Resilient and Profitable Diversified Cropping Systems For Dry Areas

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Agriculture in Drylands is more challenging

- 80% of cereal-based systems in the MENA region are under monocropping.
- Increasing rainfall variability and declining land and water resources are having a high impact on crop productivity in rainfed drylands, leading to acute food scarcity among rural communities in the region.

ICARDA, together with its partner, has been working to develop sustainable and resilience cropping systems in different fragile countries.
CROP DIVERSIFICATION CAN HELP TO MINIMIZE THOSE CHALLENGES IN DRYLANDS

Alternative crops Merchouch, Morocco

Agro-Hort. system Madhya Pradesh, India

Food and Forage system for mixed crop-livestock systems
Evaluating different crops, crop rotations and crop combinations with different agronomic practices (conservation agriculture and conventional tillage system, planting time, fertilizer management, crop species and varieties, etc.) in different countries in collaboration with national partners.

To understand the performance of crops and cropping system, resource use efficiency in variable production condition.

To identify the resilient, profitable and more sustainable rotation systems for drylands with diverse production environment.

EFFORT ON DIVERSIFYING THE CEREAL-BASED SYSTEM IN DRYLANDS

- Sola
- Quinoa
- Mustard
- Wheat
- Lentil
- Fababean
- Forage mixture
CROP PERFORMANCE IN DIFFERENT ROTATION AND PRODUCTION ENVIRONMENT

Wheat crop in its early season drought last growing season, extreme early season drought, Morocco

Cereal as previous crop

Legume as previous crop

13% higher wheat yield when legume as previous crop

Performance of crop species varies with variable rainfall and CA is more profitable in low-rainfall years

Devkota et al. 2022
CROP PERFORMANCE IN DIFFERENT ROTATION AND PRODUCTION ENVIRONMENT

In rainfed mixed-crop livestock system livestock feed is equally important as grain.

Cereal forage:
- Barley, Triticale, Oat

Legume forage:
- Forage pea, Grass pea and Vetch

Performance of different forage crops (sole and mixture) under conservation agriculture practices.

Evaluated different combinations of forage mixtures.
Option to diversify and intensify cropping system: crop choice and agronomic management

Location: ICARDA/INRA research station
Merchouch, Morocco
Rainfall: average >350 mm with highly variable rainfall pattern
Soil type: Vertisol (clay-rich soils that shrink & swell with changes in moisture content)

Explore option to diversify and intensify system - crop choice and better utilization of the available resources
- For improving crop productivity and farm profitability for smallholder farmers

Lentil in paired row: leaving around 1m in between two paired row

Five different short-duration and high economic value spring crops, i.e., bean, chickpea, onion, quinoa, and sesame were planted in between two paired rows lentil before the harvest
Option to diversify and intensify cropping system: crop choice and agronomic management

- Paired row lentil seeded in 1st week of December
- Rely seeded quinoa in between lentil end of February
- Lentil harvested in early May
- Quinoa after lentil harvest
- Rely seeded quinoa in between lentil end of February
- Quinoa harvested in June

Option to diversify and intensify cropping system: crop choice and agronomic management

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Opportunity to diversify cropping system through relay-inter cropping

Among the spring crops tested onion produced the highest yield (45.5 t/ha) followed by quinoa (3.01 t/ha), chickpea (1.11 t/ha) bean (0.98 t/ha) and Sesame (0.4 t/ha)

- All spring crops performed well in relay seeding with lentil
- No yield penalty on lentil as of sole crop
Opportunity to diversify cropping system through relay-inter-cropping

**Table: Economic benefit (US$/ha) with sole & relay-intercropping of different spring crops with winter seeded lentil & grain yield of following wheat crop**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Wheat</th>
<th>Lentil sole</th>
<th>Lentil + Bean</th>
<th>Lentil + Chickpea</th>
<th>Lentil + Quinoa</th>
<th>Lentil + Onion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Single row</td>
<td>Paired row</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit ($/ha)</td>
<td>809+93</td>
<td>658+274</td>
<td>608+281</td>
<td>1,219+481</td>
<td>1,391+191</td>
<td>10,726+1217</td>
</tr>
<tr>
<td>Following wheat yield (kg/ha)</td>
<td>3764+531</td>
<td>4232+176</td>
<td>4128+229</td>
<td>4085+418</td>
<td>4134+181</td>
<td>3994+132</td>
</tr>
</tbody>
</table>

**Benefits**
- It provides opportunity to harvest two crops in one cropping season from the same piece of land
- Utilization of rainwater both early and late-season
- It helps to improve farm income
- Diversified the crops in the field and food on the table and feed for livestock
- Helps to enrich biodiversity and soil health

**Need consideration**
- If not sufficient or well distributed rainfall, it needs to apply supp. irrigation
- Need to well match crop species and variety
- Need machinery which can plant spring crop in standing crop
- If planted in small area, problem of free grazing animal
- Need to evaluate in diverse production environment

8-12% higher wheat yield under diversifying the rotation than cereal mono-cropping
Winter seeded lentil was affected due to severe early and mid-season drought. Evaluated four different types of forage crops (barley, sorghum, maize, and grass pea).

Opportunity to diversify cropping system through relay-inter-cropping of forage crops

Highest dry biomass was obtained in Sorghum and barley (5 t/ha) followed by maize and grass pea.
Diversified Cropping System: Relay Intercropping of Lentils with Chickpeas (Morocco)

A diversified cropping system (DCS) is a more resilient and productive cropping system. In this case, DCS were introduced as a relay intercropping between small beans (lentils) and chickpeas. This practice has been known for centuries in the region, but the adoption of DCS has increased in recent years due to its benefits.

In the semi-arid regions of Morocco, agricultural productivity varies from year to year, and lentils are generally grown because of climate change. Climate change is leading to more irregular rainfall and frequent extreme weather events. Therefore, there is a need for diversified agricultural systems to ensure food security while maintaining productivity.

Diversified cropping systems (DCS) provide nutritious diets through a climate-smart and sustainable production system. By incorporating legumes (beans/chickpeas), vegetables, fruits, or rice into existing cereal systems, DCS have the potential to significantly increase income and improve nutrition for vulnerable dryland farmers under climate stress.

However, DCS are still underutilized in dry areas due to a lack of supportive policies and a market environment that continues to favor conventional cereal monocropping. To enhance policymakers and key stakeholders' awareness of DCS benefits, further biophysical and socio-economic research is needed to generate clear and credible evidence.

Diversified Cropping Systems for Better Nutrition, Livelihoods, and Soil Health

Diversified cropping systems for better nutrition, livelihoods, and soil health are critically advantageous in climate change. Diversified cropping systems (DCS) provide nutritious diets through a climate-smart and sustainable production system. By incorporating legumes (beans/chickpeas), vegetables, fruits, or rice into existing cereal systems, DCS have the potential to significantly increase income and improve nutrition for vulnerable dryland farmers under climate stress.

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Thank You