Quinoa and Lentil growing together (Mina Devkota)

Diversified Cropping System: Relay Intercropping of Lentil with Quinoa (Morocco)

DESCRIPTION

A Diversified Cropping System (DCS) results in a more resilient and intensive cropping system. In this case quinoa was introduced as an intercrop for lentil. The yield of lentil is not reduced; hence the system becomes more productive, profitable and resilient with the introduction of quinoa.

In the semi-arid regions of Morocco agricultural production is unstable, and yields are declining as consequence of climate change. Climate change leads to more irregular rainfall and more frequent extreme weather events. There is a need, where possible, to intensify agricultural systems while improving food security - through increasing the resilience of the overall system.

Cultivating lentils is common practice in rural Morocco. To intensify this cropping system, taking into account the effects of climate change, the International Centre for Agricultural Research Dry Areas (ICARDA) introduced quinoa into the common lentil production system. Importantly, quinoa does not affect the yields of lentil because it does not significantly compete for water and nutrients. With two crops harvested from the same piece of land, overall farm profit increases. Furthermore, the cultivation of two crops creates a more resilient overall system because the farmer is not dependent on one single crop. Additionally, as quinoa is harvested later than lentil, the soil is covered for a longer period, consequently protecting it from degradation, hence soil quality is improved. In addition, lentils are leguminous, fixing nitrogen in the soil, thus improving soil conditions for growth.

However the technology has some potential drawbacks. Firstly, in Morocco, the market for quinoa is not well developed, hence achieving a good market price could be problematic if planted at scale. Secondly, in years of extreme droughts, quinoa requires supplementary irrigation, especially during crop establishment. This is often inaccessible, resulting in poor crop establishment and low yield. Thirdly, if planted in small plots there may be risks of free grazing livestock as well as pest and insect infestations. This can be overcome by community farming and pest control.

In 2020 and 2021, ICARDA tested this Diversified Cropping System on a trial field of half a hectare, in an area with average annual precipitation of 400 mm. DCS is implemented in the following order of activities. The field is prepared by ploughing. In December, lentils are mechanically seeded. Two rows of lentils are planted 15 cm apart. The spacing between each two-row pair is roughly 90 cm. Compound fertilizer is applied during the seeding. In January, a herbicide is sprayed to control grassy weeds. The field is mechanically weeded twice, in mid-January and then again in February.

The quinoa is then seeded at the end of February: also in paired lines (two rows at 20 cm apart) and also with compound fertilizer. Each pair of quinoa lines is planted between pairs of lentils. Because the quinoa is planted within an already growing crop of lentils, this form of intercropping is termed "relay planting".

The quinoa is manually weeded in March. In April, the lentils are manually harvested and mechanically threshed. A single spray of insecticide is applied in April-May. Finally, in June, the quinoa is mechanically harvested.

This documentation illustrated an ICARDA innovation which is accessible since there are no establishment events and costs. This Diversified Cropping System improves a

LOCATION

Location: Merchouch, Morocco

No. of Technology sites analysed: single site

Geo-reference of selected sites
- -6.69679, 33.56509

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2020

Type of introduction
- ☐ through land users' innovation as part of a traditional system (> 50 years)
- ☑ during experiments/ research
- ☑ through projects/ external interventions

traditional system by introducing an additional crop, resulting in better farm income and more resilience.

The early growth stage of paired rows of lentils (Mina Devkota)

The germination of quinoa bordered each side by growing lentils (Mina Devkota)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Cropland

- Annual cropping: cereals - quinoa or amaranth, legumes and pulses - lentils

Number of growing seasons per year: 1
Is intercropping practiced? Yes

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

soil erosion by wind - Et: loss of topsoil

SLM group

- improved ground/ vegetation cover

SLM measures

agronomic measures - A1: Vegetation/ soil cover

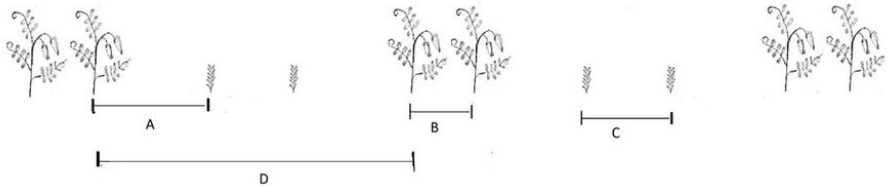
vegetative measures -

management measures - M2: Change of management/ intensity level, M4: Major change in timing of activities

TECHNICAL DRAWING

Technical specifications

The technical drawing relates to the following quantification:
A: Spacing between a row of lentil and a row of quinoa = 35 centimetres
B: Spacing between two rows of lentil in the same pair = 15 centimetres
C: Spacing between two rows of quinoa in the same pair = 20 centimetres
D: Spacing between two rows of lentil bordering a pair of quinoa = 90 - 95



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centimetres

In a row, the plants are planted continuously.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **1 Hectare**)
- Currency used for cost calculation: **Moroccan Dihram (MAD)**
- Exchange rate (to USD): 1 USD = 9.0 Moroccan Dihram (MAD)
- Average wage cost of hired labour per day: 75

Most important factors affecting the costs
n.a.

