and recommended by the CLCA research team commercialized in the CLCA project regions; ii/ Significant quantity of seeds produced: oat 100 tons, fenugreek 150 tons, faba beans 30 tons, and 30 tons of new types of ready to uses forage mixtures ; iii/ More than twenty multiplication contracts (Forage seeds multiplicator farmers) established over an area of 300 ha in the different target sites of CLCA Project ▪ **3rd Year:** i/ 85 tons of ready to uses forage mixtures marketed; ii/ 100 tons of vetch marketed ▪ **4th Year**: ii/ 150 tons of ready to uses forage mixtures ordered; 100 tons of vetch marketed
	Agreement between CLCA project and Governmental institutions	OEP	▪ Production of forage seeds on the basis of the CLCA project results ▪ Feed grinder endorsed and recommended for wider distribution by OEP, including through a specific agreement between OEP and IFAD-PROFITS

Table C. Main Trials and Scaling Achievement in the CLCA Project in Bolivia and Mexico

Trial Characteristics	Main Achievement & Result
Global Level	
Implementation of CLCA Packages for Integrated Quinoa-Llama Production System	▪ CLCA technologies in Bolivia (new and improved quinoa package of practices: wind breaks, minimum tillage, use of composts and good quinoa seeds) were implemented by 73 farmers (23 of them women) on a total of 28 hectares in the second year, by 75 farmers and 63 ha of demonstration plots in the third year, and finally on 170 farmer plots on a total surface of 100+280 ha in the fourth year. ▪ CLCA technologies in Mexico (Relay intercropping of fodder mixture with maize in Mexico: a total of 306 farmer plots where the CLCA packages were assessed and adopted with subsequent increased yields.
Individual Technological Package	
Bolivia	
I. Use of Cover Crops and Windbreaks in Bolivia for Improving Fallows and Quinoa Yields: 1. Adaptive and validation trials and scaling of cover crops and in particular wild lupin	▪ Adaptive and validation trials using wild lupins (Q'ila Q'ila) as cover crops were carried out in the first and second year with 6 demo plots with lupin-Quinoa relay cropping. ▪ A validation plot has been established on 1.5 ha land, with several legumes such as edible lupin (Lupinus mutabilis, Lupinus angustifolius) and vetches (Vicia sativa). ▪ Six new improved fallow plots established with wild lupins in the third year in two communities.
2. Production of windbreaks saplings and bushed seedlings	▪ In total, 72,966 seedlings of bushes mainly Baccharis incarum and 7,168 seedlings of grasses mainly Agropyron elongatum, 2,950 saplings/plants of grasses and bushes and 5,000 seedlings, and finally 15,900 saplings of various species, were produced respectively in years 1, 2, 3 and planted in farmers plots to improve their pastures. In the fourth year more than 95,000 seedlings of perennial grasses and shrubs were produced. ▪ 40 farmers' fields were planted with seedlings in the second year to assess their performance and to set a discussion platform with farmers on their suitability for their agricultural systems, ▪ In total during the four project years, 101 fields were protected with live windbreak barriers (46 in 2021 and 55 in 2022) in four localities of the Southern Altiplano, Chita, Chacala, Sonturo and Cotaña. The full length of the live barriers reached 17 000 meters.
3. Seven endemic grass and bushed species of potential interest were identified as cover crops and to improve pastures	▪ Improved pastures were put in place on 7 ha in three communities in the third year.
II. Animal Compost to Improve Soil Fertility in Bolivia: Sets of trials for production of animal compost treated with decomposer agent to accelerate composting process were laid out in year 1 in 4 sites, two demonstrative and validation plots were set -up in Year 2 and 3	▪ improving nutrition of llama: twenty farmers were trained in the second year on the use of quinoa residue to feed llamas and the use of probiotics for improving feed use efficiency. In the fourth year, 150 farmers from 11 municipalities of the departments of La Paz, Oruro and Potosí used probiotics with the support of PROCAMELIDOS project. ▪ Regular applications of compost in smaller quantities are better than application of larger quantities once in three or four years. ▪ In plots manuring quinoa, yield was increased between 28 and 40% relatively to the plots without manure.
III. Quinoa Pests' Biological Treatment A treatment protocol using an organic insecticide, namely BioMax (plant extract of Sophora flavescens), was tested in On-farm trials against "Ticona" (Helicoverpa quinoa) and polillas (Eurysacca quinoae), two major Quinoa pests	▪ 33 farmers participated in the trials. ▪ Biomax showed an efficacy of 84.4 to 93.3 % and above 88% for the second- and third years' trials respectively.

Table C. Main Trials and Scaling Achievement in the CLCA Project in Bolivia and Mexico (Cont'd)

Trial Characteristics	Main Achievement & Result
Individual Technological Package (Cont'd)	
Mexico	
IV. Relay Intercropping of Fodder Mixture with Maize in Mexico: 1. Two fodder mixtures tested in Year 3 VCaSCl (Vetch, Canola, Sunflowers, Clover) and GRClCaO (Grasspea, Radish, Clover, Canola, Oats) in dry/winter cycle in Year 3. 2. The trial regions for fodder-maize intercropping were decided according to farmers preferences. 3. In modules, best-bet practices (intercropping of fodder mixture planted under CA) were evaluated against traditional practice (conventional tillage and planting of maize during summer cycle). 4. Additionally, the project promoted the adoption of improved livestock management practices (feeding blocks, silage preparation, and control grassing).	▪ 13 adaptive trials (Modules), 9 demonstrations (Impact areas) and 108 adoption plots (Extension area) were planted. ▪ In total, 130 on-farm participatory field trials were conducted during the project cropping season 2020-21 ▪ The sustainable soil conserving practices resulted in an evident reduction in soil erosion as well as an improved water and nutrient availability to the crop plants resulting in higher crop and fodder yields. ▪ On average, the best-bet package produced a fodder yield of 2.2 t/ha and maize grain yield of 1.43 t/ha while in control, the maize grain yield was 1.48 t/ha. ▪ In improved practice/demonstration plots, farmers also harvested a limited quantity of ayocote beans for their household consumption
1. Different forage alternatives were tested in Year 3 in research platforms with 6 treatments under conservation agriculture for the rainy season under rainfed conditions. 2. The best bet practices included. I) maize planting at the optimum time (first fortnight of June) in conservation agriculture, ii) relay intercropping of fodder mix in rainy cycle following a dry season relay planting of fodder mix in September or October and ii) Peripheral multi species wind barrier using perennial runner beans and perennial fodder grass, to reduce erosion and conserve soil and soil moisture.	▪ 48 on farmers' fields (so called modules) were set up to assess different forages and forage mixtures in association with maize, either on relay cropping, rotations, and intercrops. The tested forage species and mixtures where collectively identified with farmers. ▪ In innovation modules, where research and development partners have a closer look and control on the management of the plots, the maize yield penalty is insignificant while cropping systems manage to produce more than 2 tons / ha of forage dry mater. ▪ In the extension areas, with less control from colleagues and partners, higher forage production was achieved but at the expense of maize yield. However, the maize yield reported of 1.2 tons/ha is around or above the regional average. ▪ Under rainfed areas cereal-legumes mixtures produced the higher fodder yields. ▪ In irrigated areas the mixture maize-sunflower produced the highest fodder yields. ▪ Forage mixture gave the highest crude protein values.

Table D. Trials on the Effect of Various CLCA Packages on WUE and Grain Yields in Different Sites in Algeria and Tunisia

Year	Trial Characteristics	Main Result
	Tunisia	
Year-I to Year-III	Different plots in all project sites. Measurement of WUE and Crop Yields.	**In Short-term CA Trials:** ▪ WUE are very low under both systems (CA vs CT) for durum wheat and for barley ▪ No significant differences between CA and ConvT for wheat WUE (low level of residue retained in the field especially in the initial years of CA implementation). ▪ Grain yields for durum wheat and barley and yields of oat hay similar between CA and CT (with however weak management of nitrogen supply and weeds management by farmers) except in the subhumid Beja district where CA gave 37% higher grain yields than CT ▪ Grain yields for durum wheat and barley are more correlated under CA and ConvT to the annual rainfall and its monthly distribution during growing season for durum wheat and barley **In Long-term CA Trials:** - WUE significantly increased in CA vs CT, CA having 15% higher grain WUE and 23% higher total dry matter WUE compared to ConvT

Table D. Trials on the Effect of Various CLCA Packages on WUE and Grain Yields in Different Sites in Algeria and Tunisia (Cont'd)

