17th Steering Committee Meeting of the CGIAR Regional Program for Central Asia and the Caucasus, 13-14 September, 2016

The CGIAR Collaborative Research & Capacity Building Program for the Development of Sustainable and Resilient Agricultural Production Systems in Central Asia under the Conditions of Changing Climate

Integrated water and land management to sustainably use natural resources

17th Steering Committee Meeting of the CGIAR Regional Program for Central Asia and the Caucasus

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Moscow, Russia

13 September 2016

ICARDA Integrated Water and Land Management Program activities: Akmal Akramkhanov, Vinay Nangia, Usman Khalid, Bogachan Benli

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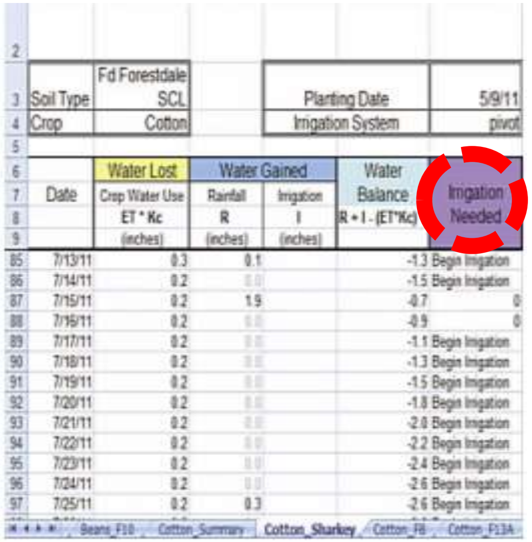
Science for Better Livelihoods in Dry Areas

Intermediate Development Outcomes

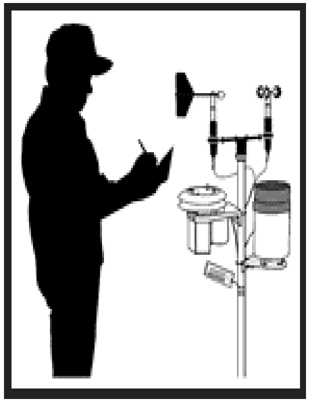
1. More resilient livelihoods for vulnerable households in marginal areas
2. More sustainable and higher income and well-being of per capita for intensifiable households
3. Women and children in households have year-round access to greater quantity and diversity of food sources
4. More sustainable and equitable management of land, water resources, energy and biodiversity
5. Women and youth have better access to and control over productive assets, inputs, information, market opportunities and capture a more equitable share of increased income, food
6. Increased and sustainable capacity to innovate within and among low income and vulnerable rural community systems, allowing them to improve livelihoods, and bring solutions to scale.

ET-based irrigation

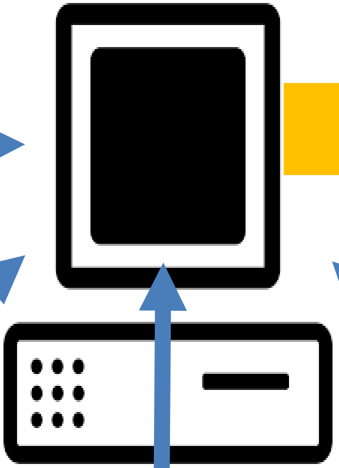


2							
3	Soil Type	Fd Forestdale SCL			Planting Date		5/9/11
4	Crop	Cotton			Irrigation System		pivot
5							
6		Water Lost	Water Gained		Water		
7	Date	Crop Water Use	Rainfall	Irrigation	Balance		Irrigation Needed
8		ET * Kc	R	I	R + I - (ET*Kc)		
9		(inches)	(inches)	(inches)			
85	7/13/11	0.3	0.1		-1.3	Begin Irrigation	
86	7/14/11	0.2			-1.5	Begin Irrigation	
87	7/15/11	0.2	1.9		-0.7		0
88	7/16/11	0.2			-0.9		0
89	7/17/11	0.2			-1.1	Begin Irrigation	
90	7/18/11	0.2			-1.3	Begin Irrigation	
91	7/19/11	0.2			-1.5	Begin Irrigation	
92	7/20/11	0.2			-1.8	Begin Irrigation	
93	7/21/11	0.2			-2.0	Begin Irrigation	
94	7/22/11	0.2			-2.2	Begin Irrigation	
95	7/23/11	0.2			-2.4	Begin Irrigation	
96	7/24/11	0.2			-2.6	Begin Irrigation	
97	7/25/11	0.2	0.3		-2.6	Begin Irrigation	

Beans_F10 | Cotton_Summary | Cotton_Sharkey | Cotton_F8 | Cotton_F13A



Weather data



Soil moisture data

Soil moisture data

Hydro-module Zone I

Hydro-module Zone II

Hydro-module Zone VIII

Traditional Irrigation

ET-based Irrigation

Traditional Irrigation

ET-based Irrigation

Traditional Irrigation

ET-based Irrigation

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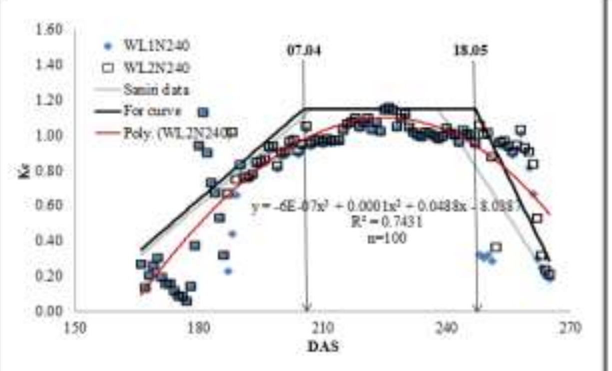
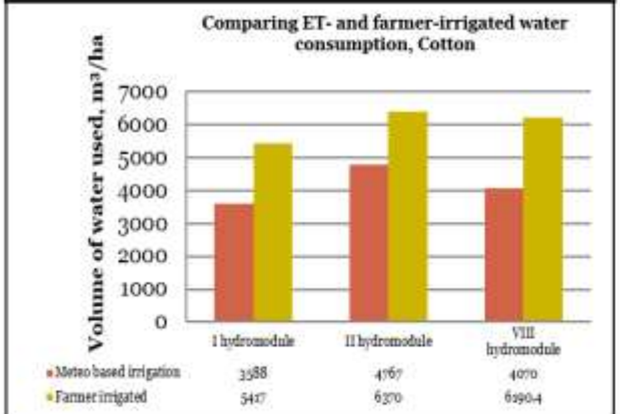
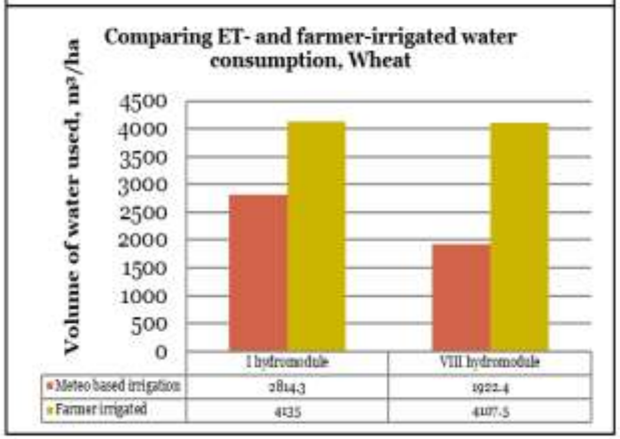
Results

