

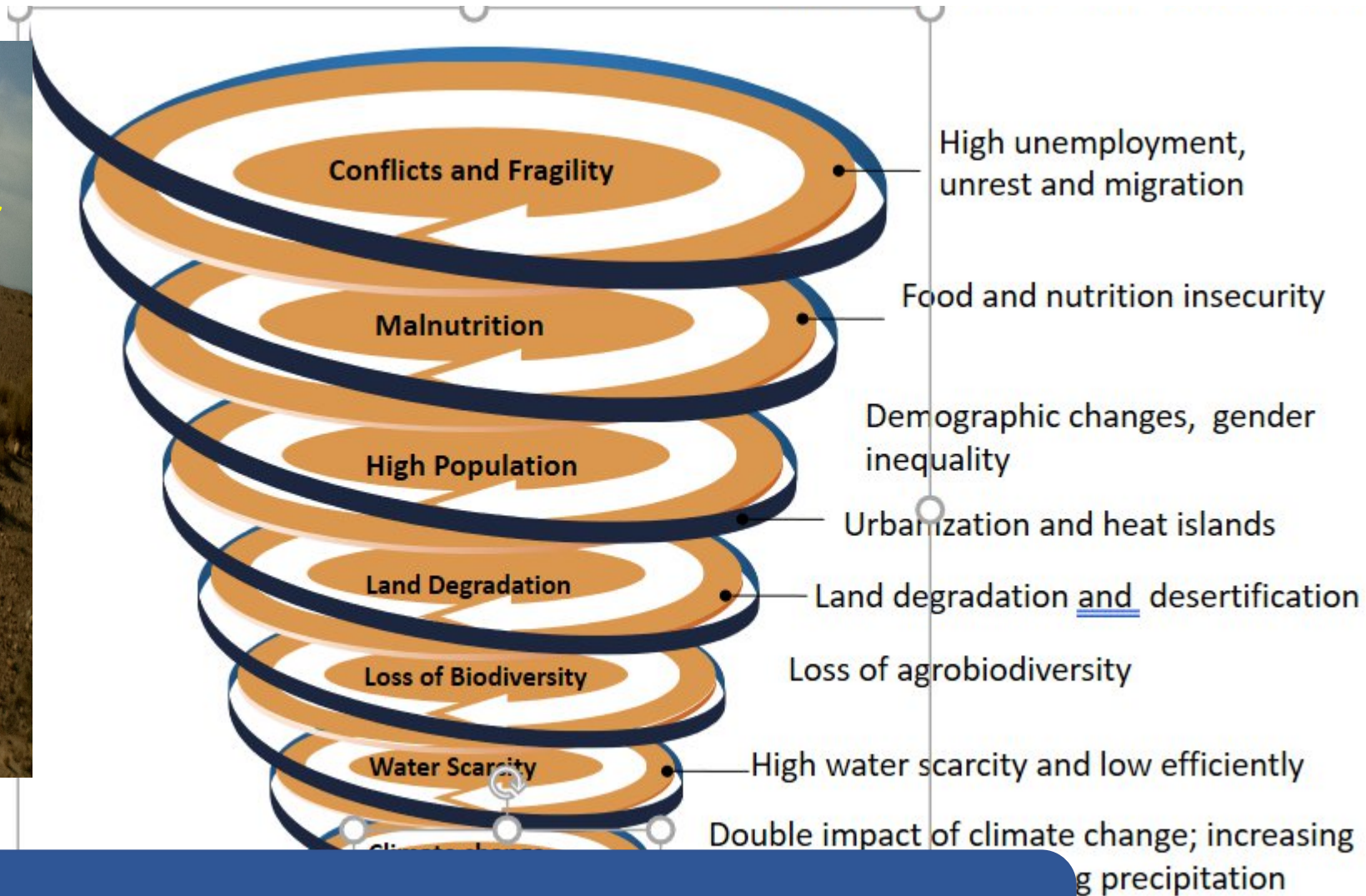


Resilient and Profitable Diversified Cropping Systems For Dry Areas

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AGRICULTURE IN DRYLANDS IS MORE CHALLENGING

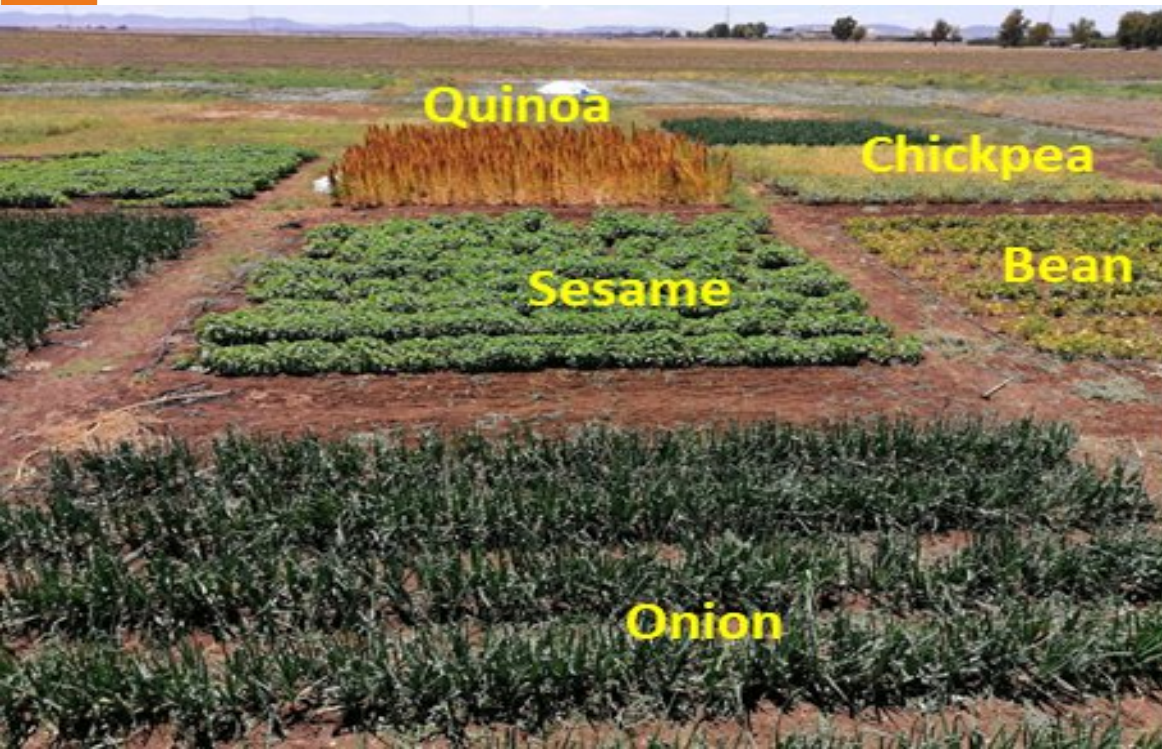
- 80% of cereal-based systems in the MENA region are under monocropping.
- Increasing rainfall variability and declining land and water resources are having a high impact on crop productivity in rainfed drylands,