Year	Trial Characteristics	Main Result
		Algeria
Year-I to Year-III	Agronomic evaluations of different no-till seeder and tillage methods were carried out in wheat yields in Algeria at the farmers' fields.	▪ No-till seeder with tine type opener produced highest yield 2.002 t/ha, followed by minimum tillage (1.83 t/ha), conventional tillage (1.81 t/ha) and lowest with no-till seeder with Disc (1.65 t/ha).
	A participatory evaluation of CA plots vs conventional tillage plots (CT) was conducted in different farmers' fields (M'Sila, Oum El Bouaghi, Setif).	▪ Despite the impact of drought, the average wheat yield was higher (2.285±0.575 t/ha) under CA compared to CT (2.128±0.647 t/ha). ▪ Similarly, the average barley yield was higher under CA (2.006 t/ha) than in CT (1.819 t/ha). ▪ For both crops, average yield was higher in M'Sila, followed by Oum El Bouaghi and lowest in Setif. The higher yield in M'Sila can be explained by the availability of supplementary irrigation. ▪ Combination of CA with sprinkler irrigation increases WUE by 26% and wheat grain yield by 1.2 t ha-1 comparatively to ConvT with sprinkler irrigation. ▪ Sprinkler irrigation increases water use efficiency by 18% compared to flood irrigation (1830 vs. 2240 m^3/ha).
	Impact of tillage method on durum wheat root growth were analyzed.	▪ At tillering, roots in a no-tillage system occupy more surface followed by conventional and minimum tillage. ▪ In heading stage, no-tillage and minimum tillage had higher root surface than conventional tillage system. ▪ Like root surface development at tillering, grain yield of wheat was significantly higher under no-tillage system followed by minimum tillage and lowest yield was observed under conventional tillage system.
		Tunisia
Year-III	A pilot, 2-years trial to assess the effects of the tillage practice (CT), previous crop, and nitrogen (N) fertilization rate on the agronomic and economic performances of rainfed durum wheat in a semi-arid environment in Tunisia.	▪ Tillage practices do not affect grain yield, grain N, and gross margins. ▪ N-use efficiency of durum wheat was significantly higher when wheat was grown using NT. Grain yield and N content in grain increased after vetch than after bread wheat. ▪ For both tillage practices, the merit of 75 kg N/ha is paramount to maximize yield through a more efficient use of available N.
		Tunisia
Year-IV	Rhahla site in Siliana (Short-term on farm trials) Comparison of three treatments (Durum wheat under minimum tillage, durum wheat under no-tillage and durum wheat under conventional tillage). Measurements of soil characterization, yield components, soil moisture during growing season, above ground biomass of crop during growing season, and determination of WUE of durum wheat.	▪ Soil water content (w/w) at different soil layers relatively higher during the growing season under NT and MT systems compared to CT. ▪ WUE-grain yield under MT and NT were increased by 41 and 23% respectively by comparison to CT. ▪ Grain yields of durum wheat increased by 41 and 21% for NT and MT relatively to CT.
	El Krib site (Long-term on farm trial with a farmer expert) with a retrospective analysis of two cropping seasons (2017-18, 2018-19) Measurement of agronomic performances and WUE of two durum wheat cultivars (Maali and Hadhba) with direct drilling under living plant cover (DDL-C) with lucerne and direct drilling under dead plant cover (DDD-C) with stubble as cover crop.	▪ Highest grain yields and WUE were obtained when durum wheat was grown in NT under DDD-C (1710 and 1690 kg m^{-2}) for the two cultivars.

Table D. Trials on the Effect of Various CLCA Packages on WUE and Grain Yields in Different Sites in Algeria and Tunisia (Cont'd)

Year	Trial Characteristics	Main Result
		Algeria
Year-IV	Assessment of wheat grain yields and financial charges in MT and NT comparatively to ConvT over the 4-year project duration	▪ MT: average yield gain of 0.15 to 0.45 t/ha and charges gain of 10-17%. ▪ NT: average yield gain of 0.6 to 1.4 t/ha and charges gain of 13-24%.
	Evaluation of long-term rotation options (10 years) using the following sequences: - Year 1: Chickpea or vetch or lentil - Year 2: wheat or barley - Year 3: legume forage depending on rainfall potential (< or > 400mm) - Year 4: wheat or barley	▪ Between 2018 and 2021, an average gain of 0.7 t/ha was observed in wheat yield after 2 years of chickpea practice in the rotation. ▪ The introduction of a food legume (lentil and chickpea) or fodder legume (vetch) between two wheat crops provides a yield gain higher than that of the fallow which can reach up to 0.26 t/ha.

Table E. Trials and Scaling of Cereal-Legume Mixtures and New Forage Varieties in Tunisia & Algeria

Year	Trial characteristics	Main result
		Tunisia
Year-I	Different plots in distinct project sites Three mixture combinations were evaluated under CA practice in Tunisia: - Oat 15% +Triticale 15% + Vetch 70%; ii/ Oat 30% + Vetch 70% - Triticale 40% + Vetch 60% - Triticale 40% + fenugreek 60%	▪ The combination of oat (30%) + vetch (70%) produced the highest biomass yield (9.9 ± 1.8 t ha-1) and total crude protein (CP) yield (985 kg CP ha-1). (Almost two-fold than the cereal monocrop, i.e., only oat). ▪ A private seed company in Tunisia (COTUGRAIN) has decided, starting from the cropping season 2019-20, to commercially put in the market the forage mixtures validated by INRAT.
Year-II	Three hay forage mixtures were evaluated in four locations (Safsafa/Beja-North, Ksar El Cheik/Beja-South, Fernana/Jendouba, Z'hir/Mateur-South, Bizerte): ▪ Vetch 70% - Oat 15% - Triticale 15% (V70-O15-T15) ▪ Vetch 60% - Oat 7% - Triticale 33% (V70-O7-T23) ▪ Vetch 70% - Oat 30% (V70-O30) Measurements and analysis were assessed at hay stage on six harvested samples of one square meter in each plot.	▪ Land Equivalent Ratio[1] values were more advantageous for the mixtures over pure stands for all studied forage mixtures. ▪ The weeds percentage was consistently high (20%) for the mixtures V70-O7-T23 and V70-O30 and was very low (4%) for the mixture V70 -O15 -T15. ▪ The three studied mixtures produced high forage yields (11.1 to 12 t DM ha-1). ▪ The V70-O30 mixture showed the highest average crude protein (CP) content (16.7%). ▪ combination of the high yield and high protein content of the tested forage mixtures represent a valuable alternative for stubble grazing of the flocks early in the summer period.

[1] [LER, defined as the relative land area required as a sole crop to produce the same yields as intercropping (Mead and Willey, 1980)]

Table E. Trials and Scaling of Cereal-Legume Mixtures and New Forage Varieties in Tunisia & Algeria (Cont'd)

Year	Trial characteristics	Main result
		Algeria
Year-III	Four mixture combinations were evaluated under CA practice: i) Pea (65%) + Triticale (35%), ii) Vetch (65%) + Oat (35%), iii) Vetch (70%) + Barley (30%) and, iv) Sole oats (100%).	▪ All the cereal and legume mixtures produced under CA higher biomass than the sole cereal (oat). ▪ Vetch + barley (10.2 t ha-1) produced higher biomass followed by pea + triticale (9.2 t ha-1) and vetch + oats (7.9 t ha-1), while lowest biomass was observed with sole oat (6.3 t ha-1). ▪ Alternative mixture forage crops can be grown under CA practice with increased biomass and quality forage than the current forage monocrop in Algeria.
		Tunisia
Year-III	Triticale-oat-Vetch mixture was tested in a long-term participatory on-farm trial under good rainfall (>500mm), different combinations of cereal and legume forage mixtures tested for three years under CA based practices. Three different management packages (MP) and their agronomic performances were used.	▪ Forage yield was maximum when vetch is crop-mixed with oat (cultivar El Alia that is a high yield, late cultivar, MP1) and remained stable when oat is partially substituted by Triticale (MP2). ▪ LER was higher than for all combinations revealing the advantage of mixing crops rather than growing sole crops. ▪ The best crop management for common vetch-based mixture includes the simultaneous use of both oat (10%) and triticale (20%) as tutors, mid-late seeding, glyphosate, and simazine application prior to seeding and emergence, respectively, and moderate input of nitrogen fertilizer (20 -30 kg/ha) at early season to ensure maximum tutor effect without hampering legume growth.
		Algeria
Year-IX	Assessment of two associations, pea-triticale, and vetch-oat at three proportions (60/40; 50/50 and 40/60).	▪ The Pea-Triticale association gave the best yield (gain of 10 t/ha of dry matter), at the pairing of 60 % pea with 40 % triticale. ▪ The Vetch-Barley association with 50% of each species gave the lowest yield.
Year-I to Year-IV	Scaling of triticale in different project sites through seed-multiplication activities.	▪ 800 kg of seeds freely distributed to farmers for multiplication purposes during the first year. ▪ Almost 33.5 tons have been commercialized to more than 20 farmers during the 2020/21 cropping season. ▪ About 40 t of triticale was used as grain feed for small ruminants (mainly sheep) by farmers in different CLCA sites. ▪ A new triticale variety named "Oued Dhaheb" has been introduced by ITGC during the third year.
		Tunisia
Year-I to Year-IV	Scaling of fodder seeds and seed mixtures by the private seed company COTUGRAIN	▪ 2nd Year: i/ oat 100 tons, fenugreek 150 tons, faba beans 30 tons, and ii/ 30 tons of new types of ready to uses forage mixtures. ▪ 3rd Year: i/ 85 tons of ready to uses forage mixtures marketed; ii/ 100 tons of vetch marketed. ▪ 4th Year: i/ CLCA team provides COTUGRAIN with the composition of five on-station validated forage cereal–legume mixtures, ii/ 150 tons of ready to uses forage mixtures ordered; ii/ 100 tons of vetch marketed. ▪ Total cultivated area of annual forage mixture and forage crops (cereal and legume) under CLCA technologies reached in the fourth year about 1200 ha, spread over 8 governorates.

