ICARDA

Science for resilient livelihoods in dry areas

Climate-resilient food legumes for higher and sustainable productivity of rain-fed crop lands in Central Asia

Shukhrat Amanov, Akmal Akramkhanov, and Ram Sharma

Central Asia Climate Change Conference

3-4 April 2019 | Tashkent, Uzbekistan

ICARDA

The International Center for Agricultural Research in the Dry Areas

- Science for resilient livelihoods in dry areas

Thematic Areas

- Genetic Resources
- Climate change adaptation
- Strengthening Resilience
- Promoting Value Chains and Policies
- Enhancing Water and Land productivity

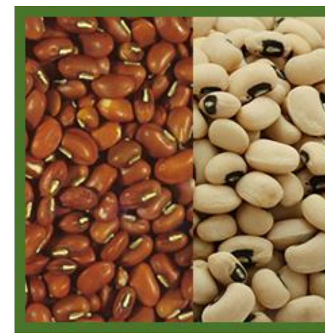
in Dryland areas

Food legumes (pulses)

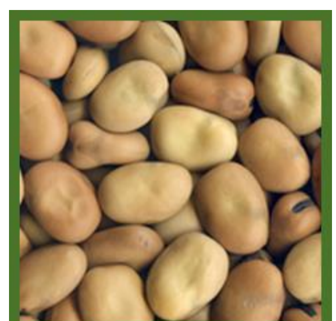
- ***Leguminosae*** family – 800 genera with 20 000 species

➢ Food legumes (pulses):

- Warm season adapted (for tropical zones) –
  - **i. Common bean / Фасоль**
  - **ii. Cowpea / Вигна горох**
  - **iii. Pigeon pea / Кайанус горох**
- Cool season adapted (for temperate zones) –
  - **i. Chickpea / Нут**
  - **ii. Faba bean / Боб садовый**
  - **iii. Lentil / Чечевица**



Rainfed zones: *chickpea, (lentil and faba bean for mild summer)*



Legume benefits for sustainable agriculture

Legumes are important for low-input-low-yield conditions

- Atmospheric N-fixation, in average 30-40 kg N/ha ***(Peoples et. al. 2009; Preissel et. al. 2015)***
- *Saves fossil energy inputs in the system by N fertilizer reduction - 277 kg CO_2/ha* ***(Jensen et. al. 2012)***
- Improves soil organic matter (***Hernanz et. al. 2009***)
- *Mobilizes soil phosphorous* ***(Shen et. al. 2011)***
- Facilitates soil nutrient circulation and water retention (***Angus et. al. 2015***)
- Soil carbon sequestration, in average 7.21 g/kg DM (***Hajduk et. al. 2015***)

Additionally performs well in:

- Conservation systems
- Intercropping systems ***(Bichel et. al. 2016)***
- also as a catch crop (mungbean)

Main climatic challenges

and their effects on water and land management practices

in rain-fed crop production

- ***Climatic challenges for rain-fed crop production:***

➢ **Droughts**

i. Low precipitation and or

ii. Poor distribution of precipitation

➢ **Heats**

i. Sudden increase of temperature (≥35°C, 2H-May) – forced maturity

ii. Summer heat (Field temperature: ≥60°C, July) - cotton

▪ *In addition, soil nutrient depletion mainly due to cropping schemes*

- ***Effects of climatic challenges on rain-fed crop production leading to loss:***

▪ Late planting of winter cereals due to low soil moisture content during OCT-NOV *(physiological delay)*

▪ Emphasis on spring cereal and oil crops *(missing winter precipitation and facing heat)*

Recent comparative study on chickpea and mungbean productions, 2018

Social survey conducted in frame of comparative study of chickpea production and non production, among farmers of rainfed zone in Kashkadarya(South), Uzbekistan

Results:

1) Chickpea **consumption** of chickpea producing farmers' families is in average 2.6 times higher in comparison with non-producing farmers' families

Chickpea	Grower families	Non-grower families	Difference (%)
Consumption/month/person (gr)	654	251	260.56

2) The **net profits** earned by the farmers under different crops were USD 267, 301, 302, and 242/ha for barley, chickpea, linseed and wheat, respectively