- There was on average **32% saving of irrigation** water and **50% increase in water productivity**
- There was **excellent match** between model-predicted and literature-reported values of **Kc**
- The pilot area selected for research is representative of **35%** of irrigated areas in Fergana Valley and **50%** in Aral Sea Basin
- Saved water can be used for supporting ecosystem services, expanding agriculture or for industrial and municipal purposes

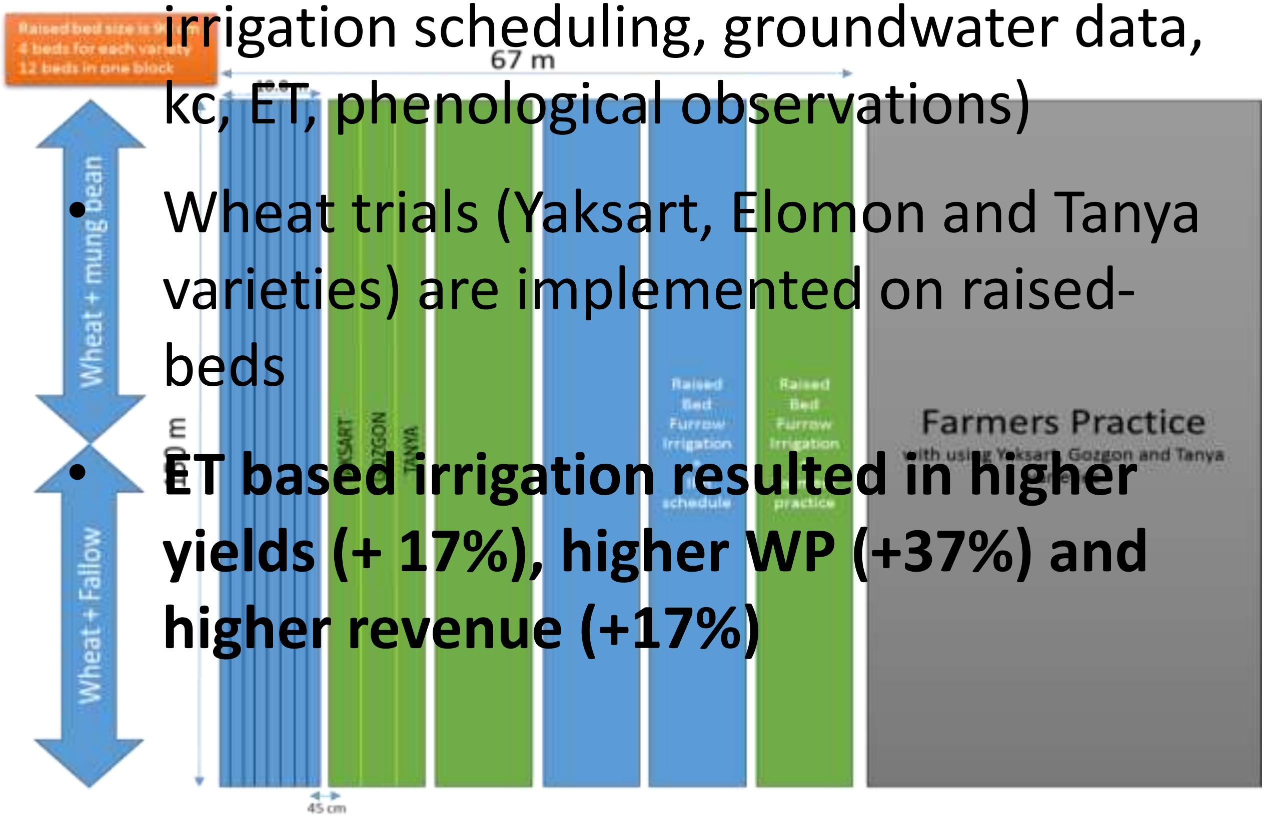






Examine performance of conventional and ET based irrigation scheduling for wheat and mungbean varieties and crop rotation options

- Mung bean trials complete (yield, biomass, LAI, soil characteristics, irrigation scheduling, groundwater data, kc, ET, phenological observations)
- Wheat trials (Yaksart, Elomon and Tanya varieties) are implemented on raised-beds
- **ET based irrigation resulted in higher yields (+ 17%), higher WP (+37%) and higher revenue (+17%)**



Soil salinity management with different furrow irrigation methods

Treatments

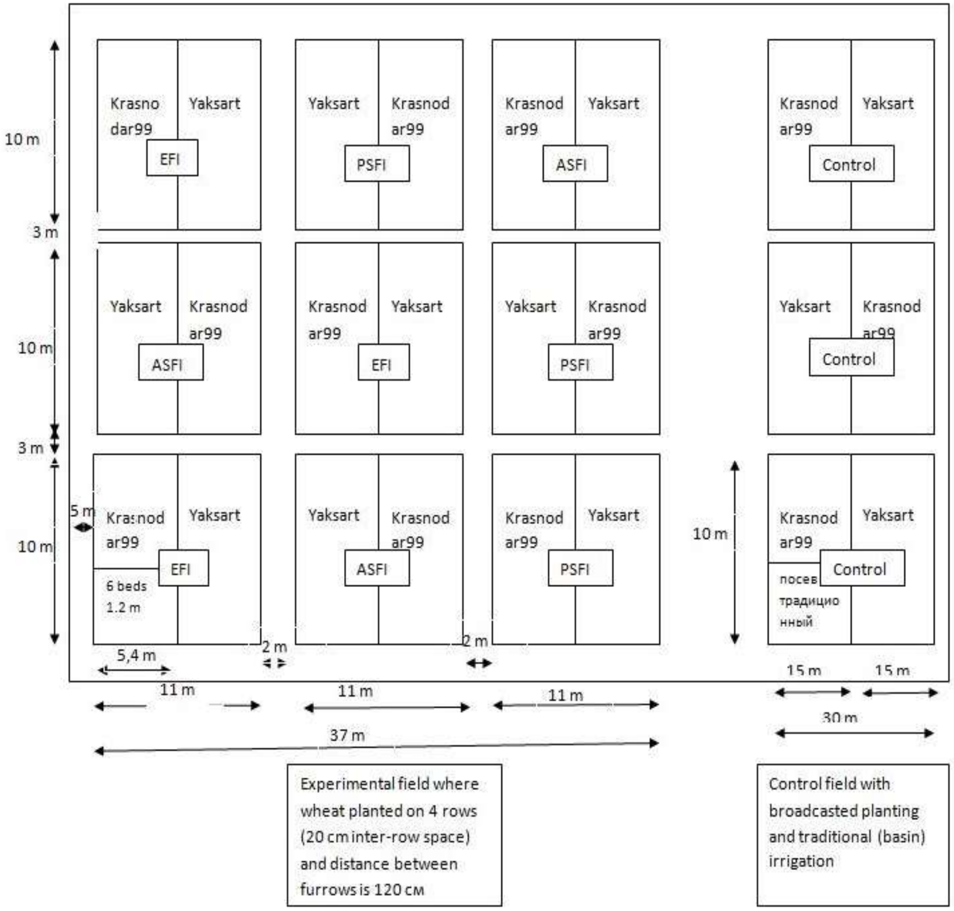
1. 2 wheat seed varieties (Yaksart + Tanya)
2. Every Furrow, Alternate Furrow Raised bed irrigation and Control (traditional basin irrigation)