Table F. Trials Aiming at Finetuning Stubble Grazing Management and Retention in Algeria & Tunisia

Year	Trial Characteristics	Main Result
	Tunisia	
Year-I & Year 2	Assessment of the 30/30 stubble grazing mode, on farms trials in Krib region after cereal harvest using a stocking rate of 30 ewes/ha for a grazing duration of one month.	▪ The model 30/30 was once again verified to be relevant, both with linear and exponential fitting. ▪ Normal progression of pregnancy in ewes with a moderate increase in live weight.
	On farm trial under CA in Fernana (Humid zone) for assessing a program for stubble management for dairy cattle. Cows grazed on bread wheat stubble under CA. The whole grazing duration lasted 75 days divided into 2 periods: 30 days under farmer practices and the following 45 days under improved CLCA package. For both practices, the same feed quantities were used.	▪ The stubble biomass dropped from 7 t DM ha-1 in the beginning to 3.5 t DM ha-1 after the first grazing period under farmer practice. During the second grazing period of 45 days the stubble biomass decreased from 3.5 t DM ha-1 to 2.4 t DM ha-1, leaving a suitable soil cover compatible with CA. ▪ Milk production increased by 16 % with the improved management practices (24.6 l/day/head compared to 21.2 l/day/head for cattle managed under conventional farmer practice).
	Further assessment in on farms trials of the effect of stocking rates on stubble management. 14 farmers from three regions involved. Stocking rates and grazing durations varied between farmers. Ewes of the Queue Fine de l'Ouest breed were the dominant sheep (79% of farmers), other flocks were of the Noire de Thibar breed. Ewes at the earliest stage of pregnancy were treated against gastrointestinal parasites and vaccinated against enterotoxaemia before being grazed on stubble.	▪ Initial biomass ranged between 540 and 3268 kg DM ha-1 and at the end of the grazing period, the residual biomass varied between 18 to 91 % of the initial biomass (average 58%). ▪ Animals maintained their BCS and sometimes a significant slight increase was obtained. ▪ Under all types of stubble, pregnant ewes were able to maintain and even increase their body condition as this is critical for the progress of pregnancy, fetal growth and for avoiding metabolic- incurred disorders. ▪ Wheat and faba bean stubble gave the highest BCS increases.
	Algeria	
	On-farm trials were undertaken in the different sites of the project to identify stubble grazing models compatible with CA-based practices under Algerian contexts.	▪ Stocking rates of five (5) to ten (10) ewes ha-1 with an average grazing time of less than twenty (20) days allowed both the preservation of a certain amount of stubble and an acceptable average female weight gain ranging between 1.5 and 2 kg. ▪ At stocking rates of 5 and 10 ewes/ ha-1, the amounts of stubble left on the ground were respectively of 0.87 and 0.64 t /ha-1 representing 29 and 21% of the initial quantities. ▪ By referring to the results from CLCA phase I, such levels of residues, which are above 0.6 t /ha-1, are considered compatible with the practice of CA in semi-arid conditions.
	Monitoring stubble use and residuals was performed with 10 different CLCA beneficiaries in the three main districts where the project is operating (M'Sila, Setif and Oum El Bouaghi).	▪ In M'Sila, most of the stubble is not grazed because the flocks, which are of large size, are herded in vast communal pastures in the south. Successful CLCA options in one context need to consider regional complementarities when these are feasible. ▪ In Setif, the farmers who have been collaborating with the project since Phase (I) are leaving all the stubble as mulch. Flocks are systematically kept in feedlots. This testifies the long-term adoption of CLCA introduced package. ▪ Biomass varies considerably between districts, crop species and agronomic practices (supplemental irrigation, intensive use of fertilizers, infestation by weeds).

Table F. Trials Aiming at Finetuning Stubble Grazing Management and Retention in Algeria & Tunisia (Cont'd)

Year	Trial Characteristics	Main Result
	Algeria	
Year-III	On-farm trials to assess stubble grazing were carried out in the district of Oum El Bouaghi. Following harvest in June and July, the available stubble biomass was estimated before and after grazing by sheep and dry matter content was determined farmers were recommended to graze their animals for up to 20 days or until exhaustion of the grains and leaves.	▪ 62% to 88% of the initial available stubble quantity was left on the ground according to the grazing duration (14 to 40 days) and the animal stocking rate.
	Algeria	
Year-IV	On farms trials to verify the relationship between the stocking rate, the grazing duration and residual biomass of residues	▪ Grazing capacity of 5 and 10 ewes/ha with an average grazing time of less than 20 days allowed both the conservation of a certain amount of stubble and an acceptable average weight gain of the females. ▪ The quantities of residue left on the ground are respectively 0,87 and 0,64 t/ha which represent 29% and 20.49 % of the initial quantities.
	Tunisia	
	On station trial comparing the quality of stubbles of wheat grown under NT and ConvT and the rumen fermentation characteristics of Barbarine ewes grazing stubble from the fields under NT and ConvT	▪ Dry matter, protein, fiber, and ash contents were lower for stubble under NT compared to CT. Consequently, the concentration of the volatile fatty acid, propionic acid, was lower for ewes grazing stubble under NT. ▪ Sheep's body weight at the end of the two-month grazing period was found to be similar for NT and CT. ▪ The amount of residue remaining on the soil surface at the end of the grazing period were similar for NT and CT

Table G. Trials and Activities to Promote Alternative Feed Systems and their Main Achievements in Bolivia and Mexico

Trial/Activity Characteristics	Main Achievement
Bolivia	
Planting of model pastures under MT in three communities using indigenous species (Year-I). Establishment in PROINPA research center in Quipaquipani, in Northern highland of thirteen exotic forage species to Bolivian highlands received from University of Copenhagen, and transplantation of the germinated seeds for evaluation.	▪ Native grasses appeared better adapted to the area, tall fescue or Iru Ichu (*Festuca orthophylla*) and purple grass (*Nassella sp.*) are preferred by the llamas and have interestingly quick regrowth ability. ▪ Native lupine (q'ila-q'ila) is preferred by Llama as dry fodder in field during winter cycle. ▪ Six new improved fallow plots established with wild lupins in the third year in two communities.
Establishment of demonstrative plots in two communities for improving fallows using wind (Year-II).	▪ Twenty-three demonstrative plots were set up. ▪ Wind breaks of 5,100 m were established using fodder bushes such as Sup-u- tula (*Parastrephea lepidophilla*) Nak-u-tula (*Baccharis incarum*), Uma tula (*Parastraphia luceda*).

Table G. Trials and Activities to Promote Alternative Feed Systems and their Main Achievements in Bolivia and Mexico (Cont'd)

Trial/Activity Characteristics	Main Achievement
Bolivia (Cont'd)	
Alternative Feeding	**Year I & II** ▪ Seventeen farmers engaged in feeding quinoa residue and on the use of probiotics for improving feed digestion efficiency by llamas with positive appreciation by farmers. ▪ Use of probiotics improved the use efficiency of feeds, decreased the need for veterinary products. **Year III** ▪ Supplement feeding of livestock during the dry period (September to December) using jipi (grain husk or chaff from quinoa threshing normally done in the field) in order to avoid animals losing weight during those months.
Mexico	
48 plots on farmers' fields were set up to assess different forages and forage mixtures in association with maize, either on relay cropping, rotations, and intercrops. Different combinations of oat, vetch, canola, triticale, and grass were used (Year-III).	▪ In the innovation modules, where research and development partners have a closer look and control on the management of the plots, the maize yield penalty is insignificant while that cropping systems manages to produce more than 2 tons/ha of forage dry mater. ▪ In the extension areas, with less control from colleagues and partners, higher forage production was achieved but at the expense of maize yield. ▪ analysis of the different forage species and forage mixtures showed values of crude protein between 7 and 13%.

Table H. Trials and Activities Carried out to Promote Alternative Feed Systems and their Main Achievements in Algeria and Tunisia

Trial/Activity Characteristics	Main Achievement
Algeria	
Inventory of the number of industrial units producing agro-industrial by-products and the total volume produced by each of these industrial units (Year-I).	▪ 24 industrial units identified covering the following activity: - Wheat flour mill: 12 units - Pasta/ couscous: 8 units - Olive mill: 3 units - Apricot processing: 1 unit
Development of a contextualized approach by ITELV technical team to formulate rations for sheep during the summer gap according to the farm management practices, the stubble biomass and its characteristics in each district (Year-2).	▪ Proposed rations based on partial and limited grazing of stubble, limited integration of alfalfa hay in irrigated areas or a combination of cereal/legume hay with a supplementation with barley grains and olive pomace (widely available in the project area). ▪ The rations were adapted to the type of sheep and their physiological stage.
Knowledge transfer on by-products valorization (Year-III).	▪ Production of a brochure entitled "Valorization of by-products in small ruminant feeding" by the Technical Institute of Livestock (ITELV) to increase awareness of CLCA farmers about the incorporation of by-products and promote the reduction of stubble grazing.