- leading to acute food scarcity among rural communities in the region.



ICARDA, together with its partner has been working to develop sustainable and resilience cropping system in different fragile countries

CROP DIVERSIFICATION CAN HELP TO MINIMIZE THOSE CHALLENGES IN DRYLANDS

Alternative crops Merchouch, Morocco



Agro-Hort. system Madhya Pradesh, India



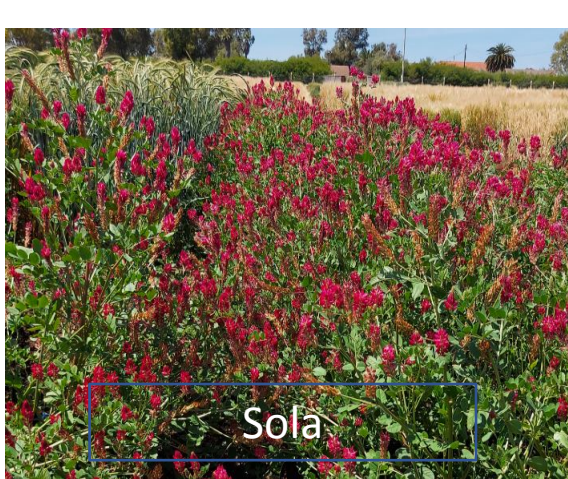
Food and Forage system for mixed crop-livestock systems