3) **Gross profit by total cost ratios** are 4.06 for rainfed barley crop production, 3.74 for wheat, 4.8 for chickpea and 5.76 for linseed oilcrop production on rainfed areas

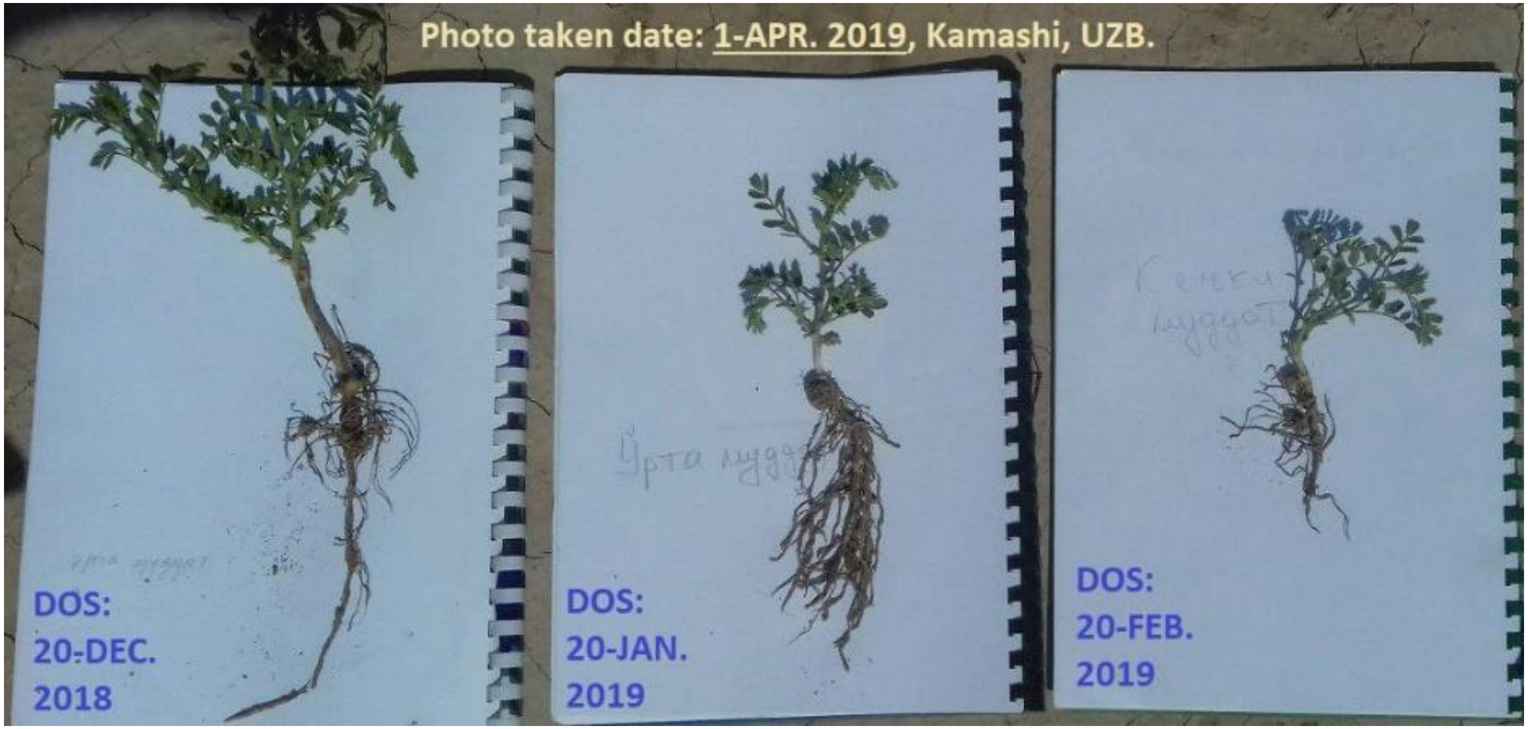
Earning\Crop	Barley	Chickpea	Linseed	Wheat
Net profit per ha	$267	$301	$302	$242
Gross profit / Total cost ratio	4.06	4.80	5.76	3.74

4) The farmers **saved** USD 5 to 22/ha on the cost of **nitrogenous fertilizers** by growing chickpea