Table H. Trials and Activities Carried out to Promote Alternative Feed Systems and their Main Achievements in Algeria and Tunisia (Cont'd)

Trial/Activity Characteristics	Main Achievement
Tunisia	
Development of a Public-Private-Partnership business model involving INRAT, ICARDA, a private seed producing company "COTUGRAIN" and the OEP for the production and marketing of forage seeds and forage see mixture (Year-I & II). Extension and development of the PPP with COTUGRAIN and OEP for the production of new forage seeds and forage seed mixtures (Year-III & IV).	▪ 2nd Year: i/ oat 100 tons, fenugreek 150 tons, faba beans 30 tons, were produced and ii/ 30 tons of new types of ready to uses forage mixtures. ▪ 3rd Year: i/ 85 tons of ready to uses forage mixtures marketed; ii/ 100 tons of vetch marketed. ▪ 4th Year: i/ CLCA team provides COTUGRAIN with the composition of five on-station validated forage cereal–legume mixtures adapted to different bioclimatic regions of Tunisia, ii/ 150 tons of ready to use forage mixtures were ordered; ii/ 100 tons of vetch were marketed. ▪ The total cultivated area of annual forage mixture and forage crops (cereal and legume) under CLCA technologies reached in the fourth year about 1,200 ha, spread over 8 governorates. ▪ In Year-II, agronomic performances of some forage mixtures (Mix 1 and Mix 2) tested under both systems (CA and CT) and disseminated at large scale, showed the same average forage yield (about 6 t DM/ha) with greater legume proportion and lesser weed proportion than in monocrop fields.
Development of a mobile android application "ALAFI" by the National Institute of Agronomic Research of Tunisia (INRAT) in the framework of the CLCA project. Data and information provided in the android application are the result of a long experience in the field of forage crops. The scientific content of the android application was developed by Mr. Salah Ben Youssef, researcher at INRAT (Years-III & IV).	▪ "ALAFI" aims to guide and advise farmers and agricultural extension services on the choice of the best combination of forage species (cereals and legumes) allows to obtain adequate forage mixtures adapted to local context and a good quality of hay. ▪ ALAFI helps farmers to calculate the populations rate envisaged for each forage species, according to the percentage of population desired for each forage species and allows them to calculate the sowing rate (kg/ha) of the forage mixtures chosen by user. ▪ ALAFI guides and advises farmers on the best forage mixtures and combinations recommended for their local pedoclimatic context. ▪ The android application offers to users several documentations related to the technical package of forage mixtures and documentations on forage crops in general.
On station trial to assess that grazing on dried vetch only represents a cost-effective alternative to wheat stubbles grazing for sheep during summer season under the context of conservation agriculture (Year-II & III).	▪ DM, OM, and CP intakes were higher in animal grazing vetch alone or combined to wheat stubble. ▪ Average daily gain of lambs grazing vetch alone or combined to wheat stubble was three times greater ($p < .05$) than for lambs grazing wheat stubbles. ▪ Grazing vetch alone or combined with wheat stubble increased substantially the growth performance and carcass yield of lambs compared to wheat stubble alone.

Table I. Trials and Activities Carried for Promoting Small Business Model for Seed Cleaning & Treatment Unit (+ related machines) in Tunisia and Algeria

Main Activity	Main Achievement
Tunisia & Algeria	
Assessment of the situation in Tunisia and Algeria (Year-I).	▪ Valorize the locally produced and marketed seed cleaning and treating units by an SME in Beja (Tunisia) based on a prototype of a "mobile seed cleaning and treatment unit" which was designed and developed by ICARDA and its national partners. ▪ One-unit costs 12,500 TND (about 4,350 US$) and has a capacity of about 800 kg/hour depending on the kind of seeds treated. ▪ CLCA team are currently working at a post marketing phase to improve machine to make it easier for use by farmers and more effective in terms of seed quality.

Table I. Trials and Activities Carried for Promoting Small Business Model for Seed Cleaning & Treatment Unit (+ related machines) in Tunisia and Algeria (Cont'd)

Main Activity	Main Achievement
	Tunisia
Assessment of the situation in Tunisia and Algeria (Year-I).	▪ Valorize the locally produced and marketed seed cleaning and treating units by an SME in Beja (Tunisia) based on a prototype of a "mobile seed cleaning and treatment unit" which was designed and developed by ICARDA and its national partners. ▪ One-unit costs 12,500 TND (about 4,350 US$) and has a capacity of about 800 kg/hour depending on the kind of seeds treated. ▪ CLCA team are currently working at a post marketing phase to improve machine to make it easier for use by farmers and more effective in terms of seed quality.
Development of a small business model for seed cleaning service provision based on small or medium SMSA (Mutual Association of Agricultural Services/Societé Mutuelle des Services Agricoles), a kind of farmer cooperatives providing services to their members. The machine would benefit more farmers and the business could bring additional income for the cooperative (Years-II – IV). Beneficiaries were carefully selected based on their interest and need for the machine, they contributed 10 % of the total price of the machine (1,250 TND/435 US$). This amount was used to coach and to train them in the machines and for the use of general good practices for seeds production and cleaning (Year-II).	▪ Four mobile seed cleaning and treatment units were delivered to farmers' associations having between 150 and 350 members each and located in different CLCA target areas (Northwestern and Central regions of Tunisia) – globally, over 1,000 small-scale farmers have benefited directly from these units. Young farmers and women were considered among the beneficiaries. ▪ A total of 66 tons of seeds were cleaned and 173.6 t cleaned and treated in Year-II and 138 farmers benefited from the 4 units (Year-II). ▪ The total benefit for these four 4 cooperatives of about 2,000 TND (682 US$) is not significant as the intention of some cooperatives during this first experience was rather to attract members using this service than making a benefit. ▪ All 4 cooperatives employed one person on a temporary basis to operate the unit.
	Algeria
Adaptation and production in Algeria starting from the ICARDA seed cleaner prototype marketed in Tunisia through an agreement between ITGC and a local manufacturer. The CLCA project facilitated the purchase of the units by local farmers for their personal use (Year-III – IX). An agreement has been established between the CLCA project, represented by the ITGC of Sétif and a local manufacturer of seed cleaning equipment (Ets Keffi Youcef), for the manufacture and development of a model of a cereal seed sorting machine and legumes (Year-III – IX).	▪ This machine model is considered unique and the first of its kind in Algeria which is 100% locally made and specially designed in the CLCA project. These units were made available on the market at a relatively affordable cost (2,050 USD) especially for farmers' groups. ▪ The machine is currently manufactured with two sorters: the first sorter is for cleaning, and it is composed of three interchangeable sieves (sorting three seed sizes), the second one is equipped with a liquid seed treatment unit. ▪ Seven prototypes of this machine were purchased by local farmers for their personal use. ▪ CLCA team members are currently working at a post marketing phase to improve machines to make it easier to use by farmers and more effective in terms of seed quality. ▪ An extension program has been established to sensitize farmers on the importance of cleaning farm seeds and encourage small farmers (women and men) to acquire this type of equipment and provide services for the neighbors.
Development and marketing of a small size straw chopper, intended for use by women to ensures a low workflow and small chopping capacity (Year-III – IX).	▪ Produced at a cost of around 580 USD and it can be used in households that have a small number of herds.

Table J. Sequence Chronogram of the Milestones Leading up to the Marketing at Scale of the Boudour No-Till Seeder in Algeria

