Collaborative work of ICARDA on climate-resilient technologies for improved land and water productivity in Central Asia

R.C Sharma, A. Amanov, S. Saidov, O. Amanov, A. Akramkhanov and V. Nangia
4 April 2019, Tashkent

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icarda.org
International Center for Agricultural Research in the Dry Areas
Scope of presentation – climate-resilient technologies

- Crop varieties
- Water Management
- Cropping system diversification
- Conservation agriculture
- Rangeland improvement
Example of climate change

- Temperature variations in Karkalpakstan 2013 and 2016
Constraints to wheat production under climate change in Central Asia
Seven stripe rust epidemics since 2009

30% yield reduction in Tajikistan and Uzbekistan due to yellow rust
Sharma et al. (2016), J. Phytopathology
Climate-resilient Winter Wheat – Gozgon

Characters:
1. Highly resistant to yellow rust
2. Heat tolerance
3. Medium maturity
4. Grain yield
   - 9 t/ha under normal soil, irrigation
5. Quality – satisfactory
6. High straw yield

Has remained yellow rust resistant 2009 - 2018
Climate-resilient Winter Wheat – Buniyodkor

Characters:
1. Highly resistant to yellow rust
2. Heat tolerance
3. Medium maturity
4. Grain yield
   - 9 t/ha under normal soil, irrigation
   - 6 t/ha on medium saline soil
5. Quality – satisfactory
6. High straw yield

Has remained yellow rust resistant
2010 - 2018
Climate-resilient Winter Wheat – Chimbay and Amudarya

Dynamic nature of salinity can cause complete loss of winter wheat crop

Characters:
1. Suitable for medium saline soil
2. Suitable for normal soil
3. Tolerant to winter frost and cold temperatures upto -29°C
4. Heat tolerance
5. Moderately leaf rust tolerance
6. Grain yield
   - 9 t/ha under normal soil, irrigation, fertilizers
   - 6 t/ha on medium saline soil
7. Quality - satisfactory
Climate-resilient Chickpea – Malhotra, Khalima and Obod, Sino

Characters:
1. Tolerant to cold (-15 C)
2. Suitable for autumn planting
3. Suitable for spring planting
4. Heat tolerance
5. Suitable on medium saline soils
6. Grain yield potential
   2.5 t/ha under normal soil and irrigation
   Upto 50% higher yield for winter crop vs. spring crop
Cropping system diversification for climate-resilience

Many ways of diversification

- Food legumes
- Fodder crops
- Cropping geometry
- Crop-livestock integration
Cropping system diversification on irrigated land using climate-resilient varieties of wheat

Increasing cropping intensity by incorporating legumes – an example with mungbean

<table>
<thead>
<tr>
<th>Crop rotation</th>
<th>1st YEAR (Nov-Jun)</th>
<th>1st YEAR (Jul-Sep)</th>
<th>2nd YEAR (Oct-Feb)</th>
<th>2nd YEAR (Mar-Oct)</th>
<th>Cropping intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wheat-Cotton</td>
<td>Wheat</td>
<td>Fallow</td>
<td>Fallow</td>
<td>Cotton</td>
<td>2 crops in 2 years (100%), no legume</td>
</tr>
<tr>
<td>2 Wheat-Mungbean-Cotton</td>
<td>Wheat</td>
<td>Mungbean</td>
<td>Fallow</td>
<td>Cotton</td>
<td>3 crops in 2 years (150%), once legume</td>
</tr>
<tr>
<td>3 Wheat-Mungbean-Green manure-Cotton</td>
<td>Wheat</td>
<td>Mungbean</td>
<td>Green manure</td>
<td>Cotton</td>
<td>4 crops in two years (200%), twice legumes</td>
</tr>
<tr>
<td>4 Wheat-Mungbean-Wheat-Mungbean</td>
<td>Wheat</td>
<td>Mungbean</td>
<td>Wheat-Mungbean</td>
<td>Wheat-Mungbean</td>
<td>4 crops in two years (200%), twice legumes</td>
</tr>
</tbody>
</table>
Cropping System diversification on irrigated land

Inclusion of leguminous crops in wheat-wheat rotation

<table>
<thead>
<tr>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>Mai</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>winter wheat</td>
<td>Fallow / Mungbean</td>
<td>Winter wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Benefits from mungbean:
- Nutrients added in soil
- Additional income from mungbean crop
Cropping system diversification on rainfed land using climate-resilient varieties of chickpea

Wheat planted on 16 November in dry year

Chickpea planted on 28 February in dry year

Chickpea planted in autumn

Autumn planted

Spring planted

Conclusion:
• Replace winter cereals with chickpea on rainfed land
• Plant chickpea in autumn and not in spring

• 35-50% higher productivity when planted in autumn
• Higher income from chickpea than growing cereals
Cropping system diversification on rainfed land

Wheat planted on 16 November

Chickpea planted on 28 February

Chickpea planted on 10 October

Conclusion:
- Replace winter cereals with chickpea on rainfed land
- Plant chickpea in autumn and not in spring