Approach to decrease climate change impact

Demonstration trial set in Kamashi, Uzbekistan (2019) of winter sown cold tolerant chickpea variety developed by ICARDA

- Conventionally planted in Spring (Feb-Mar), but cold tolerant chickpea variety planted in 20-Dec.(2018), followed by 20-Jan. and 20-Feb. of 2019



Advantages:

1)Utilizes winter precipitation;

2)Has longer duration to grow and develop before the onset of high temperatures and

3)Matures earlier for around 10-12 days

Cropping system diversification on rainfed land using chickpea

Wheat planted on 16 November in dry year

Chickpea planted on 28 February in dry year

Chickpea planted in autumn

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 irrigated land using legumes

Increasing cropping intensity by incorporating legumes – an example with mungbean

	Crop rotation	1st YEAR (Nov-Jun)	1st YEAR (Jul-Sep)	2nd YEAR (Oct-Feb)	2nd YEAR (Mar-Oct)	*Cropping intensity*
1	Wheat-Cotton	Wheat	Fallow	Fallow	Cotton	*2 crops in 2 years (100%), no legume*
2	Wheat-*Mungbean*-Cotton	Wheat	*Mungbean*	Fallow	Cotton	*3 crops in 2 years (150%), once legume*
3	Wheat-*Mungbean*-Green manure-Cotton	Wheat	*Mungbean*	Green manure	Cotton	*4 crops in 2 years (200%), twice legumes*
4	Wheat-Mungbean-Wheat-Mungbean	Wheat	*Mungbean*	Wheat	Mungbean	*4 crops in 2 years (200%), twice legumes*

Soil analysis of 5 fields - prior and after mungbean crop production as a catch crop in wheat-wheat rotation, in irrigated fields of Soghd, Tajikistan

Soil after mungbean	Positive change 5 fields' average
Soil organic matter	16%
Plant available nitrogen	17 kg/ha
Phosphorous mobilization	10.6 kg/ha

Summary

- Environmental benefits legumes
  - Heat and drought tolerance
- Health benefits of legumes
  - Improves soil health
  - Improves human health
- Economic benefits of legumes
  - Improving land and water productivity

- *Practical comparative studies and demonstrational approaches starting from simple field trials, along with eco-sociological studies including post harvest and marketing issues to be emphasized on, more then various kinds of theoretical estimations, assumptions and forecasting related to sustainable, climate resilient methods of Agro-production, in order to* better translate research and science outputs to evidence-based decision-making and policies to address climate change issues in Central Asian countries

References

1. Angus JF, Kirkegaard JA, Hunt JR, Ryan MH, Ohlander L, Peoples MB. Break crops and rotations for wheat. Crop Pasture Sci. 2015;66:523–52.

2. Bichel A, Oelbermann M, Voroney P, Echarte L. Sequestration of native soil organic carbon and residue carbon in complex agroecosystems. Carbon Manag. 2016;7:1–10.

3. Hajduk E, Właśniewski S, Szpunar-Krok E. Influence of legume crops on content of organic carbon in sandy soil. Soil Sci Ann. 2015;66:52–6.

4. Hernanz JL, Sanchez-Giron V, Navarrete L. Soil carbon sequestration and stratification in a cereal/leguminous crop rotation with three tillage systems in semiarid conditions. Agric Ecosyst Environ. 2009;133:114–22.

5. Jensen ES, Peoples MB, Boddey RM, Gresshoff PM, Hauggaard-Nielsen H, Alves BJ, Morrison MJ. Legumes for mitigation of climate change and the provision of feedstock for biofuels and biorefineries. A review. Agron Sustain Dev. 2012;32:329–64.

6. Peoples MB, Brockwell J, Herridge DF, Rochester IJ, Alves BJR, Urquiaga S, et al. The contributions of nitrogen-fixing crop legumes to the productivity of agricultural systems. Symbiosis. 2009;48:1–17.

7. Preissel S, Reckling M, Schläfke N, Zander P. Magnitude and farmeconomic value of grain legume pre-crop benefits in Europe: a review. Field Crop Res. 2015;175:64–79.

8. Shen J, Yuan L, Zhang J, Li H, Bai Z, Chen X, et al. Phosphorus dynamics: from soil to plant. Plant Physiol. 2011;156:997–1005.

Thanks for Your kind attentions!