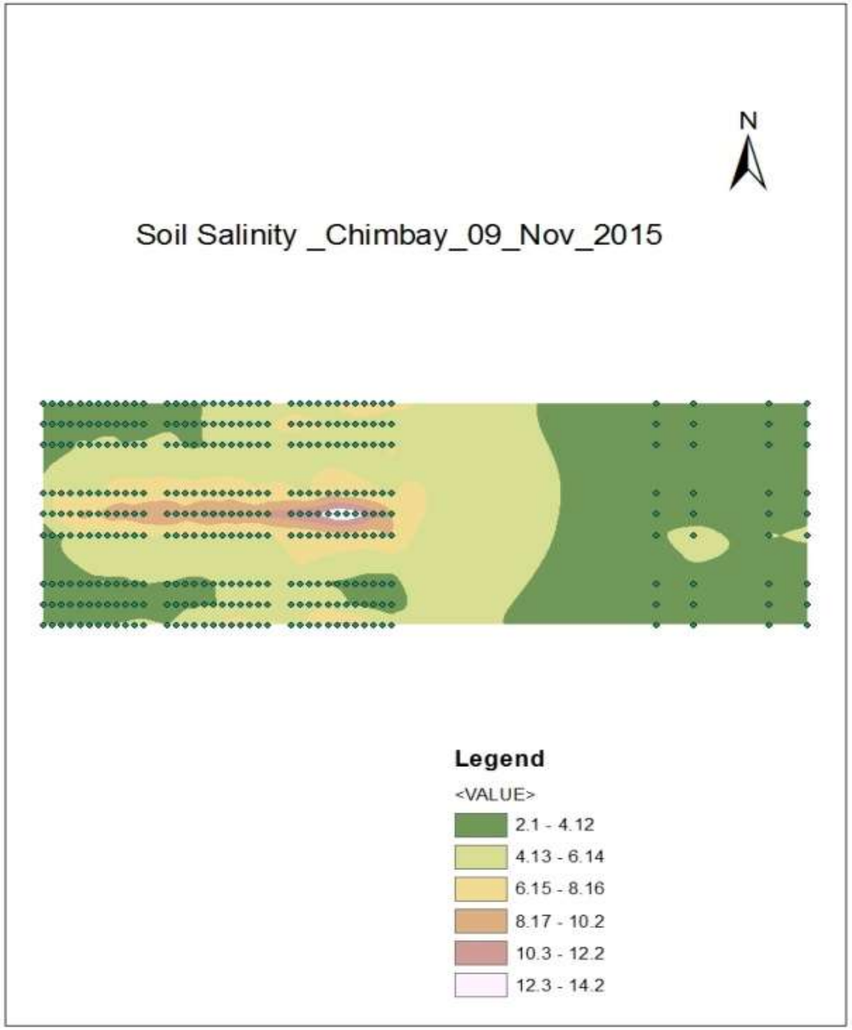
Main goal is to investigate the performance of two furrow raised bed irrigation methods on salt dynamics of the soil and wheat agriculture.



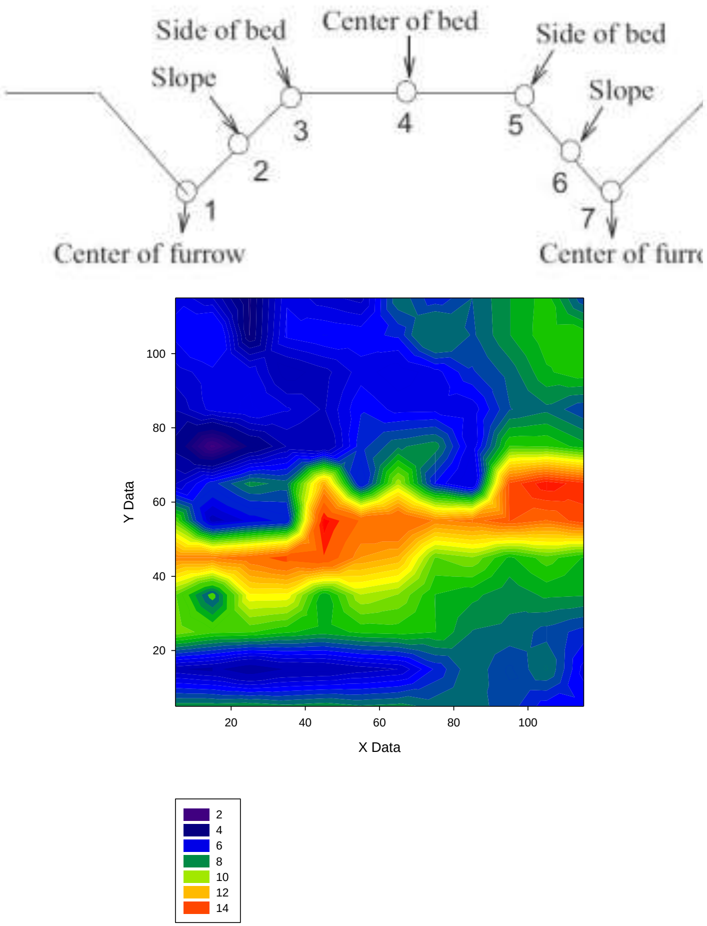
Soil salinity management with different furrow irrigation methods

Layout of site and soil salinity map

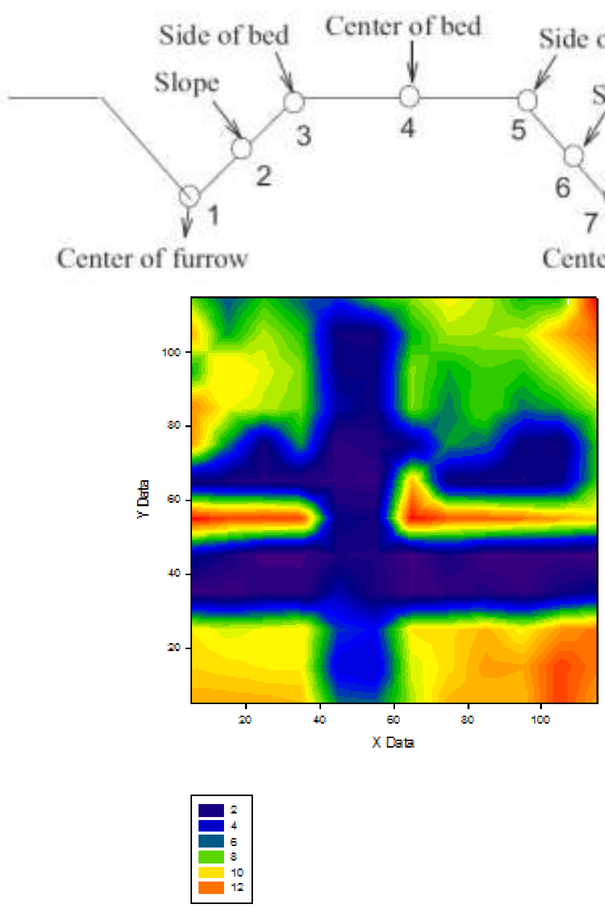




Soil salinity on raised beds



Every furrow irrigation



Alternate furrow irrigation

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Soil salinity management with different furrow irrigation methods

Irrigation regime

Irrigation rates applied for different treatments

Treatment	First Irrigation (13.05.16)	Second irrigation (1.06.16)	Total irrigation rate
EFI	284	800	1084
AFI	283	705	988
Control	583	785	1369