EFFORT ON DIVERSIFYING THE CEREAL-BASED SYSTEM IN DRYLANDS

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

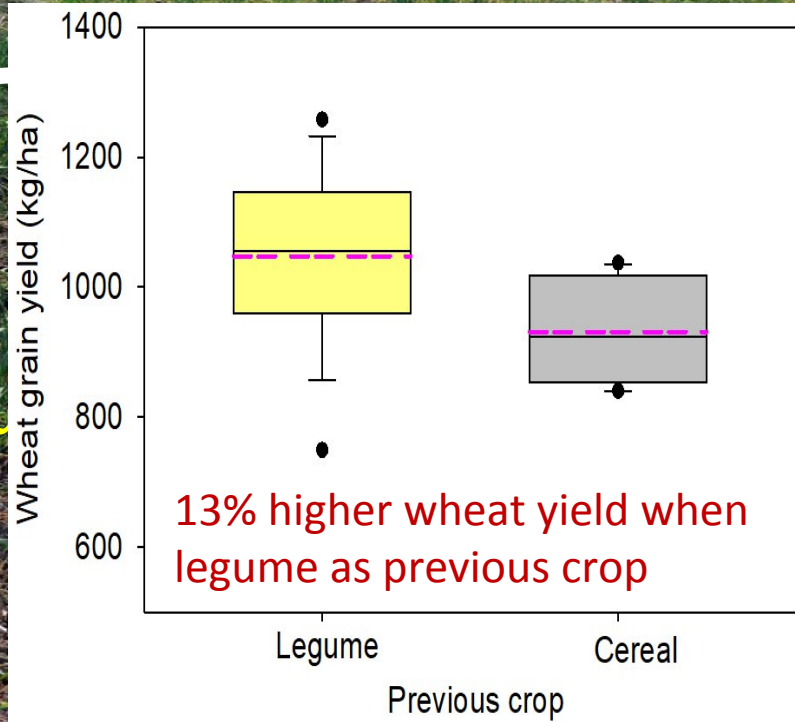
To identify the resilient, profitable and more sustainable rotation systems for drylands with diverse production environment



