Drip Irrigation in a Lentil-Onion production System (Mina Devkota)

Diversified Cropping System: Relay Intercropping of Lentils with Onions (Morocco)

DESCRIPTION

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

In the semi-arid regions of Morocco agricultural production is increasingly unstable as consequence of changing climate, variable rainfall and more frequent extreme weather events. There is a need, where possible, to intensify agricultural systems while improving food security - and increasing the resilience of the overall system.

Cultivating lentils in cereal-based systems 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 onions into the common lentil production system. This was a part of research trials to find suitability and economic profitability of crop rotation systems. The introduction of onions as a relay intercrop within lentils has multiple benefits and advantages. Firstly, with two crops are harvested from the same piece of land, thus overall farm profit increases. Secondly, the cultivation of two crops creates a more resilient overall system because the farmer is not dependent on one single crop. Thirdly, as onions are harvested later than lentils, the soil is covered for a longer period, consequently protecting it from degradation, hence soil quality is improved. Fourthly, lentils are leguminous, fixing nitrogen in the soil, thus improving soil fertility. Lastly, the market linkage for onions is very good in Morocco because it is a commonly cultivated crop with high cultural and culinary value: indeed, onions are a cash crop.

However, the technology has potential drawbacks. Firstly, onions require supplementary irrigation if there is not enough late season rainfall. Highly efficient irrigation systems (e.g. drip) require initial investment. In this case the Moroccan government supports 80% of the investment cost for installing drip irrigation. This establishment activity is thus a one-time cost. Secondly, 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 95 cm. Compound fertilizer is applied during the seeding. In January, a single spray of herbicide is applied to control grassy weeds. The field is mechanically weeded twice, in mid-January and then again in February.
Onion seedlings are raised in January. These are then transplanted in March: also in paired lines (two rows at 20 cm apart). Compound fertilizer is applied before transplanting. Each pair-row of onion seedlings is planted between two pair-rows of lentils. Because the onions are planted within an already growing crop of lentils, this form of intercropping is termed "relay planting".
The onions are manually weeded in March-April. In April, the lentils are manually harvested and mechanically threshed. Finally, in June, the onions are manually harvested.

LOCATION

Location: Merchouch, Morocco

No. of Technology sites analysed: single site

Geo-reference of selected sites
- -6.68688, 33.56218

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

During a period from March until May, the onions are irrigated three times. Because the irrigation is just partial, it is termed "supplementary irrigation". The average irrigation amount per event was 15 millimetres. This is done through drip irrigation.

Onions growing in a field after the lentils were harvested. (Mina Devkota)

Lentils growing before the onions were seeded (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: legumes and pulses - lentils, vegetables - root vegetables (carrots, onions, beet, other)

Number of growing seasons per year: 2
Is intercropping practiced? Yes

Water supply

- [ ] rainfed
- [x] 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

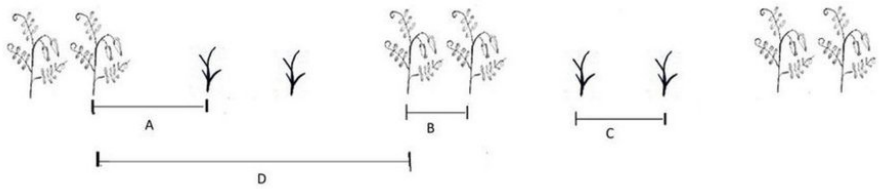
vegetative measures -

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 lentils and a row of onions = 35 centimetres
B: Spacing between two rows of lentils in the same pair = 15 centimetres
C: Spacing between two rows of onions in the same pair = 20 centimetres
D: Spacing between two rows of lentils bordering a pair of onions = 90 - 95 centimetres



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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: **MDH**
- Exchange rate (to USD): 1 USD = 8.92 MDH
- Average wage cost of hired labour per day: 75

Most important factors affecting the costs

n.a.

Establishment activities

1. Set-Up Drip Irrigation System (one time) (Timing/ frequency: None)

Establishment inputs and costs (per 1 Hectare)

Specify input	Unit	Quantity	Costs per Unit (MDH)	Total costs per input (MDH)	% of costs borne by land users
Other					
Total Cost for Drip Irrigation	Total	1.0	40000.0	40000.0	20.0
Total costs for establishment of the Technology				**40'000.0**	
Total costs for establishment of the Technology in USD				*4'484.3*	

Maintenance activities

1. Field Ploughing (Timing/ frequency: Prior of seeding)
2. Lentils: Seeding (Timing/ frequency: December)
3. Lentils: Fertilizer Application (Timing/ frequency: December)
4. Lentils Herbicide Application (if needed) (Timing/ frequency: January)
5. Lentils: Mechanical Weeding (Timing/ frequency: Mid-January)
6. Lentils: Mechanical Weeding (Timing/ frequency: Mid-February)
7. Lentils Fungicide Application (if needed) (Timing/ frequency: February-March)
8. Onions: Seedling raising (Timing/ frequency: January)
9. Onion: Transplanting (Timing/ frequency: March)
10. Onions: Fertilizer Application (Timing/ frequency: March)
11. Lentils: Harvesting (Timing/ frequency: April)
12. Onions Manual Weeding (Timing/ frequency: March-April)
13. Onions: Irrigation (Timing/ frequency: March-May)
14. Onions: Harvesting (Timing/ frequency: June)