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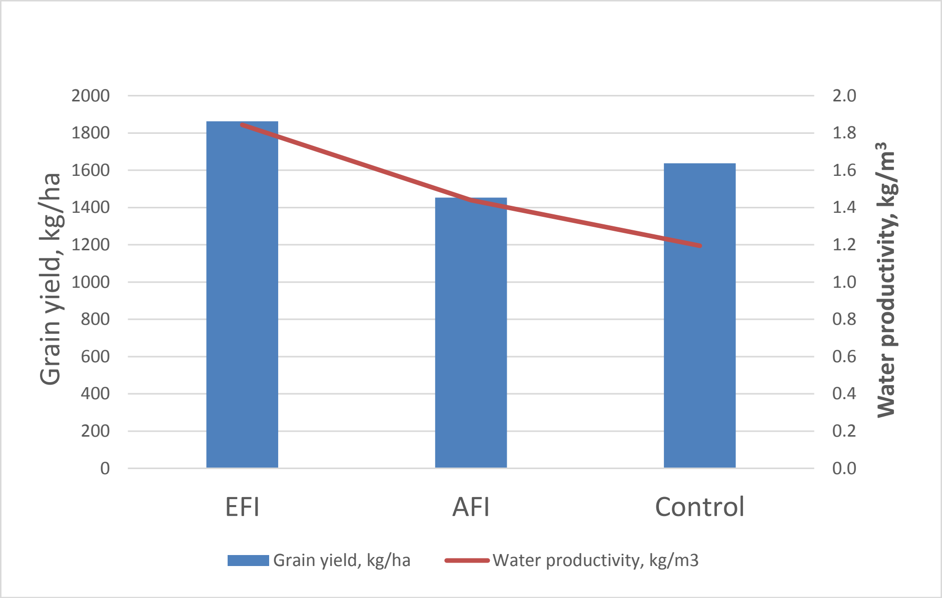
Soil salinity management with different furrow irrigation methods

Yields of wheat



Treatment	Irrigation rate, mm	Yield, kg/ha	Water productivity, kg/m3
EFI	101	1863	1.8
AFI	100.9	1453	1.4
Control	137	1637	1.2

Raised bed technology demonstrated 20-54% higher Water Productivity

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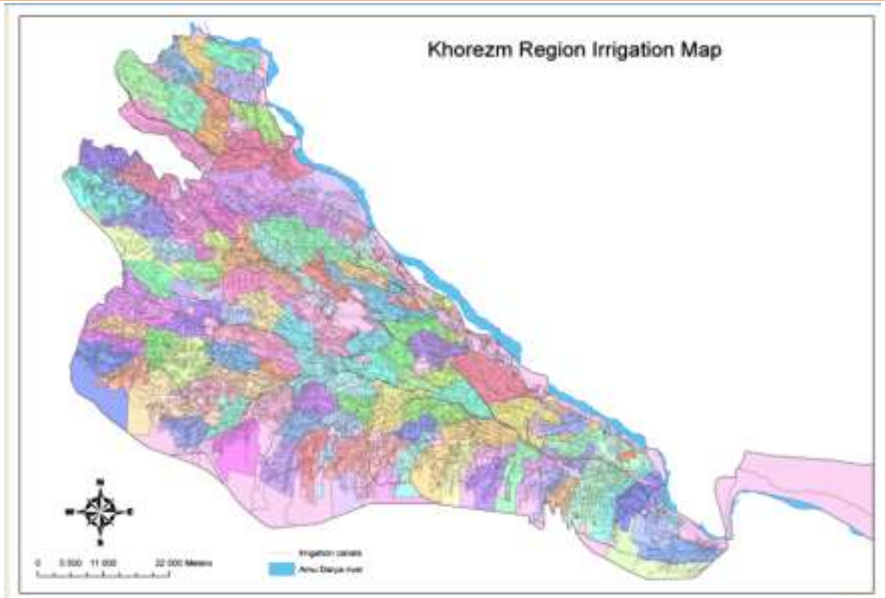
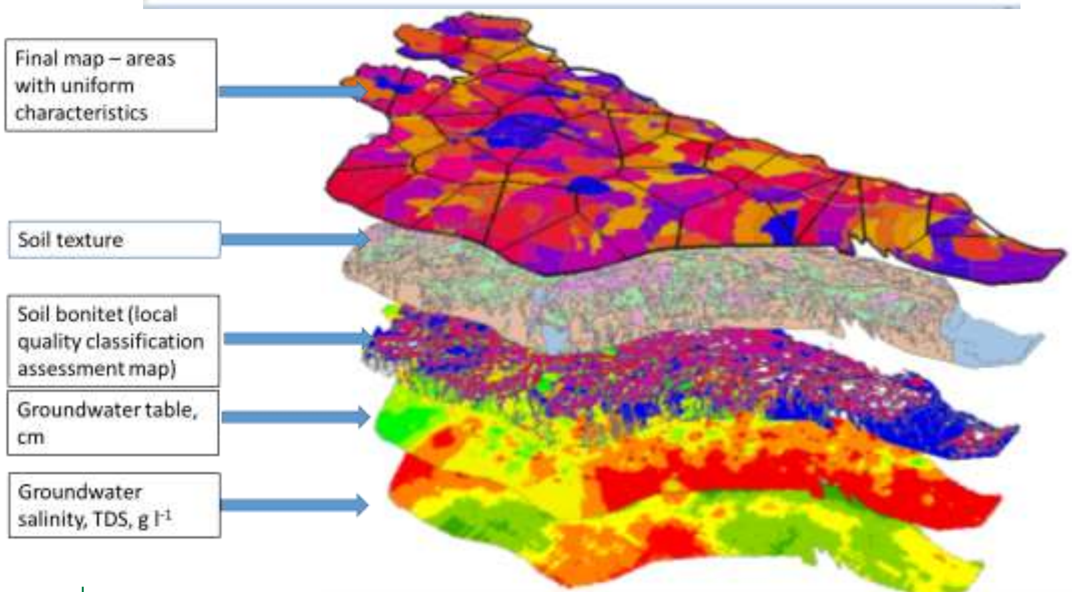
Determining optimum water and nutrients leaching requirements for the saline areas





- Data collected (groundwater table, groundwater salinity, soil texture, climate data and soil salinity)
- Site selection completed
- **Calibration/validation of HYDRUS is on-going**

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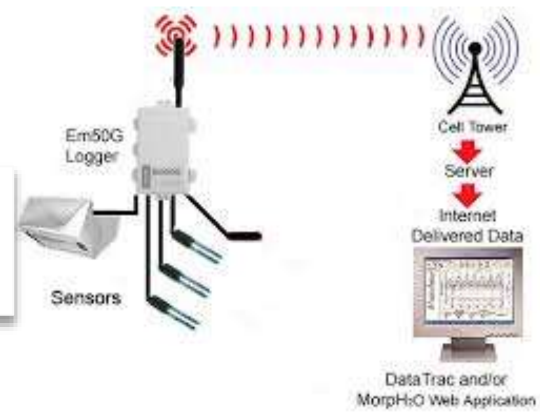
Determining optimum water and nutrients leaching requirements for the saline areas

Research field of the training site of the SANIIRI scientific-production organization in the Nauhas Water Users' Association

EM50G Monitoring Soil Salinity, Moisture and Temperature with Telemetry (GSM Module)