Activity	Output/Outcome
1. Signature in June 2018, at the project start, of an agreement between CLCA national coordinator (ITGC) and the PMAT concerning the NT seeder Boudour.	▪ Engagement of the manufacturer in the scaling process. ▪ A stock of 20 seeders is available for the scaling process.
2. Advocating on facts to the government the subsidization of the locally produced Boudour NT seeder [integration level, agronomic, environmental, and financial benefits] (Year-I & II).	▪ The seeder was included in the official nomenclature list of the Algerian Ministry of Agriculture; it is subjected to 30% subsidy when it is purchased individually and to 40% when it is purchased by a farmer association.
3. Marketing of the Boudour NT seeder by PMAT and issuing of proforma invoices (Starting from Year-II).	▪ The launch price of 13, 000 USD corresponding to a cost of 9,100 USD for an individual farmer and of 7 800 USD for a farmers' association considering the government subsidies. ▪ Farmers and local companies providing agricultural services started purchasing the Boudour seeders and renting them to farmers in their respective regions.
Development and marketing of a small size straw chopper, intended for use by women to ensures a low workflow and small chopping capacity (Year-III – IX).	▪ Produced at a cost of around 580 USD and it can be used in households that have a small number of herds.
4. Supporting activities to increase the NT seeder demand: **4.1. The true economic cost the Boudour NT seeder was calculated for an individual investor (individual farmer) and for a collective group of farmers (cooperative or association of farmers), therefore the financial feasibility of investing in this seeder was evaluated under both scenarios (Year-II).** **4.2. A well-documented "Business Model for "Boudour" No-Till Seeder" in Algeria is being used to promote the purchase of the seeder by service providers, cooperatives, and even SME of machinery service delivery. The study model suggests that the annual usage of the seeder should be at least 32 hectares to generate profit out of the investment (Year-III).** **4.3.** Creation of four machinery service provision companies (3 farmers and 1 SME) supported by the CLCA team through a feasibility study, to purchase the newly released Boudour NT seeders with the aim to rent them to their neighboring farmers, thus responding to the increasing demand for NT by small farmers in the region of Setif (Year-III).	▪ Empirical findings indicate that the Break-Even Point (BEP) for the two scenarios are quite similar, more precisely, a minimum of 31.68 hectares per year for an individual farmer and of 30.29 hectares for a farmers' association. ▪ A total area of 880 ha was covered by the four machinery service providers only. ▪ In addition to seeding, the service providers who were trained by the CLCA project, advised the beneficiary farmers on seeding doses, importance of weeding prior to seedling, optimal fertilization of cereal crops, optimal grazing practices to preserve soil fertility. ▪ The CLCA project started in 2018/19 with a total of 5 NT seeders (all owned by our National partner ITGC) and facilitated the active use of 39 seeders used by farmers in all project sites in 2020/21. ▪ Among the 39 seeders, 12 of them are concentrated in Setif, which can be considered the Excellence Knowledge Hub on Conservation Agriculture for Algeria. ▪ In the fourth project year, an additional number of 17 seeders were marketed by PMAT and purchased by farmers in various regions of Algeria.

Table K. Main Characteristics and Results of the Farm Modelling Studies Carried out in Bolivia & Mexico

Typology and Farm Modelling Analysis	Main Result
Bolivia	
Farm household typology developed based on the ProCamelidos baseline survey data set for five selected municipalities [initially Uyuni and Challapata then extended to three more municipalities with more livestock] (Year-I & IV). The typology was based on 47 variables related to land use, crop and livestock diversity, farm income and sources, family structure, and production destination. Principal Component Analysis (PCA) and hierarchical clustering (cluster analysis) were used to construct the typology.	▪ In Challapata where farms are larger, the planted crops are commonly used for home consumption, and are not a source of cash flow, activities outside the farm are important for income generation. ▪ In Uyuni, crop production is usually intended for marketing therefore generating a higher income. ▪ Llama herds are slightly larger in Uyuni, but livestock diversity is greater in Challapata including a few alpacas or sheep. ▪ In Uyuni the following three farm types are found: - U1) Livestock farms with crops for home consumption, low agricultural income, and existence of off-farm activities. - U2) Mixed crop-livestock farms with large land holdings and high incomes with off-farm activities. - U3) Mixed crop-livestock farms with income mainly generated from on-farm activities. ▪ In Challapata the following types were found: - Ch1) Low-income farms with diversified livestock, large land holdings and off-farm activities. - Ch2) Commercial farms based on llama trading with smaller land holdings, and significant income generated off-farm. - Ch3) Farms with high off-farm income and livestock and crops for self-consumption.
Farm Design were used for modeling farming systems in Bolivia, which were identified from the previous typology step. Three representative farms were initially selected for in depth data collection. A participatory approach was used to identify and select additional farms of interest for modeling (Years-I & II). A final step was to develop a trade-off model using the Farm Level Modeling analysis with multiple indicators and tradeoff analysis. This allowed to assess different scenarios of crop-livestock integration under conservation agriculture (Year-II & IV).	Three farm types retained for modelling: ▪ Farm-I in Challapata is completely dependent on crop- livestock activities on a medium land area of 16 ha. It produces three (3) species of crops: quinoa, barley, and potato, and rear 3 species of livestock. Grazing is undertaken in pasture lands outside the farm production unit. ▪ Farm-II in Uyuni, crops area is bigger (60 ha) and is mostly under quinoa production for commercial purposes. A smaller proportion of land is under potato cultivation for self- consumption. Off- farm income (especially from renting machinery and labour) is high in this farm type. ▪ Farm-III in Challapata is a smaller farm type (average of 5.5 ha) but is more diversified in terms of sources of income and types of crops and livestock activities. They dedicate long periods of time to migration and off-farm activities. Pastures of alfalfa and barley are usually grown on farms for their livestock. Dairy milk and cheese from cows represent their main products and source of income. Some sheep and llamas are also grown for self- consumption and sales. Quinoa is grown for commercialization and a small amount is saved for food.
Mexico	
Farm typology analysis and modelling using the FarmDESIGN model was also set in Santa Catharina municipality, based on previous work in Mixteca Alta. The modelling was built upon the typology developed by UAM. Three farms with different levels of crop-livestock integration were selected for analysis (Year-II). Based on the typology analysis, four areas of improvement were identified for optimizing productivity and assessing related trade-offs using the Farm Design model (Year-II & III). These are: crop-livestock integration, livestock production, nutritive efficiency of crops, and poly-cropping intensification. A trade-off model was developed using Farm Level Modelling analysis with Multiple Indicators and Trade-off Analysis (Year-II & IV), which included three main alternatives: maize-bean intercropping, forage production, and improved fertility management in maize production.	The typology analysis of these farms revealed five types: ▪ Mixed Crop-livestock farms. ▪ Farms dependent on external agricultural labors and low monetary income. ▪ Farms dependent on government programs. ▪ Farms with high non-agricultural income. ▪ Farms with medium external income. Results of the FarmDesign modelling show that: ▪ Forage production and improved maize management can represent advantages for the farm households in Oaxaca, mainly in relation to economic performance, contribution of agriculture to total income as well as to food and forage self-sufficiency. These advantages are marginal when partial adoption (on part of the cropping area) is considered. ▪ Some trade-offs can be identified in relation to the whole farm organic matter balance (decrease of dependence on pastures and therefore biomass inputs) and negative consequences to the emission of greenhouse gases.

Table L. Main Studies and Results of the Financial Evaluation and Adoption Assessment of CLCA related Technologies in Algeria & Tunisia

Study	Main Result
Algeria	
Cost-Benefit analysis for comparing CA practices [NT and Simplified Cultivation Technique (SCT)] with the conventional farming system, to highlight the economic effects of CA under crop-livestock farming system. Partial budget analysis (PBA) was used and applied to compare plots under CA (NT and SCT/MT) and conventional agriculture (CT). Two different farming systems were considered, rainfed (Setif) and irrigated systems (M'Sila). The expenses generated by the management of the herd (vaccination and expenses of the shepherded of animals) and the supplementary feeding (concentrate) were integrated in the analysis. Two feeding plans were considered, a conventional feeding plan and a feeding plan practiced by CA farmers (Year-I & II) .	In irrigated cropping system: ▪ Total costs were reduced under CA comparatively to Conventional tillage (CT) in the range of 19.3 to 20.9 USD/ha (Year-I). ▪ Wheat/barley and wheat/wheat rotations are not profitable to farmers, the wheat/barley rotation induced less losses (Year-III). In rainfed system: ▪ NT reduced total costs, compared to conventional (CT) tillage, by 37.2 USD/ha. ▪ NT produced almost a similar CBR to CT (3.29 et 3.3 respectively). ▪ Wheat-legumes rotations reduced costs by 46.9 - 44.3 USD /ha comparatively to CT. ▪ CBR for wheat-legumes rotations were almost 2 times higher that these of wheat-wheat rotations (3.1 versus 1.6 in Year-I). In Year-II the rotation wheat-vetch/oat produced almost three times more return compared to the wheat-wheat rotations. ▪ Barley-vetch/oat rotations produced a gain of 75,5 USD /ha compared to barley-barley rotations, CBR were quite similar for both rotations (1,9 and 1,8 respectively).
A prospective study was carried out to predict likely rates and peak levels of adoption of CLCA technologies, and to identify and analyze the importance of factors and determinants influencing adoption of these improved technologies. **Two focus groups were conducted with researchers and extension staff and two others with farmers respectively in M'Sila (under irrigation system) and Setif (under rainfed system).** Under irrigated farming system, the ADOPT software was implemented with two different focus groups composed of farmers practicing CA in addition to technicians and extension staff (Year-I).	In the irrigated system: ▪ Predicted level of adoption for farmers at the beginning of the project was around 66%, and the time to peak for this adoption level was found to be 21 years. ▪ Presence of a reluctant attitude regarding the adoption of the CLCA technologies due to: The silty nature of the soil texture in the area, which is leading, when irrigated, to the formation of a layer of fine elements making the soil become heavily compacted, thus requiring tillage. Competition between mulching and livestock feeding on crop residues. Predictive levels of adoption for researchers and extension agents are around 95% with 13.7 years to peak adoption level. In the rainfed system: ▪ The peak level of CLCA technologies adoption was 94% and 95% after 16 years and 21 years respectively for farmers and research/extension. ▪ Both categories recognize that the cost of investment (i.e., no-till seeder) and the high competition between crops and sheep are the main key factors that influence both time and level of adoption.
Tunisia	
The prospective adoption studies involved three focus group discussions (FGDs) with farmers using the same methodology as in Algeria. Additionally, data from a survey conducted in March-April 2019 among CA adopters in the same governorates was analyzed using the Simple Multi-Attribute Rating Technique (SMART) to calculate a Composite Capital Index (CCI) that reflects social, human, and physical capital (Year-I).	ADOPT results suggest that: ▪ The adoption peak is estimated at 95% in 22 years in Beja with a CCI of 0.361. ▪ The adoption peak in Siliana is 95% would be reached in 16 years with a CCI of 0.311. ▪ The adoption peak in Zaghouan of 95% would be reached in 27 years with a CCI of 0.0295.