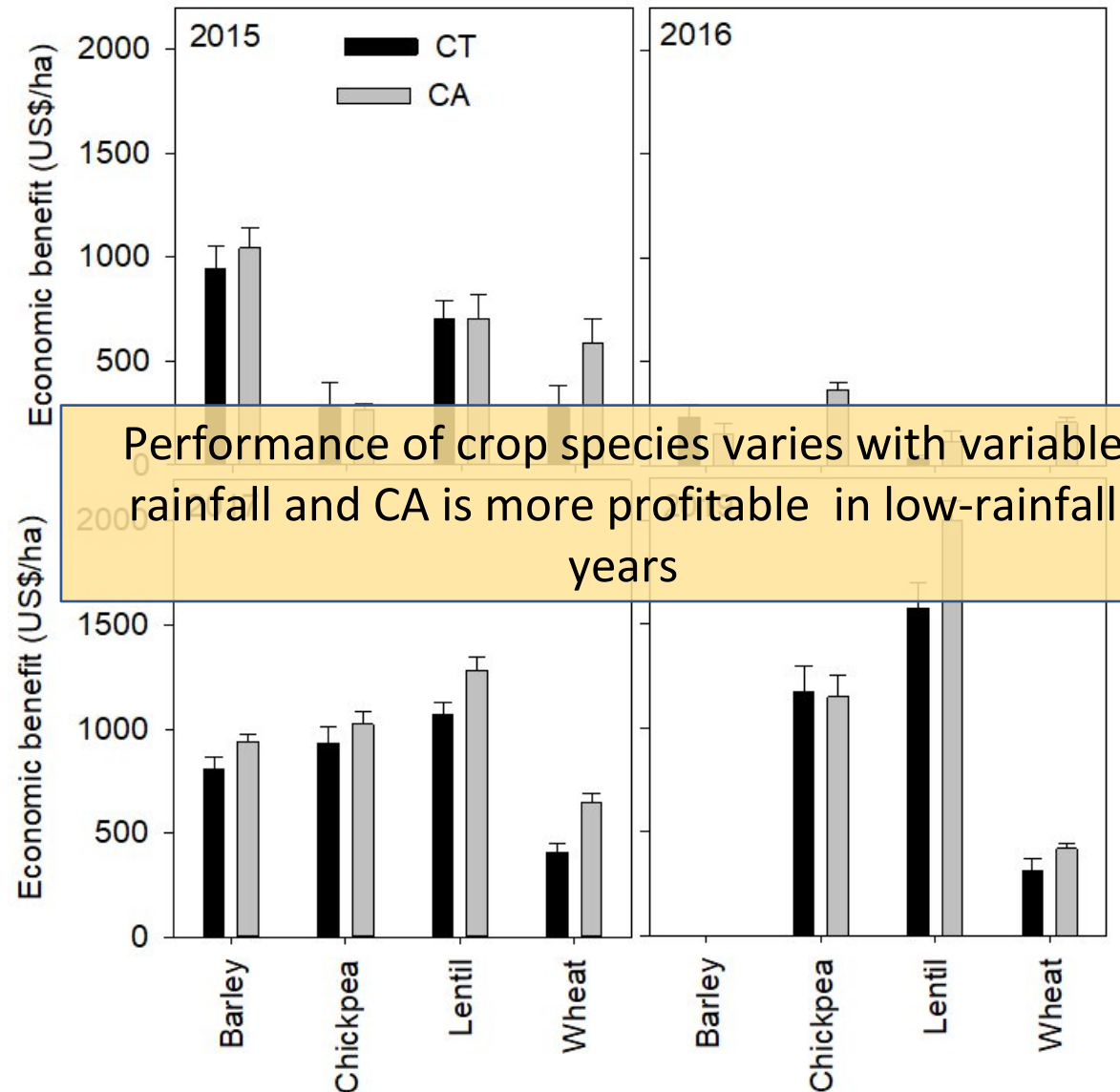
CROP PERFORMANCE IN DIFFERENT ROTATION AND PRODUCTION ENVIRONMENT

Cereal as previous crop

Legume



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



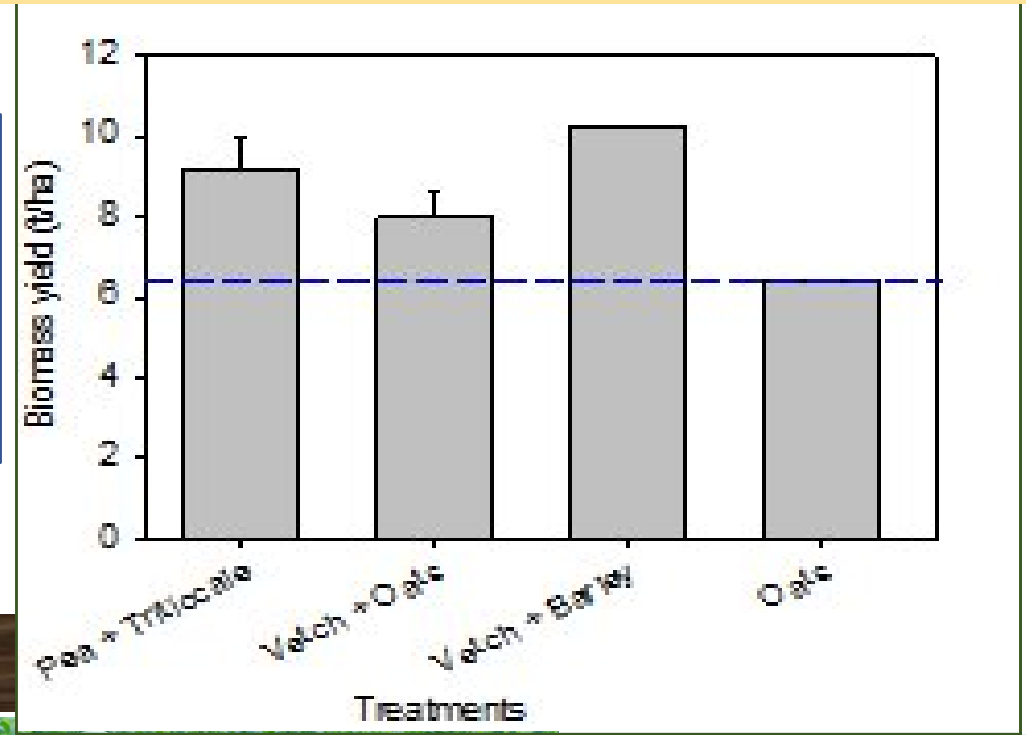
Performance of crop species varies with variable rainfall and CA is more profitable in low-rainfall years