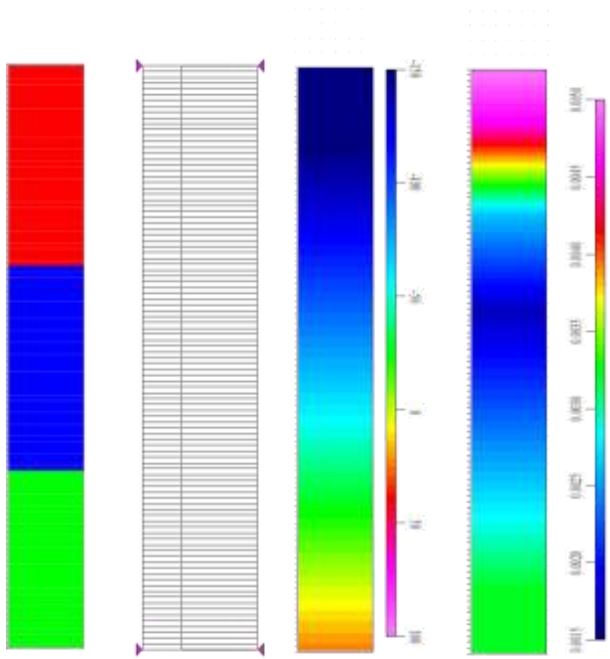
5TE Soil Salinity, Moisture and Temperature Sensors

CTD-10 Groundwater salinity and depth sensors

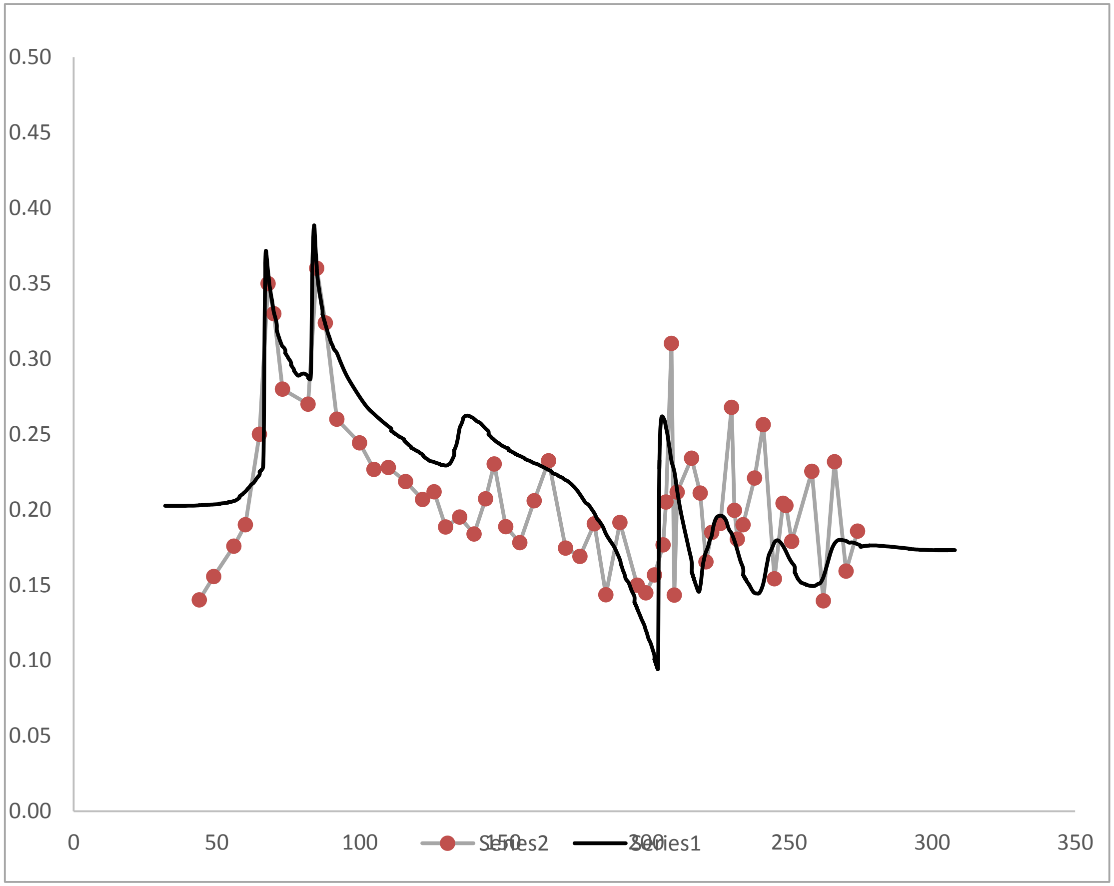
PROCHECK Irrigation water salinity

Determining optimum water and nutrients leaching requirements for the saline areas

Model Inputs



Soil Prof ile | **Soil Profi le** | **Press ure Head** | **Solute concent ration**



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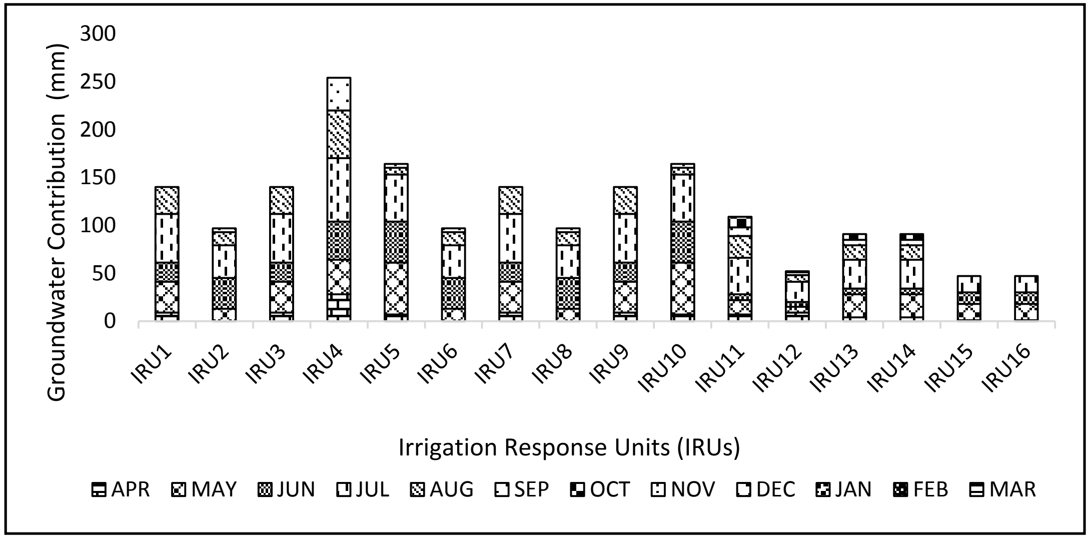
Conjunctive water management using canal and groundwater



- Controlled drainage.
- Saving of surface water of 45- 50%
- Reduction of the drainage outflows near to a target value of 10 to 15%
- Journal publication - Impact of controlled drainage on crop yield and soil salinity