Maintenance inputs and costs (per 1 Hectare)

Specify input	Unit	Quantity	Costs per Unit (MDH)	Total costs per input (MDH)	% of costs borne by land users
Labour					
Onion Seedling Planting	Person-Days	15.0	75.0	1125.0	100.0
Onion Seedling raising	Person-Days	20.0	75.0	1500.0	100.0
Weeding	Person-Days	30.0	75.0	2250.0	100.0
Harvesting	Person-Days	20.0	75.0	1500.0	100.0
Equipment					
Lentil Seeding	Machine-Hours	1.0	150.0	150.0	100.0
Lentil Weeding	Machine-Hours	2.0	100.0	200.0	100.0
Threshing of Lentils	Machine-Hours	2.0	150.0	300.0	100.0
Herbicide Application	Machine-Hours	1.0	60.0	60.0	100.0
Fungicide Application	Machine-Hours	1.0	60.0	60.0	100.0
Plant material					
Lentil Seeds	Kilogram	45.0	8.0	360.0	100.0
Onion Seeds	Kilogram	4.0	600.0	2400.0	100.0
Fertilizers and biocides					
Fertilizer (NPK 10-20-20) for Lentil	Kilogram	100.0	3.0	300.0	100.0
Fertilizer (NPK 10-20-20) for Onion	Kilogram	100.0	3.0	300.0	100.0
Herbicide for Lentils	Liter	0.5	100.0	50.0	100.0
Fungicide for Lentils	Liter	0.5	150.0	75.0	100.0
Other					
Irrigation Costs	Per Event	3.0	200.0	600.0	100.0
Total costs for maintenance of the Technology				**11'230.0**	
Total costs for maintenance of the Technology in USD				*1'258.97*	

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
- ☐ > 4,000 mm

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

Specifications on climate
n.a.

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

Landforms
- ☑ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude
- ☐ 0-100 m a.s.l.
- ☑ 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
- ☑ not relevant

Soil depth
- ☐ very shallow (0-20 cm)
- ☐ shallow (21-50 cm)
- ☑ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

Soil texture (topsoil)
- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ fine/ heavy (clay)

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

Topsoil organic matter content
- ☐ high (>3%)
- ☑ medium (1-3%)
- ☐ low (<1%)

Groundwater table
- ☐ on surface
- ☐ < 5 m
- ☑ 5-50 m
- ☐ > 50 m

Availability of surface water
- ☐ excess
- ☐ good
- ☐ medium
- ☑ poor/ none

Water quality (untreated)
- ☐ good drinking water
- ☑ poor drinking water (treatment required)
- ☐ for agricultural use only (irrigation)
- ☐ unusable

Water quality refers to: ground water

Is salinity a problem?
- ☐ Yes
- ☑ No

Occurrence of flooding
- ☐ Yes
- ☑ No

Species diversity
- ☐ high
- ☐ medium
- ☑ low

Habitat diversity
- ☐ high
- ☐ medium
- ☑ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- subsistence (self-supply)
- ✓ mixed (subsistence/ commercial)
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- ✓ poor
- average
- rich
- very rich

Level of mechanization
- manual work
- animal traction
- ✓ mechanized/ motorized

Sedentary or nomadic
- ✓ Sedentary
- Semi-nomadic
- Nomadic

Individuals or groups
- ✓ individual/ household
- groups/ community
- cooperative
- employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- children
- youth
- ✓ middle-aged
- elderly

Area used per household
- < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- ✓ 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
- ✓ small-scale
- ✓ medium-scale
- large-scale

Land ownership
- state
- company
- communal/ village
- group
- ✓ individual, not titled
- ✓ individual, titled

Land use rights
- open access (unorganized)
- communal (organized)
- leased
- ✓ individual

Water use rights
- open access (unorganized)
- communal (organized)
- leased
- ✓ 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
demand for irrigation water	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

seasonal rainfall increase — not well at all ✓ very well — Season: summer

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
- Cultivation of a cash crop

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

- Improved resilience due to diversified crops
- Reduces fallow period which help to improve soil quality

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

- Irrigation is required → Implementing supplementary irrigation
- Spreading variety of lentils makes it difficult to plant onions and inhibits their early crop growth → Selecting suitable lentil varieties

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 onion season → Using adequate pest control, improved biodiversity, and/or increased area under cultivation
- Open grazing animal may occur especially if a small area is planted, as there is not much greenery in the surroundings at the end of onion season, bordering the filed → Improved fencing and/or greenery

REFERENCES

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Date of documentation: Sept. 7, 2021

Last update: Jan. 25, 2022

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5992/

Linked SLM data
n.a.

Documentation was faciliated by
Institution
- International Center for Agricultural Research in the Dry Areas (ICARDA) - Lebanon

Project
- ICARDA Institutional Knowledge Management Initiative

Links to relevant information which is available online

- Mina Devkota Wasti, Vinay Nangia. (13/10/2021). Diversified Cropping System: Relay Intercropping of Lentil with Quinoa (Morocco). Global: WOCAT.: https://hdl.handle.net/20.500.11766/66329 / https://qcat.wocat.net/en/summary/5967/?as=html