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



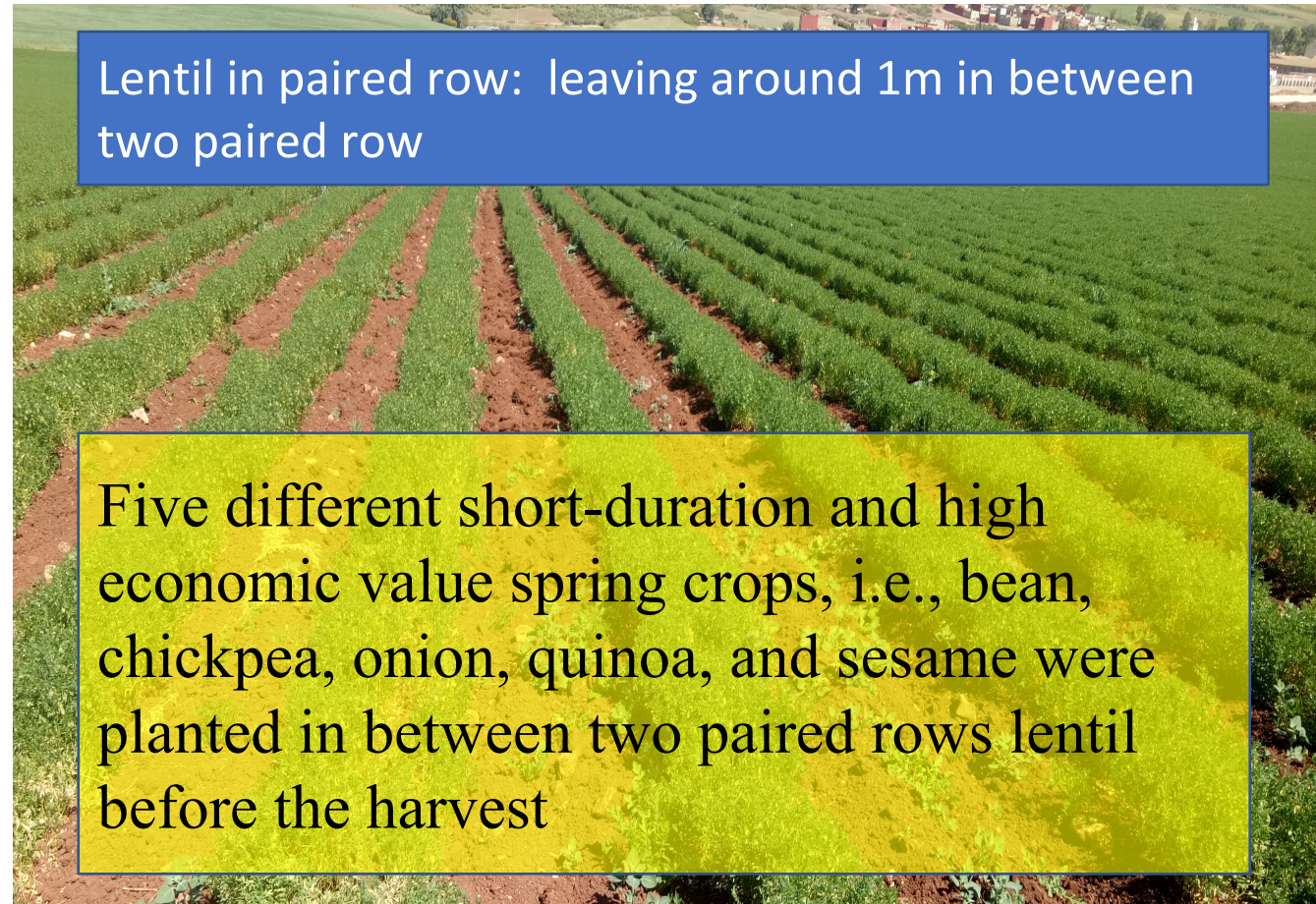
Evaluated different combinations of forage mixtures