Crop modeling to determine SLM options



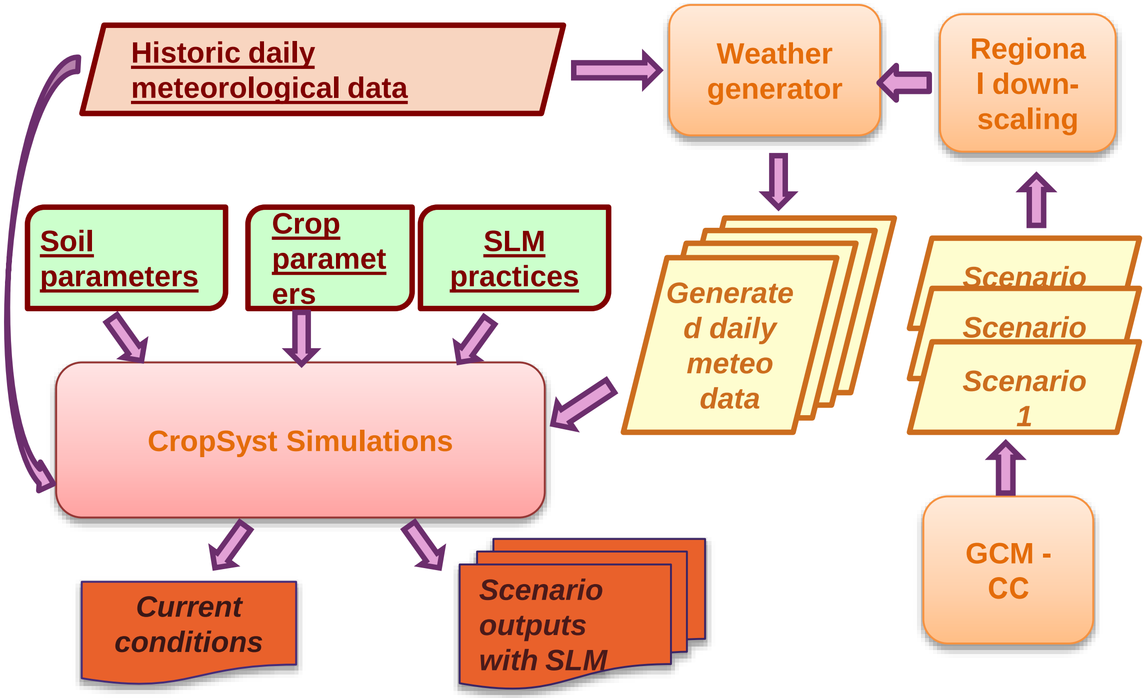


Area of degraded land in the Khorezm Province - 20,000 ha

Soil organic matter (humus) is very low 0,4-1,2 %, total content of organic matter in depth of 0-50 cm is 29 -70 t/ha.

Photos: ZEF/UNESCO Khorezm project

Assessment of the impacts of climate change and the effects of adoption of SLM technologies on crop productivity (modeling)



Outputs	
Calibrated crop model for cotton and wheat	
Manual on processing and using CORDEX climate change data and crop models	
Quantified climate change impact on crop production	
Capacity building of scientists in processing and using CORDEX climate change models	

The CropSyst model (Stockle et al., 2003), version 4.19.06

Climate change from IPCC (2013) CMIP5 scenarios RCP 2.6, RCP4.5-6.0 and RCP 8.5

Crop modeling to determine SLM options

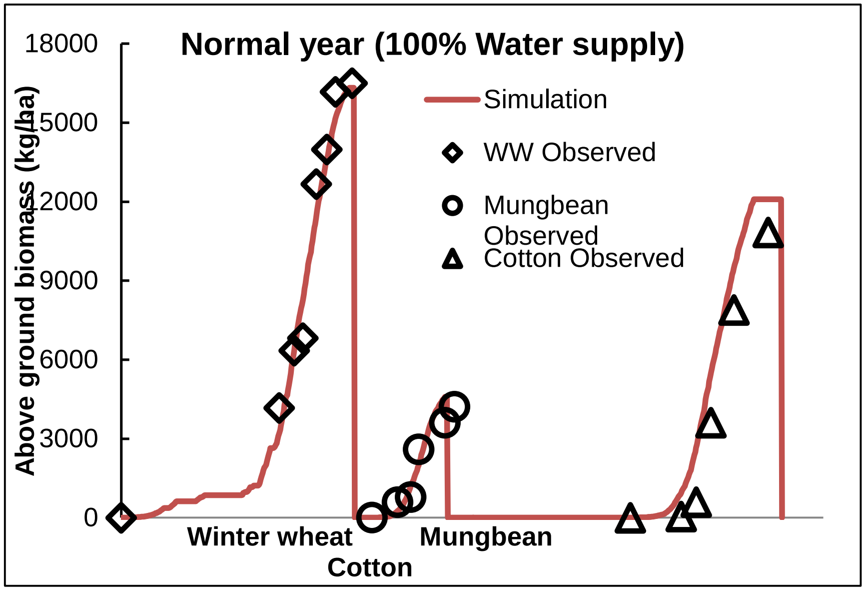
Winter Wheat

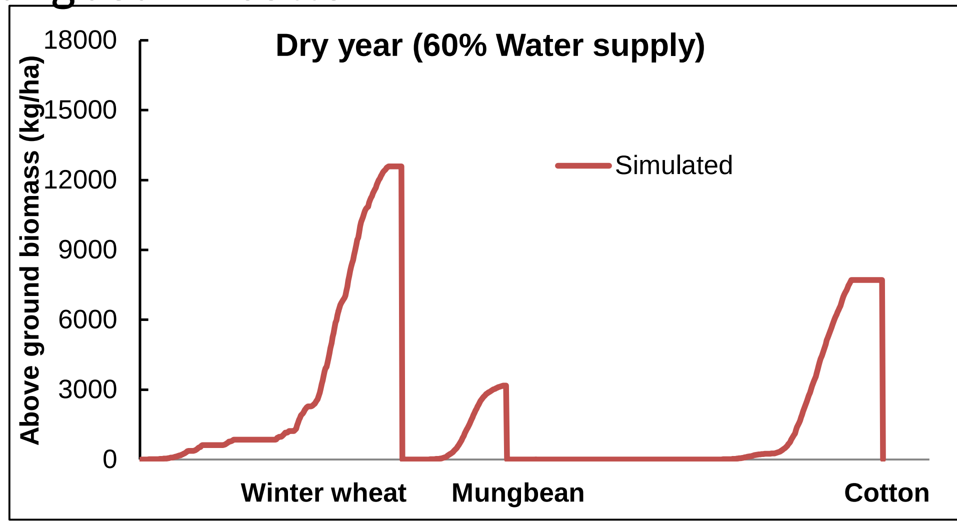
Mungbean

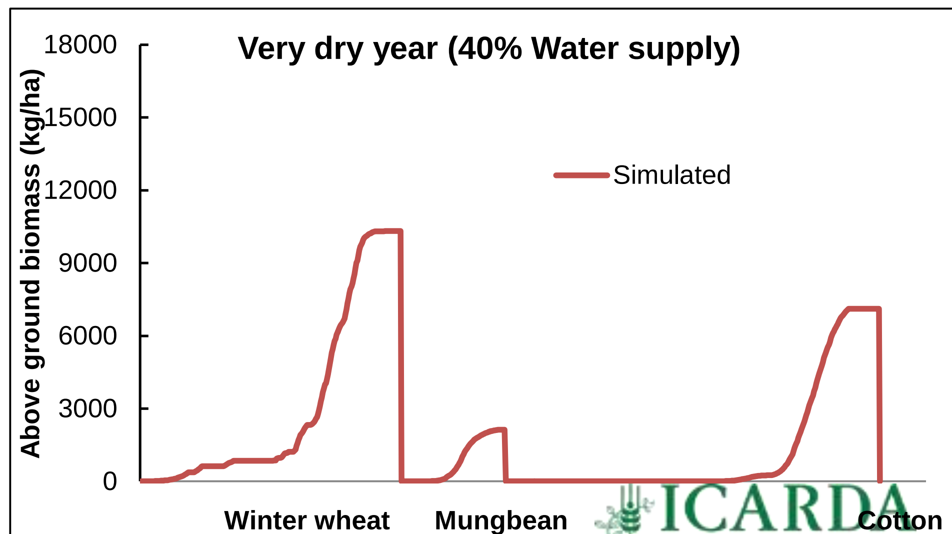
Cotton

Crop modeling to determine SLM options

Good fit between the simulated and empirical values for the various parameters in crop rotation "winter wheat - summer mungbean – cotton"