- 35% higher productivity when planted in autumn
- Higher income from chickpea than growing cereals
Conservation Agriculture for climate-resilience crop production

Benefits

• Lower inputs cost
• Higher stable yields
• Improved soil nutrient exchange
• Enhanced long-run profitability
Conservation Agriculture

Mungbean after wheat using minimum and zero tillage with retention of crop residues in Karshi, Uzbekistan (2011-2013)

<table>
<thead>
<tr>
<th>Planting method</th>
<th>Spent fuel for planting, l/ha</th>
<th>Root length, cm</th>
<th>Plant height, cm</th>
<th>Yield, t/ ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>53.6</td>
<td>25.4</td>
<td>67.2</td>
<td>1.85</td>
</tr>
<tr>
<td>One cultivation</td>
<td>13.6</td>
<td>23.5</td>
<td>68.8</td>
<td>1.97</td>
</tr>
<tr>
<td>No-till</td>
<td>5.9</td>
<td>23.8</td>
<td>65.4</td>
<td>2.24</td>
</tr>
</tbody>
</table>

- Fuel saving
- Higher yield
- Improves soil health

Source: A. Nurbekov, ICARDA
Tillage management

**NT= No tillage; CT=Conventional tillage**

Benefit-cost ratio for double-cropped mungbean under no-till and conventional tillage in Uzbekistan

<table>
<thead>
<tr>
<th>Cost items</th>
<th>No tillage</th>
<th>Conventional tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Durona</td>
<td>Local</td>
</tr>
<tr>
<td>Yield kg/ha</td>
<td>427</td>
<td>250</td>
</tr>
<tr>
<td>Crop price per kg/USD</td>
<td>2.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Yield USD/ha</td>
<td>897</td>
<td>525</td>
</tr>
<tr>
<td>Total variable costs, USD/ha</td>
<td>570</td>
<td>570</td>
</tr>
<tr>
<td>Profit, USD/ha</td>
<td>327</td>
<td>-45</td>
</tr>
</tbody>
</table>

Profitability may depend on choice of crop variety.
Tillage management as a climate resilient technology

Raised-bed planting: maximizing water use efficiency

- 25% average saving in applied irrigation water
- 30% average increase in grain yield
- 73% average increase in water use efficiency
- 30-50% saving in the quantity of seed used for planting.

Source: ICARDA

https://www.icarda.org/update/raised-bed-planting-maximizing-water-use-efficiency
Sustainable land management

Laser technology improves farm productivity

• saves up to 25% irrigation water
• Lowers soil movement during irrigation
• Enhance the effectiveness of salt leaching

Source: ICARDA
https://www.icarda.org/blog/%5Bnode%3ABlog%20type%5Dlaser-technology-improves-farm-productivity
Evapo-transpiration-based irrigation scheduling

Weather data

Soil moisture data

Hydro-module Zone I

Traditional Irrigation

ET-based Irrigation

Hydro-module Zone II

Traditional Irrigation

ET-based Irrigation

Hydro-module Zone VIII

Traditional Irrigation

ET-based Irrigation

Save approx. 30-35% irrigation water at the field level without adversely affecting yields.
Rangeland improvement and diversifying sources of animal feed

- Controlled grazing
- Utilization of desert land for fodder production
- Alternative sources of animal feed and fodder
- Dual purpose crops
- Multipurpose tree species
- Agro-forestry
Rangeland improvement and diversifying sources of animal feed

• Key to sustainable meat production from small ruminants
Knowledge sharing and capacity building

- Formal and informal training
- Print materials
- Short videos
- Website (cacilm.org)
- On-site demonstrations
Climate resilient technologies through collaboration of ICARDA

Summary

• High yielding crop varieties tolerant to biotic and abiotic stresses
• Cropping system diversification for improved land and water productivity
• Conservation agriculture
• Tillage practices
• Animal and rangeland improvement
• Knowledge sharing / capacity building
ICARDA New Strategy 2017 - 2026

REDUCED POVERTY

SRP1. Collect, Conserved and use agricultural biodiversity in drylands in order to meet future climate and market related challenges.

SRP2. Improved and resilient crops for greater food security in face of climate change and market volatilities.

SRP3. Develop integrated drylands farming systems for improved and resilient livelihoods.

SRP4. Support the establishment of functional value chains and viable off-farm activities for diversified incomes and improved livelihoods in drylands.

SRP5: Support sustainable use and management of water and land resources in drylands.

FOOD & NUTRITION SECURITY

SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

Taking Research to Scale – Partnerships for Impact

CROSS-CUTTING OUTCOMES (CCO)

Climate Change Adaptation & Mitigation

Gender Equity & Youth

Capacity Development

Big Data & ICT

STRATEGIC RESEARCH OUTCOMES (SRO)

SDGs

CGAR SLOs

1. No Poverty
2. Zero Hunger
5. Gender Equality
6. Clean Water and Sanitation
12. Responsible Consumption and Production
13. Climate Action
15. Life on Land
17. Partnerships for the Goals

OUR RESEARCH

5

4
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- Others