Establishment activities
n.a.

Maintenance activities
1. Field Ploughing (Timing/ frequency: Prior of Seeding)
2. Lentil Seeding (Timing/ frequency: December)
3. Fertilizer Application (Lentil) (Timing/ frequency: During Seeding)
4. Herbicide Application (Lentil) (Timing/ frequency: January)
5. Mechanical Weeding (Lentil) (Timing/ frequency: Mid January)
6. Second Mechanical Weeding (Lentil) (Timing/ frequency: Mid February)
7. Fungicide Application (Lentil) (Timing/ frequency: February-March)
8. Quinoa Seeding (Timing/ frequency: End of February)
9. Fertilizer Application (Quinoa) (Timing/ frequency: During Seeding)
10. Lentil Harvesting (Timing/ frequency: April)
11. Manual Weeding (Quinoa) (Timing/ frequency: March)
12. Insecticide Application (Quinoa) (Timing/ frequency: April-May)
13. Harvesting Quinoa (Timing/ frequency: June)

Maintenance inputs and costs (per 1 Hectare)

Specify input	Unit	Quantity	Costs per Unit (Moroccan Dihram (MAD))	Total costs per input (Moroccan Dihram (MAD))	% of costs borne by land users
Labour					
Lentil Harvesting	Person-Days	10.0	75.0	750.0	100.0
Weeding (lentil)	Person-Days	10.0	75.0	750.0	100.0
Weeding (quinoa)	Person-Days	20.0	75.0	1500.0	100.0
Equipment					
Lentil Thresher	Machine-Hours	2.0	150.0	300.0	100.0
Quinoa Harvester	Machine-Hours	1.0	500.0	500.0	100.0
Lentil Seeder	Machine-Hours	1.0	150.0	150.0	100.0
Quinoa Seeder	Machine-Hours	1.0	150.0	150.0	100.0
Sprayer	Machine-Hours	3.0	60.0	180.0	100.0
Weeder	Machine-Hours	2.0	100.0	200.0	100.0
Plant material					
Lentil Seeds	Kilogram	45.0	8.0	360.0	100.0
Quinoa Seeds	Kilogram	3.5	40.0	140.0	100.0
Fertilizers and biocides					
NPK 10-20-20 (for Lentil)	Kilogram	100.0	3.0	300.0	100.0
NPK 15-15-15 (for Quinoa)	Kilogram	150.0	3.0	450.0	100.0
Herbicide (for Lentil)	Liter	1.0	170.0	170.0	100.0
Insecticide (for Quinoa)	Milliliter	50.0	1.5	75.0	100.0
Fungicide (for Lentil)	Liter	0.5	150.0	75.0	100.0
Total costs for maintenance of the Technology				**6'050.0**	
Total costs for maintenance of the Technology in USD				*672.22*	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☑ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm

Agro-climatic zone
- ☐ humid
- ☐ sub-humid
- ☑ semi-arid
- ☐ arid

Specifications on climate
Average annual rainfall in mm: 400.0

- [ ] > 4,000 mm

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: ground water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village group
- [x] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor	✓		good
education	poor		✓	good
technical assistance	poor		✓	good
employment (e.g. off-farm)	poor		✓	good
markets	poor		✓	good
energy	poor	✓		good
roads and transport	poor		✓	good
drinking water and sanitation	poor	✓		good
financial services	poor	✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased						✓	increased

crop quality	decreased	✓	increased
risk of production failure	increased	✓	decreased
product diversity	decreased	✓	increased
production area (new land under cultivation/ use)	decreased	✓	increased
land management	hindered	✓	simplified
expenses on agricultural inputs	increased	✓	decreased
farm income	decreased	✓	increased
workload	increased	✓	decreased

Socio-cultural impacts

food security/ self-sufficiency	reduced	✓	improved
SLM/ land degradation knowledge	reduced	✓	improved

Ecological impacts

soil moisture	decreased	✓	increased
soil cover	reduced	✓	improved
soil loss	increased	✓	decreased
nutrient cycling/ recharge	decreased	✓	increased

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓	very positive
Long-term returns	very negative	✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓	very positive
Long-term returns	very negative	✓	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	✓	very well

Climate-related extremes (disasters)

epidemic diseases	not well at all	✓	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ✓ single cases/ experimental
- 1-10%
- 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ✓ 0-10%
- 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes
- ✓ No

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Improved farm income and cropping intensity
- Better utilization of available rainwater
- Reduces fallow period which help to improve soil quality

Strengths: compiler's or other key resource person's view

- Improved resilience due to diversified crops

Weaknesses/ disadvantages/ risks: land user's view → how to overcome

- In drought year, especially late season drought, spring planted quinoa needs supplementary irrigation → Implementing supplementary irrigation
- Spreading type of lentil variety makes difficult for quinoa seeding and early crop growth → Selecting suitable lentil varieties
- Poor market linkage for quinoa → Conducting research in improving the linkage between market and quinoa

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome

- Insect infestation may occur especially if a small area is planted, as there is not much greenery in the surroundings at the end of quinoa season → Using adequate pest control,

improved biodiversity, and/or increased area under cultivation

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5967/

Linked SLM data
n.a.

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