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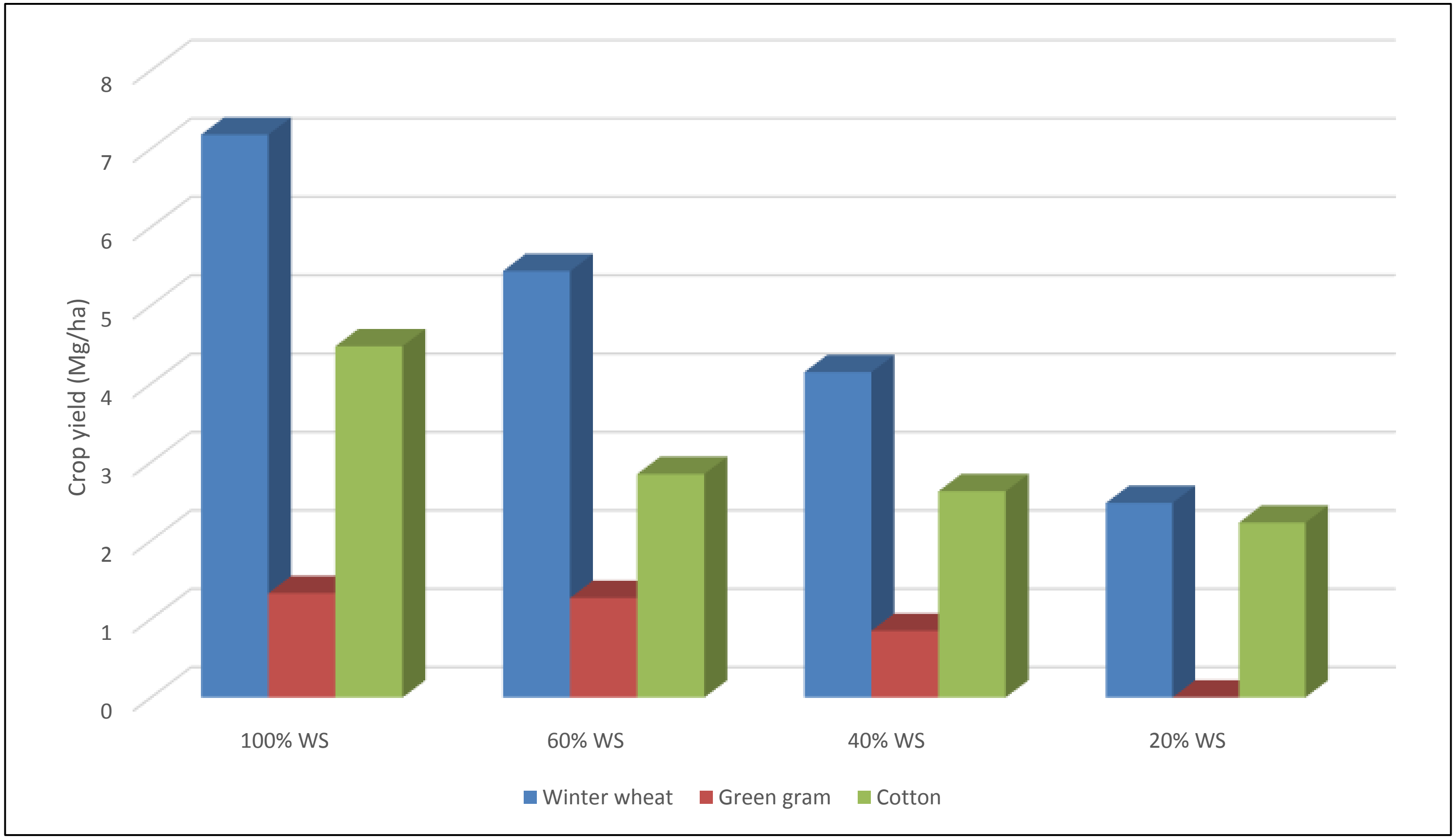
Crop modeling to determine SLM options

Crop yield in the treble rotation under different irrigation water availability scenarios



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Crop modeling to determine SLM options

- Good simulation estimates of higher yields of winter wheat and cotton on the higher fertility soil (7.2 t ha^{-1} of wheat grain and 4.5 t ha^{-1} of seed-lint cotton) compared to the soil with lower fertility (less 12% for wheat and 31% for cotton)

- Deficits of irrigation (40 and 20% of 'normal', respectively) could decrease yields up to 65%.

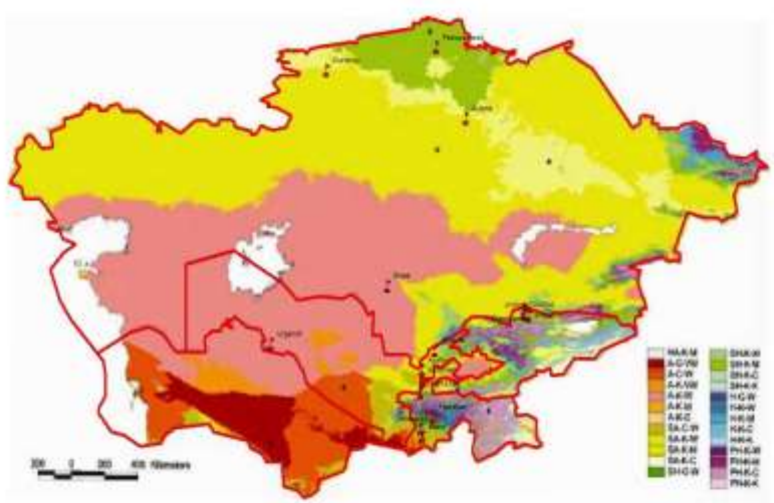
- Even though groundwater is basically very shallow in Khorezm, full irrigation according to crop demand is prerequisites to achieve high yields of the crops in the treble rotation unless the water table is higher than 2 meters.

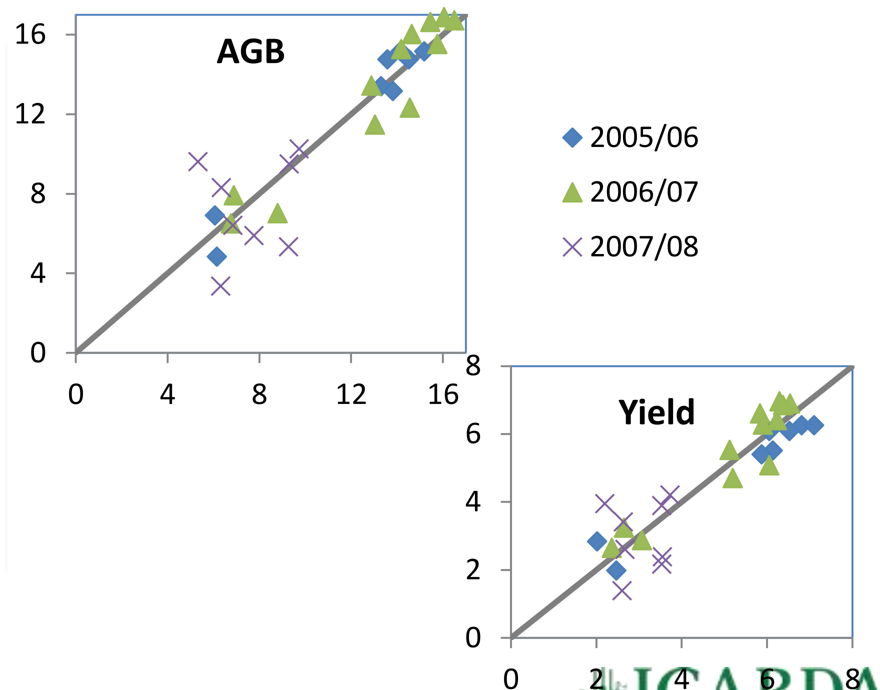
- Contribute to decision making – whether or not to concentrate or to spread-out (thin) the available irrigation water resources in dryer years. At the same time this distinction mimicked differing levels of access to water (up-stream vs. down-stream)