Table M. Coherence of the CLCA Activities and Outputs with the IFAD ENRM Core Principles

IFAD ENRM Core Principle	Examples of CLCA Project activities Coherent with the IFAD ENRM Core Principles
1. Scaled-up investment in multiple-benefit approaches for sustainable agricultural intensification.	Subsidization of the No-till seeder in Algeria for increasing adoption of CA packages in Algeria.
2. Recognition and greater awareness of the economic, social, and cultural value of natural assets.	Demonstration of the financial competitiveness of CLCA packages in NA and LAC relatively to CT.
3. 'Climate-smart' approaches to rural development.	Better yields stability and enhanced WUE of different crops under CLCA in particular in NA.
4. Greater attention to risk and resilience in order to manage environment- and natural-resource- related shocks.	Adoption of vetch for improving forage and feed availability as well as valorization of crop residues and agro-industrial by-products for better resilience to the volatility of the feed markets, the disruption of the international grain supply chains and the persistent drought.
5. Engagement in value chains to drive green growth.	▪ Territorialized value chain for forage seeds and mixed seeds. ▪ Territorialized value chains for seed cleaners and treatment in NA Proximity value chains for 0-till seeder service provision in Algeria. ▪ Adoption of living wind barriers in LAC.
6. Improved governance of natural assets for poor rural people by strengthening land tenure and community-led empowerment.	▪ Improvement of stubble management in wheat based mixed crop-livestock systems in NA for securing mulching under CLCA practices. ▪ Increased crop yields and fodder availability by relay cropping with lupin in quinoa-Llama system, relay cropping with legumes in maize-based mixed crop-livestock system in Mexico, and finally relay cropping using vetch in wheat-based crop-livestock mixed systems. ▪ Production of native species windbreaks sapling and bushes seedlings and production of lupin seeds by smallholder farmers In Bolivia for soil coverage, relay cropping and windbreaks. ▪ Knowledge hubs managed/centred on farmers needs and expectations in NA and LAC. ▪ Development of machinery service provision to farmer members by local farmers cooperatives for better quality of farm forage seeds in NA.
7. Livelihood diversification to reduce vulnerability and build resilience for sustainable natural resource management.	▪ Relay cropping and crops diversification in NA and LAC for improving soil health and animal feeding and increasing yields. ▪ Improvement of food security by cropping diversification for farmers consumption (Mexico with an improved bean production). ▪ Machinery service provision models for farmers and farmers' cooperative and rural SMEs to support scaling of CLCA packages.
8. Equality and empowerment for women and indigenous peoples in managing natural resources.	▪ Capacity development centred on women farmers in Bolivia, Algeria, and Tunisia. ▪ Training sessions focused on capacity development of women, for instance in Algeria (training on cheese making in Algeria a group of 30 women). ▪ Creation of a gender-friendly knowledge hub in Northwest of Tunisia (Sers – District of Kef) specifically designed to cater for the need of women farmers in terms of good quality feed for small ruminants and cows using CLCA climate and environment smart technologies.
9. Increased access by poor rural communities to environment and climate finance.	Not covered by the project activities.
10. Environmental commitment through changing its own behavior.	Preservation through valorization by farmers of local genetic plant and animal resources (wild lupin, bushes and grasses, Quinoa and Llama in Bolivia; local vetch, indigenous varieties of food legumes and local breeds of sheep in Tunisia; triticale, less glyphosate and Ouled Jellal breed of sheep in the steppes of Algeria).

Table N. List of CLCA Practices, Packages, Policies, and Analytical Methods Having Positive Environmental Effects

Technology Introduced by the CLCA Project	Positive Environmental Effect	Time Frame Effect
	Complex CLCA Package	
CA-based packages (NT, MT, mulching, crop-rotation, windbreaks)	▪ Soil erosion reduction. ▪ Increased soil health indicators (OM, Microbial activity, etc.). ▪ Increased WUE.	Medium- and long-term
	▪ Yields' stabilization under climatic variability (NA) with higher plant resilience due to better roots development.	Short- and medium-term
	Single Technology	
Biological treatment of Ticona in Quinoa	Avoid pollution with chemical herbicides and exposure of users to toxic risks.	Short-term
Weed glyphosate treatment with reduced doses and controlled water quality in Algeria	Reduce pollution with glyphosate and reduce treatment costs.	Short-term
Definition of N2 fertilization protocols in wheat-based system in Tunisia	Provide farmers with operational N2 fertilization guidelines for securing the adoption of CA based packages (reducing risks of decreased yields) and avoiding overdosing of N2 chemical fertilizer.	Short-term
Relay cropping with legumes (forage legumes in NA and Mexico, lupin in Bolivia) Animal manuring in quinoa-Llama system	▪ Increasing crop diversity. ▪ Reducing monospecific plant pathogens. ▪ Increasing yields without requirements to additional chemical fertilizers.	Short- to medium-term
Short value chains for forage and forage mixture seeds and for service provision (Tunisia and Algeria, lupin seeds in Bolivia)	▪ Less requirements for transport and use of fossil fuels (lesser expected carbon footprint). ▪ Valorization of locally available crop residues and food industry residues: circular economy with territorial low transaction costs value chains embedded in the local economy. ▪ Locally produced machinery within regional/national value chains with more affordable costs.	Short- to medium-term
	Policy	
Subsidization of the locally produced NT seeder	Facilitating adoption of NT practices.	Medium- to long-term

Table N. List of CLCA Practices, Packages, Policies, and Analytical Methods Having Positive Environmental Effects (Cont'd)

Technology Introduced by the CLCA Project	Positive Environmental Effect	Time Frame Effect
	Analytical Methodology	
FarmDesign (LAC and NA Countries)	Providing decision-aid for improving stubbles management strategies.	Medium- to long-term
Spatial predictive models for soil erosion and effects and CBA of CA in Tunisia and LAC	Providing decision-aid for implementing CLCA packages in priority zones were highest soil and financial benefits are expected to be recorded.	Medium- to long-term

Table O. Alignment of the Country Strategic Objectives and Project Outputs/Outcomes for Bolivia, Mexico, and Tunisia

Country Strategic Objective	CLCA Project Outputs/Outcomes Contributing to the Strategic Objective
Bolivia COSOP (2021-25)	
1. Improve the agricultural productive capacity of inclusive production systems in a way that is environmentally sustainable and resilient to climate change.	Adoption of CLCA packages (wind breaks, minimum tillage, use of composts, good quinoa seeds and lupin-quinoa relay cropping) were shown to increase yields under farmer practices in Bolivia while reducing erosion and providing more resources for household consumption. Production of seeds, seedlings, and saplings for cover plants, grasses, and bushes by farmers.
2. Facilitate market access for competitive, sustainable, and inclusive agricultural and non-agricultural products that are produced by rural smallholder producers.	Partially covered by the analysis on value chains for seed production in Bolivia.
3. Cross-cutting thematic areas: access to finance; improved nutrition; empowerment of women and youth; and natural resource management.	Capacity development activities targeting women and youths. Use of CA based-practices in a farming system highly exposed to soil and wind erosion.
Mexico COSOP (2020-25)	
1. Contribute to improving the food and nutritional security of small producers and indigenous populations, by strengthening their assets and organizational capacities to enable them to participate in markets, and by supporting the transition to more inclusive, more productive, more resilient, and more sustainable food systems in marginalized territories.	Increased crop yields in the smallholder maize-based crop-livestock farming system with more resources for household consumption. Climate resilient and soil friendly CLCA packages with improved WUE and lesser soil erosion Sheep and goat meet value chain analysis (barbacoa)
2. Strengthen the impact and sustainability of the results of national programs prioritized by the Government, through the adoption and scaling up of innovations and working methods developed in the context of operations of IFAD to provide transition trajectories from social protection to economic inclusion of youth, women, indigenous peoples, and other vulnerable populations in the southern and south-eastern territories of the country.	Development of scaling hubs based on the scaling pathway approach for reducing the vulnerability of smallholder farmers and their households by increasing sustainably their yield performances and incomes.