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



Relay seeded quinoa in between lentil end of February



Relay seeded quinoa in between lentil end of February



Lentil harvested in early May

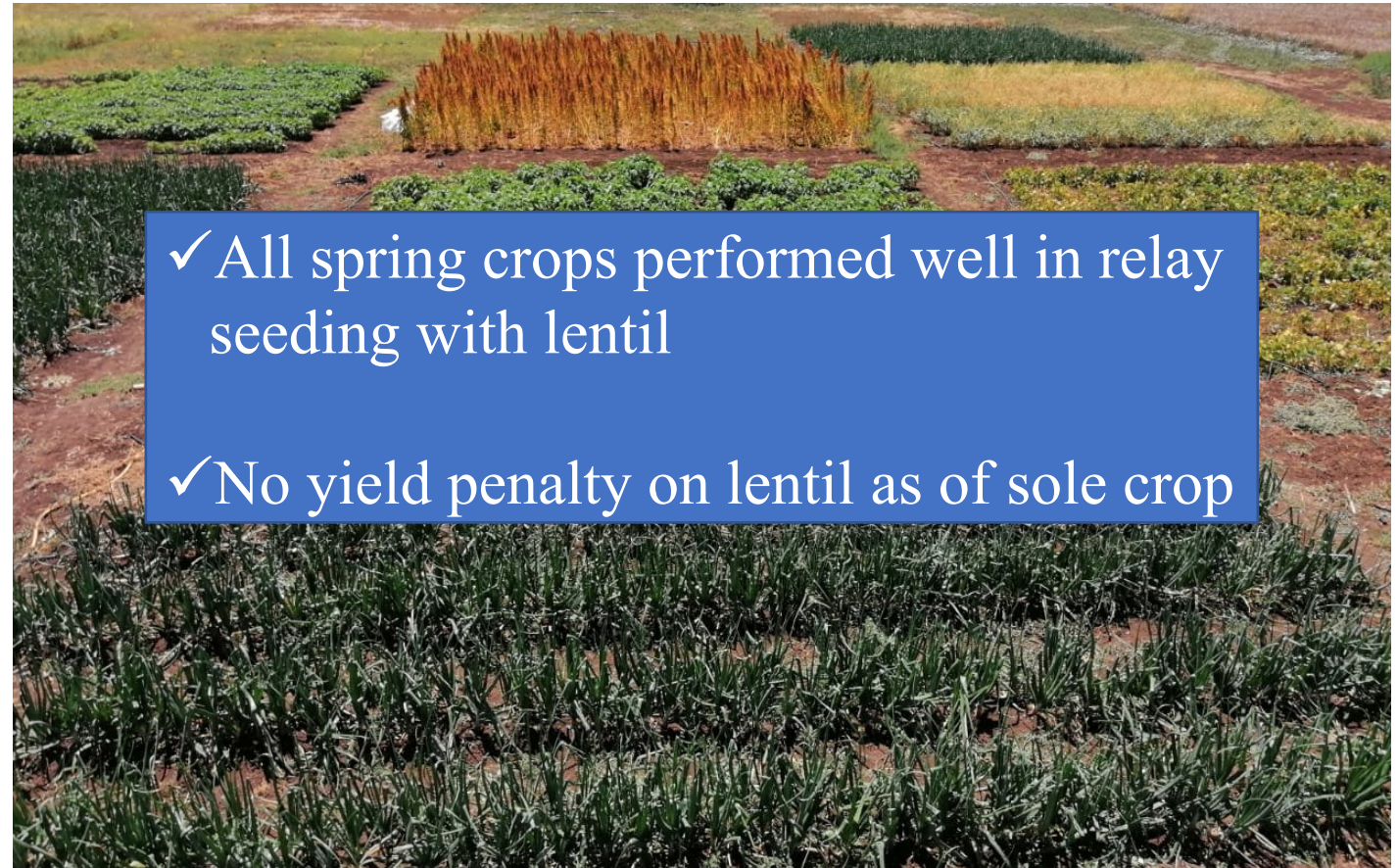
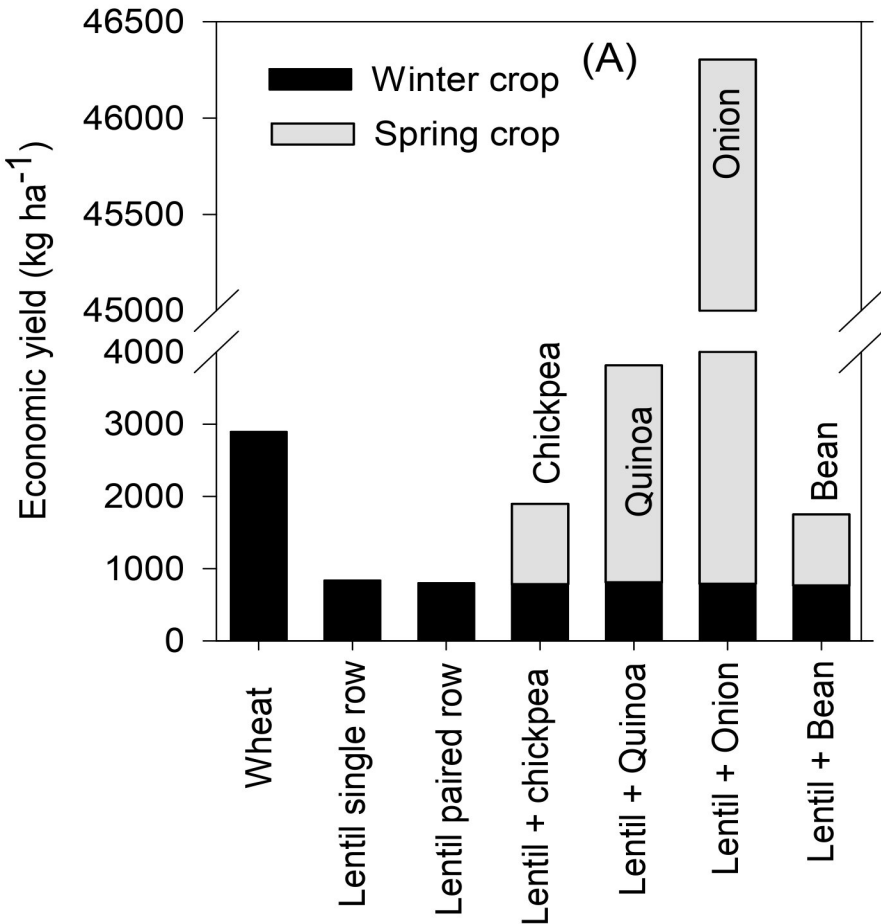