Assessment of wheat yield gap in Central Asia

- Goal to estimate yield gap in wheat between the potential yield and actual yield of wheat in Central Asia and find out reasons for such a gap and identify package technologies to eliminate this Gap
- 18 sites in rainfed and irrigated (saline and non saline) agro ecological zones

Calibration CropSyst model





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Assessment of wheat yield gap in Central Asia – Methodology

Farmers Yield
Survey, National Agricultural Research Centers (1991-2015)

Research Yield
Review of Existing Studies

Potential Yield
CropSyst (Crop, soil and irrigation management)

Identification of the causes of gaps

Management options to reduce the gaps

Assessment of wheat yield gap in Central Asia

Sample of agroecological zones (out of total 18)

Country	Province	AEZ	Agro Cilmat Explanation	Salinity_D
Kazakhstan	Kyzylordinskaya	A-k-W	Arid, cold winter, warm summer	Irrigated -Low salinity
Kazakhstan	Kustanayskaya	SA-K-W	Semi-arid, cold winter, warm summer	Rainfed-Low salinity
Kazakhstan	Sever-Kazakhstanskay	SA-K-W	Semi-arid, cold winter, warm summer	Rainfed-Medium Salinity
Kazakhstan	Jambylslkaya	A-K-W	Arid, cold winter, warm summer	Rainfed - High Salinity
Kyrgyzstan	Bishkek province (Chiu Valley)	SA-K-W	Semi-arid, cold winter, warm summer	Irrigated - High Salinity
Tajikistan	Bokhtar	SA-C-W	Sub-humid, cold winter, warm summer	Rainfed-High Salinity
Uzbekistan	Syrdarya province	A-K-W	Arid, cold winter, warm summer	Irrigated-High Salinity
Uzbekistan	Khorezm province	SA-K-W	Semi-arid, cold winter, warm summer	Irrigated-Medium Salinity
Uzbekistan	Bukhara	A-C-W	Arid, cool winter, warm summer	Irrigated - Low Salinity
Uzbekistan	Bukhara	A-C-W	Arid, cool winter, warm summer	Irrigated-High Salinity

Assessment of wheat yield gap in Central Asia

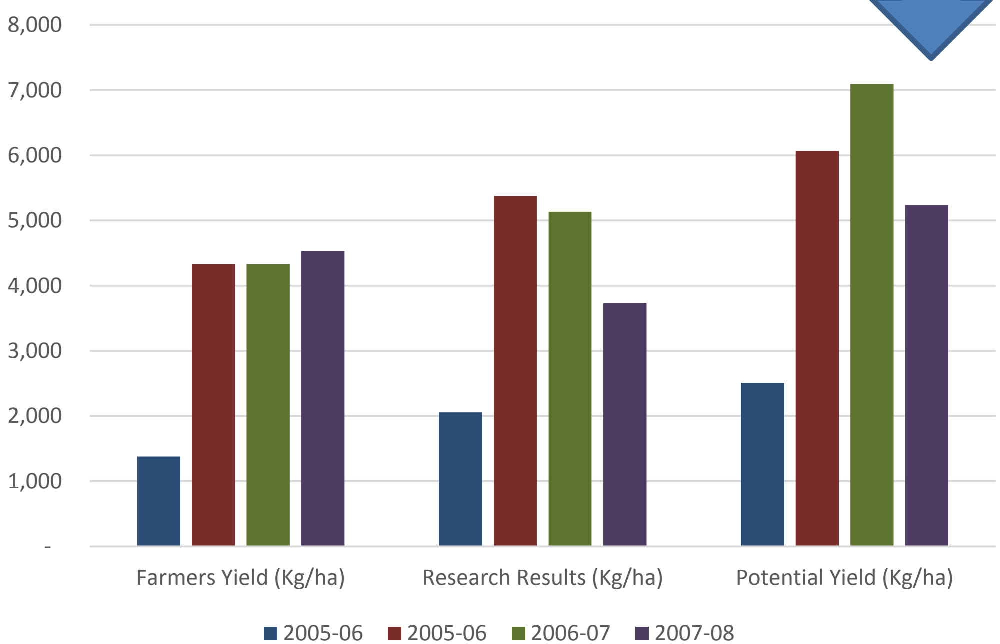
Irrigated Medium Salinity – Khorezm, Uzbekistan

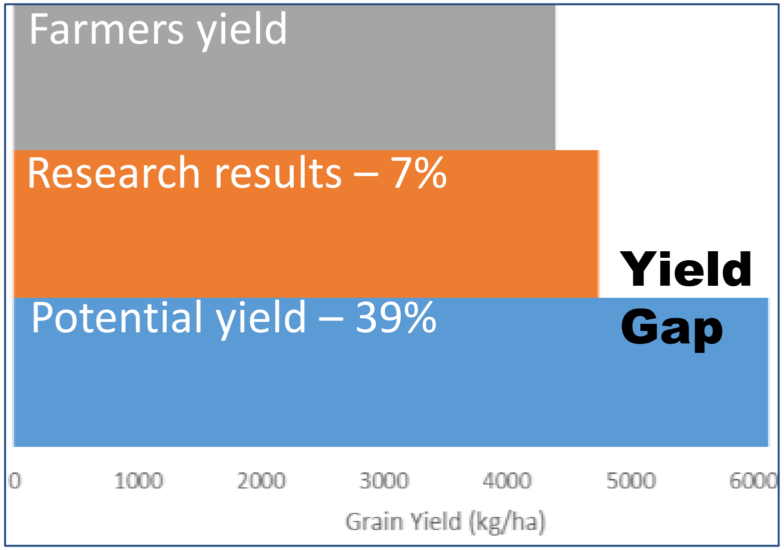
Farmers Practices

- Planting date: Sep -Dec; Mainly Cotton & Wheat Rotation
- No Land levelling
- Hydro Module Zone Approach in Irrigation

Research Results (Ibragimov et al. 2009)- 600 mm of IRR and N240

Optimum IRR (250 – 275 mm. And 240kg N application)





Technology development and delivery through international collaboration in the CAC region: Improved soil and crop management practices

- **How long does it take for innovation to take off? ~ 5–10–15 years?**

Conservation Agriculture in rainfed areas of Kazakhstan 2000 – 2010?

Laser-guided land leveling in irrigated areas of Uzbekistan 2005 – 2016?

- **What does it take for innovation to take off? Inter/Multi-disciplinarity?**

Thank you for attention!

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