Table O. Alignment of the Country Strategic Objectives and Project Outputs/Outcomes for Bolivia, Mexico, and Tunisia (Cont'd)

Country Strategic Objective	CLCA Project Outputs/Outcomes Contributing to the Strategic Objective
Mexico COSOP (2020-25) – Cont'd	
3. Contribute to strengthening strategies for mitigating climate change and adapting to its effects, in the context of family farming activities of vulnerable rural populations in order to develop resilience and support the sustainable use of ecosystems.	Up-scaling of validated CLCA packages fitted to smallholder farmers for coping with the climate change dynamics through improving crops resilience and WUE to climatic volatility.
Tunisia COSOP (2019-24)	
1. Improved access to productive infrastructure and sustainable management of natural resources.	Access to small machinery proximity service provision for seed cleaning and treatment. Improved access to high quality forage seeds and forage seed mixtures ready to uses at affordable prices.
2. Inclusion of the rural poor in better structured agricultural value chains.	Development of territorialized small machineries service provision value chains promoting SMEs and farmer cooperatives with reduced transaction costs and integration of values produced in the rural local economies.
3. Economic and social empowerment of vulnerable rural women and youth.	Specific targeting of women and youth by competence development digital activities (i.e., 50 and 30% respectively in the third year). Specific targeting of women and youth by CLCA training in animal health and feeding.

Table P. CLCA Scientific Papers[2]

ID N°	Title	Link	Research Country
04	Evaluation de la biologie du sol sous l'effet du traitement chimique en semis direct dans une zone semi-aride de l'Algérie	Link	Algeria
05	Optimum Herbicide Dose Management in Direct Seeding for Cereals Production: Case of Semi-arid Area of Algeria	Link	Algeria
06	Integration crop-livestock under conservation agriculture system	Link	Tunisia
07	Effect of supplementation by cactus (Opuntia ficus indica f. inermis) cladodes on reproductive response and some blood metabolites of female goat on pre-mating phase	Link	Tunisia
08	Assessing the long-term impact of conservation agriculture on wheat-based systems in Tunisia using APSIM simulations under a climate change context	Link	Tunisia
09	Adoption of Conservation Agriculture Technologies by Smallholder Farmers in the semiarid region of Tunisia: Resource constraints and partial adoption	Link	Tunisia
10	Socioeconomic assessment of no-till in wheat cropping system: a case study in Algeria	Link	Algeria
11	Livelihoods Strategies and Household Resilience to Food Insecurity: A Case Study from Rural Tunisia	Link	Tunisia
12	Foraging behaviour, digestion and growth performance of sheep grazing on dried vetch pasture cropped under conservation agriculture	Link	Tunisia
13	Wheat Stubble from Conventional or Conservation Agriculture Grazed by Ewes: Biomass Dynamics and Animal Performances	Link	Tunisia
14	Effect of Tillage, Previous Crop, and N Fertilization on Agronomic and Economic Performances of Durum Wheat (Triticum durum Desf.) under Rainfed Semi-Arid Environment	Link	Tunisia
15	Tunisian Consumer Quality Perception and Preferences for Dairy Products: Do Health and Sustainability Matter?	Link	Tunisia
16	Patterns of Use of Residue Biomass in Cereal–Sheep Production Systems of North Africa: Case of Tunisia	Link	Tunisia
17	Effects of spatial resolution of terrain models on modelled discharge and soil loss in Oaxaca, Mexico	Link	Mexico
18	Rendimiento y análisis bromatológico de subproductos de trilla de cuatro variedades de quinua (Chenopodium quinoa Willd.) en Kiphakiphani, La Paz - Bolivia	Link	Bolivia
19	"Dear Brother Farmer": Gender-Responsive Digital Extension in Tunisia during the COVID-19 Pandemic	Link	Tunisian
20	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	Link	Tunisia
21	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	Link	Tunisia
22	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	Link	Algeria & Tunisia
23	Assessing complementary synergies for integrated crop–livestock systems under conservation agriculture in Tunisian dryland farming systems	Link	Tunisia

[2] Papers published with full or partial support from CLCA II project

Table Q. Evaluation Method of the Peer-reviewed Papers Published with Full or Partial support from CLCA II Project

Domaine thématique de l'article (FORD)	**Référence de l'article (ID N°)**	**1. Typologie scientifiques et technologique (Manuel de Frascatti, 2015, et Innospice) et description du travail** 1.1. New basic science knowledge (pure or oriented toward fields of application) 1.2. Applied science knowledge creation (Applied research) 1.3. Experimental science knowledge creation (new potentially operational products) (experimental development)	**2. Champs d'application potentiel**	**3. Représentativité échantillonnage** (Recrutement aléatoire ou non-aléatoire ; Représentativité bioclimatique)	**4. Fiabilité des résultats :** (Fiabilité des méthodes, Cohérence avec d'autres publications, similarité des résultats dans d'autres régions, reproductibilité des résultats et des grandes tendances dans d'autres études dans les mêmes régions) Se restreindre à la discussion	**5. Perspectives scientifiques potentielles issues du travail mené**	**6. Extrants Technologiques valorisables (Innospice) X IRL** (Prototype expérimental < TRL5 et description ; Prototype technologique > TRL5 ; autres produits valorisables)	**7. Perspectives de scaling-up des extrants technologiques mâtures** **(Evidences motivant** le scaling up; Degré de changement introduit ; Où: zones agroécologiques et géographiques si applicable) (Scaling readiness)	**8. Groupes/ Institutions cibles** (Clients et types, utilisateurs finaux et type) Attention organisations agricoles sont des end-users
4. Agricultural and Veterinary Sciences **4. 1 Agriculture, Forestry and Fishery** **Weed treatment and CA**	01	1.2. Applied science knowledge creation (Applied research): Verification of the hypothesis that combination of glyphosate and NT do not affect soil biological activity and herbicide degradation.	NT and MT packages.	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. Pilot study in experimental station under natural conditions Experimental trial with blocks.	Reference analytical methods. Coherence with literature data.	Analyse specific effects on dominant soil microorganisms. Confirm results with durum wheat.	< 5, early prototype of application with experimental blocks under operational environment).	Needs for confirming the results after scaling under usual cropping conditions and in other similar sites in Algeria and Tunisia. Needs for confirmation of similar trends in distinct sites in TN and ALG. Outputs required for developing prototypes of technical guidelines for weed treatment.	Research organization Extension
4. Agricultural and Veterinary Sciences **4. 1 Agriculture, Forestry and Fishery** **Weed treatment and CA**	02	1.2. Applied science knowledge creation (Applied research): Verification of the hypothesis that direct seeding machinery combined to a suitable dose of glyphosate can enhance cereal production and preserve soil quality with safety measures at the same time.	NT and MT packages	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. Pilot study in experimental station under natural conditions Experimental trial with blocks.		Confirm results with durum wheat. Confirm the formulated doses hypothesis by on farm assessment.	< 5, early prototype of application with experimental blocks under operational environment).	Needs for confirming the results after scaling under usual cropping conditions and in other similar sites in Algeria and Tunisia. Needs for confirmation of similar trends in distinct sites in TN and ALG. Outputs required for developing prototypes of technical guidelines for weed treatment.	Research organisation Extension
4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Nutrition and CA**	03	1.2. Applied research work Review of basic and applied research works for development of operational research.	Potential application for decision-aid for developing NT and MT packages in mixed crop-livestock systems.	NA	NA		1-2 (data from applied research publications to be used for developing specific R&D objectives in TN).	NA	Research organisation Extension
4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Animal nutrition**	04	1.2. Applied research work to investigate the effect of a substitution of barley grains by the cactus on reproductive parameters and some blood metabolite levels on goat.	Potential application to improve NT and MT packages in mixed crop-livestock systems.	Mixed crop-livestock system under the biophysical and socio-economic context of the study region. Pilot study in experimental station under natural conditions.	Good, well experienced team.	Further exploration of the absence of effect of cactus on Ca metabolism.	< 5, early basic feeding prototype under operational environment in experimental stations, small experimental group and a specific diet).	Need for validation on larger samples and with other types of diets.	Research organisation Extension

Table Q. Evaluation Method of the Peer-reviewed Papers Published with Full or Partial support from CLCA II Project (Cont'd)