Quinoa after lentil harvest



Quinoa harvested in June

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)

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

Parameters	Wheat	Lentil sole		Lentil + Bean	Lentil + Chickpea	Lentil + Quinoa	Lentil + Onion
		Single row	Paired row				
Benefit (\$/ha)	809 ₊₉₃	658 _{+ 274}	608 ₊₂₈₁	1,219 ₊₄₈₁	1,391 _{+ 191}	10,726 ₊₁₂₁₇	11,104 _{+ 1327}
Following wheat yield (kg/ha)	3764 ₊₅₃₁	4232 ₊₁₇₆	4128 ₊₂₂₉	4085 ₊₄₁₈	4134 _{+ 181}	4077 ₊₁₀₅	3994 ₊₁₃₂

8-12% higher wheat yield under diversifying the rotation than cereal mono-cropping

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

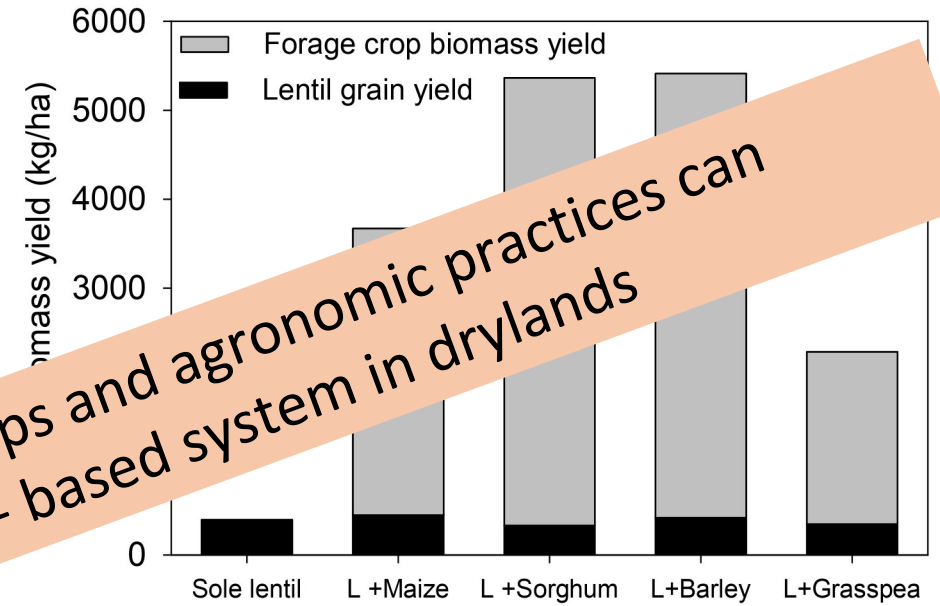
Need consideration

- 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

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



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).



Diversifying cropping system with low water demanding crops and agronomic practices can improve resilience and profitability over the current cereal-based system in drylands



Highest dry biomass was obtained in Sorghum and barley (5 t/ha) followed by maize and grass pea



Double legume cropping consisting of lentils (yellow rows) intercropped with chickpeas (green rows) (Mina Devkota)

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

DESCRIPTION
A Diversified Cropping System (DCS) results in a more resilient and productive cropping system. In this case, chickpeas were introduced as a relay intercrop between established lines of lentils. This not only had no negative effect on lentil yields, but also enabled the harvest of an extra crop: chickpeas.

In the semi-arid regions of Morocco, agricultural production varies from year to year, but yields are generally declining because of climate change. Climate change is leading to more irregular rainfall and frequent extreme weather events. Wherever possible, there is a need to intensify agricultural systems to ensure food security while simultaneously increasing resilience. Cultivating lentils (*Lens culinaris*) as a sole crop is common practice in rural Morocco. To intensify this cropping system, the International Centre for Agricultural Research Dry Areas (ICARDA) introduced chickpeas (*Cicer arietinum*) as a relay intercrop into the common lentil production system. Because chickpeas are planted within an already



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.



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



https://qcat.wocat.net/en/wocat/technologies/view/technologies_641



DIVERSIFIED CROPPING SYSTEMS

Better food, income, and resilience for rural dryland farmers.

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

However, DCS are still underused in dry areas due to a lack of supportive policies, and a market environment that continues to favor conventional cereal monocropping. To convince policymakers and key stakeholders 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

Dryland family farmers across Africa and Asia are critically vulnerable to climate change. Soaring temperatures, pest invasions, shrinking water supplies, loss of biodiversity, and soil degradation all threaten farmers' livelihoods and the quality of their produce. Monocultures also diminish wild pollinators and natural pest-enemies, making crops increasingly unsuccessful and more vulnerable to pests.

DCS integrate several nutrition-sensitive, climate-smart, sustainable, and innovative techniques that increase the income and diets of family-farming households. DCS increase farmer's outputs in different ways: through the introduction of a secondary crop (legume/vegetables/fruit or nut trees/seeds/spices); by increasing natural pollinators and natural enemies; by reducing pests and diseases pressure; and by improving soil fertility, soil health, and water productivity.



Relay-cropping: The second crop is planted into the first crop before harvest rather than waiting until after harvest.

DIVERSIFIED CROPPING SYSTEMS FOR SUSTAINABLE INTENSIFICATION OF DRYLAND FAMILY FARMING



Thank You