1. Natural Sciences **1.5. Earth and related environmental science**	05	1.2. Applied research work to a prospective analysis aimed to evaluate the potential of CA to adapt wheat-based-systems to climate change in Tunisia.	Potential application to scaling and policy development of NT and MT packages.	Mixed crop-livestock system in semi-arid and sub-humid bioclimatic zones.		Validation of the outputs of the predictive analysis by actualized (+ retrospective ?) field data.	< 5, set of evidence supporting the long-term impact of CA practices on soil health need to be used as a component of a framework for aiding decision for CA.	Validation work Outputs required for developing a decision aid framework for scaling CA and for developing supporting policies.	Research organisations Land conservation administrations Policy makers Extension
5. Social Sciences **5.4. Sociology** **Rural socioeconomy**	06	1.2. Applied research work to determine the factors governing the adoption of CA e the factors governing the adoption of CA in the governorate of Siliana, which is classified nationally as the most threatened by land degradation.	Potential application to scaling and policy development of NT and MT packages	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. Non-random selection of the farmer's sample.	Experienced team. Is it including a sociologist?	Explore the results apparently incoherent with literature to confirm the explanation hypothesis raised in the study.	< 5 early methodological prototypes even if tested under operational conditions. Validate the model hypothesis and structure. In fact, two components: questionnaire for generating data and logit program for analyzing data.	the model needs further validations on larger farmer samples from different biophysical and socioeconomic backgrounds. The results of the model need to be validated by the success of the scaling options they determine.	Clients: policy makers, extension, and development, Farmers organisations
5. Social Sciences **5.4. Sociology** **Rural socioeconomic**	07	1.2. Applied research work to determine the factors governing the adoption of CA in Setif Algeria.	Potential application to scaling and policy development of NT and MT packages.	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. Non-random selection of the farmer's sample.	Negative control group? Is it including a sociologist?	Scientific validation of the results on farmers that have abandoned CA	< 5 set of results obtained on a very limited sample.	The results need further validations on larger farmer samples from different biophysical and socioeconomic backgrounds. Outputs required for developing a decision aid framework for scaling CA and developing supporting policies.	Clients: policy makers, extension, and development, Farmers organisations
5. Social Sciences **5.4. Sociology** **Rural socioeconomic**	08	1.2. Applied research work to identify and analyse the main dimensions of household resilience to food insecurity and compare the results between two villages, Zoghmar and Selta, in Sidi Bouzid.	Potential application to scaling and policy development of NT and MT packages.	Mixed crop-livestock under the biophysical and socio-economic context of the study region. Random selection of the sample farms.	Questionnaire developed by specialist in socioeconomy and tested before use.		< 5, predictive model needs to be validated.	RI model to validate upon convergence of its output with true data.	policy makers, development, farmers organisations
4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Animal nutrition**	09	1.2. Applied research work to test the hypothesis that grazing on dried vetch only is a cost-effective alternative to wheat stubbles grazing under CA context.	Potential application to develop CA technical packages in wheat based-mixed crop livestock systems.	Wheat based-mixed crop livestock systems under semi-arid climates. Pilot study in experimental station under natural conditions.			< 5, proof of concept and experimental feeding prototype under experimental natural condition.	Validation after scaling in larger plots under usual farming operational conditions. To be translated into a technical practice targeting farmers.	Zootechnicians Extensionist Farmers and farmer organisations

Table Q. Evaluation Method of the Peer-reviewed Papers Published with Full or Partial support from CLCA II Project (Cont'd)

4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Animal nutrition**	10	1.2. Applied research work to investigate whether CA and CT could influence the biomass dynamics and the responses of ewes to wheat stubble grazing in the semi-arid regions at different stocking rates.	Potential application to develop CA technical packages in wheat based-mixed crop livestock systems.	wheat based-mixed crop livestock systems under semi-arid climates. Pilot study in experimental station under natural conditions.			< 5, proof of concept and experimental feeding prototype under experimental natural condition.	Validation after scaling in larger plots under usual farming operational conditions. To be translated into a technical practice targeting farmers.	Zootechnicians Extensionist Farmers and farmer organisations
4. Agricultural and Veterinary Sciences **4. 1 Agriculture, Forestry and Fishery** **Crop production**	11	1.2. Applied research work to identify and analyse the effects of NT and CT on gross margin and productivity under five levels of N fertilizer.	Potential application to support scaling of CA.	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. Pilot study in experimental station under natural conditions.	Experienced team	Analyze effects in long term adoption of CA.	< 5, proofs of concept Could be integrated as one component of a framework for aiding decision for CA scaling and for developing policies.	Validation after scaling in larger plots under operational conditions and different biophysical contexts.	Research organisations extension
5. Social Sciences **5.4. Sociology** **Consumption behaviors**	12	1.2. Applied research work to identify and analyse the general trends of dairy consumption in Tunisia, the perception of dairy quality and consumer relation with health and sustainability.	Potential application to promote consumption of dairy products.	Socioeconomic contexts of the target region.			<5 , because this study generated data that need to be translated into policies and promotion strategy for dairy products.	Outputs required for developing a decision aid framework for promoting dairy products consumption in Tunisia.	Research organisations GILVR Dairy farmers organizations Milk industries
4. Agricultural and Veterinary Sciences **4. 1 Agriculture, Forestry and Fishery** **Crop production**	13	1.2. Applied research work to assess the influences importance and interdependencies of different types of factors affecting crop residues management.	Potential application to promote CA policies and practices.	Wheat based mixed crop-livestock under the biophysical and socio-economic context of the study region. On farms study.			< 5, set of evidence supporting the long-term impact of CA practices on soil health. Need to be integrated as one component of a framework for aiding decision for CA scaling and for developing policies.	Validation of the main factors identified by specific on field verifications. Outputs required for developing a decision aid framework for scaling CA and for developing supporting policies.	Research organisations Policy makers Extension
1. Natural Sciences **1.5. Earth and related environmental science**	14	1.3. Experimental science knowledge creation to identify an appropriate spatial resolution for modelling soil losses in the study area (final product: evaluation method for soil erosion modelling).	Potential as a method for decision aid to promote CA policies and scaling strategies according to soil vulnerability.	Specific to Oaxaca region?	Experienced team		Advanced analytical prototype at TRL 7.	Need to be further confirmed by further application in modelling soil erosion under operational environment.	Research organisations Land conservation administrations
4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Animal nutrition**	15	1.2. Applied research work to evaluate the yield of grain and quinoa threshing by-products.	Potential application to develop CA technical packages in quinoa-llama production systems.	quinoa-llama production systems in arid Andean zones. Complete Random Blocks design.			< 5, elements of concepts toward developing technical practices for integrated Quinoa Llama systems.	Prospects for developing technical practices.	Research Extension and development

Table Q. Evaluation Method of the Peer-reviewed Papers Published with Full or Partial support from CLCA II Project (Cont'd)

5. Social Sciences **5.4. Sociology**	16	1.2. Applied research work to assess usefulness, impact on adoption of agricultural practices of digital extension.	Data for orienting decision in tools supporting scaling for CA.	Different Production system and biophysical and socio-economic contexts. Farmers sample.		Analyze the root causes of the default of impact for some indicators.	< 5, need to develop a framework for aiding decision in digital extension. Need to be integrated as a component of a framework for aiding decision in digital extension**.**	Outputs required for developing a decision aid framework for extension activities and developing supporting policies.	Research Extension and development
4. Agricultural and Veterinary Sciences **4. 1 Agriculture, Forestry and Fishery** **Crop production**	17	1.2. Applied research work to assess impact of long-term CA on soil health.	Data for orienting decision in tools supporting scaling for CA.	Wheat based mixed crop-livestock in semi-arid climate in an experimental station. Pilot study in experimental station under natural conditions.	Experienced team.	Reproducibility of the same trends in different biophysical production systems.	< 5, set of evidence supporting the long-term impact of CA practices on soil health. Need to be integrated as one component of a framework for aiding decision for CA scaling and for developing policies.	Validation after scaling in larger plots under operational conditions and different biophysical contexts. Outputs required for developing a decision aid framework for scaling CA and developing supporting policies.	Research Extension and development
4. Agricultural and Veterinary Sciences **4.2. Animal and dairy Sciences** **Animal nutrition**	18	1.2. Applied research work to assess impact of long-term CA on stubble biomass and nutritional quality.	Data for improving technical packages in mixed crop-livestock systems and for orienting decision in CA scaling.	Wheat based mixed crop-livestock in semi-arid climate in an experimental station Pilot study in experimental station under natural conditions.	Experienced team.	Confirm and analyze the root causes of the decrease in stubble quality under CA. Analyze the relationship between stubble quality and stubble digestibility and intake.	< 5, set of evidence impact of CA practices animal nutrition needs to integrate as a one component of a framework for aiding decision for CA scaling and for developing policies.	Validation after scaling in larger plots under operational conditions and different biophysical contexts. Outputs required for developing a decision aid framework for scaling CA.	Research Extension Policy makers Farmers organisations
4. Agricultural and Veterinary Sciences **4. 1. Agriculture, Forestry and Fishery** **4.2. Animal and dairy Sciences**	19	1.2. Applied research work consisting of a Review on the capacity of CA to Enhance Agricultural System Resilience and Food Security under Climate. Change dynamic in NA.	Data for improving technical packages in mixed crop-livestock systems and for orienting decision in CA scaling and policy development.	Mixed crop livestock systems in NA.			< 2, providing data to build on for policy orientations and justifications and for developing experimental technology protypes.		Research Extension Policy makers Farmers organisations
5. Social Sciences **5.2. Economics and business**	20	1.2. Applied research work to assess the impact of crop-livestock diversification under CA farming systems.	Data for orienting decision in CA scaling.	Wheat based mixed crop-livestock and crop-livestock systems in sub-humid and semiarid zones Tunisia.	Experienced team.		< 5, data guiding decision making in policies for diversifying mixed crop-livestock systems. need to be used as a component of a framework for developing policies.	Validation of the main factors identified by specific on field verifications. Outputs required for developing a decision aid framework for scaling CA and developing supporting policies.	Research Extension Policy makers

Acknowledgment

ICARDA and CIMMYT would like to acknowledge the following partner institutions for their valuable contributions to the Project activities design and implementation:

Algeria

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

Bolivia

- Fundación para la Promoción e Investigación de Productos Andinos – PROINPA

Mexico

- Universidad Autonoma Metropolotana-Xochimilco – UAM-X

Tunisia

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