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Releasing water from high delta crops for other beneficial uses:

Potential and Challenges as seen in a computable general equilibrium (CGE) model

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Paper Overview

Amidst growing scarcity and increasing demands, maybe at 10% per year, water in Pakistan is not optimally used and could go to higher valued uses.

- Population growth, urbanization and industrialization create mounting demand for water resources, while climate change and better diets will affect water requirements in agriculture.

With fixed supply, the per capita availability of water is continuously decreasing.

Paper Outline

This presentation has the following sections:

- A Base run that keeps acreage of main crops and resulting water use roughly constant from 2014 to 2030 but that is constructed to

Reflecting recent interest from the irrigation department in Punjab, we simulate

- A 15% reduction in both basmati and Irri rice acreage across all provinces
- A similar 15% reduction in sugarcane acreage
- Reductions of both sugarcane and rice acreages by 20%
    - Changes in acreage and water use across the simulations
    - Changes in water use across all simulations
    - Changes in water stress and environmental flows below Kotri barrage
    - Briefly Agricultural production changes by province and simulation, housold income and nutrition

SECTION 1-A

Impact of Reduction in Rice and Sugarcane on Acreage

Crop Water Use Changes with Taxes on Both Sugarcane and Rice, without Climate Change

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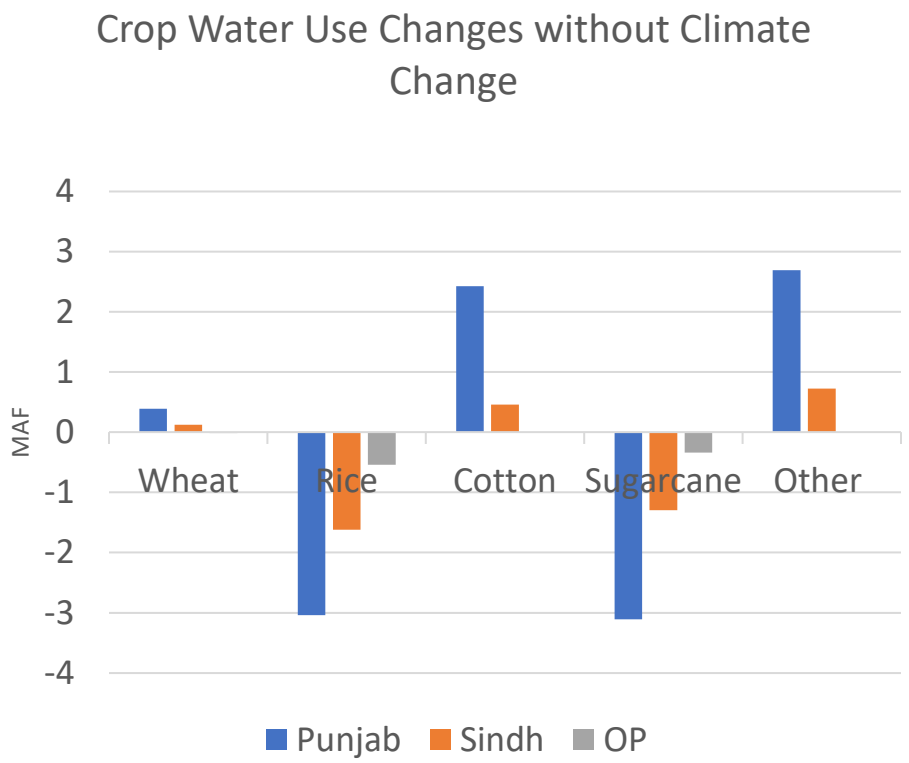
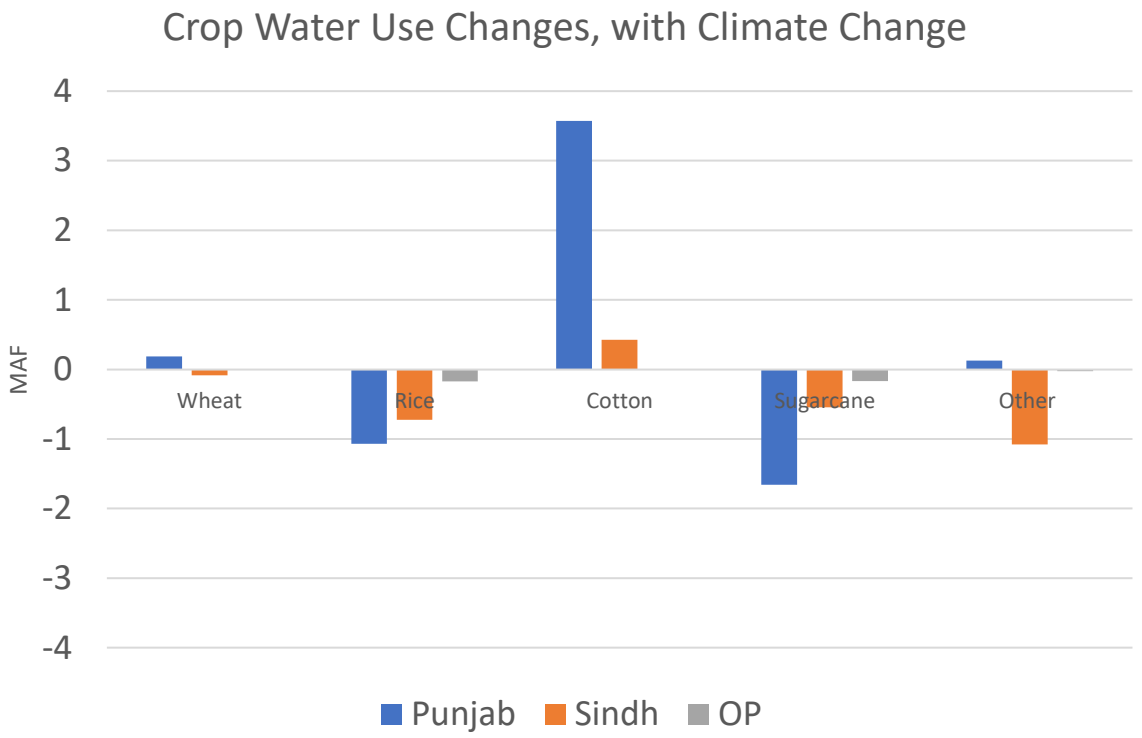
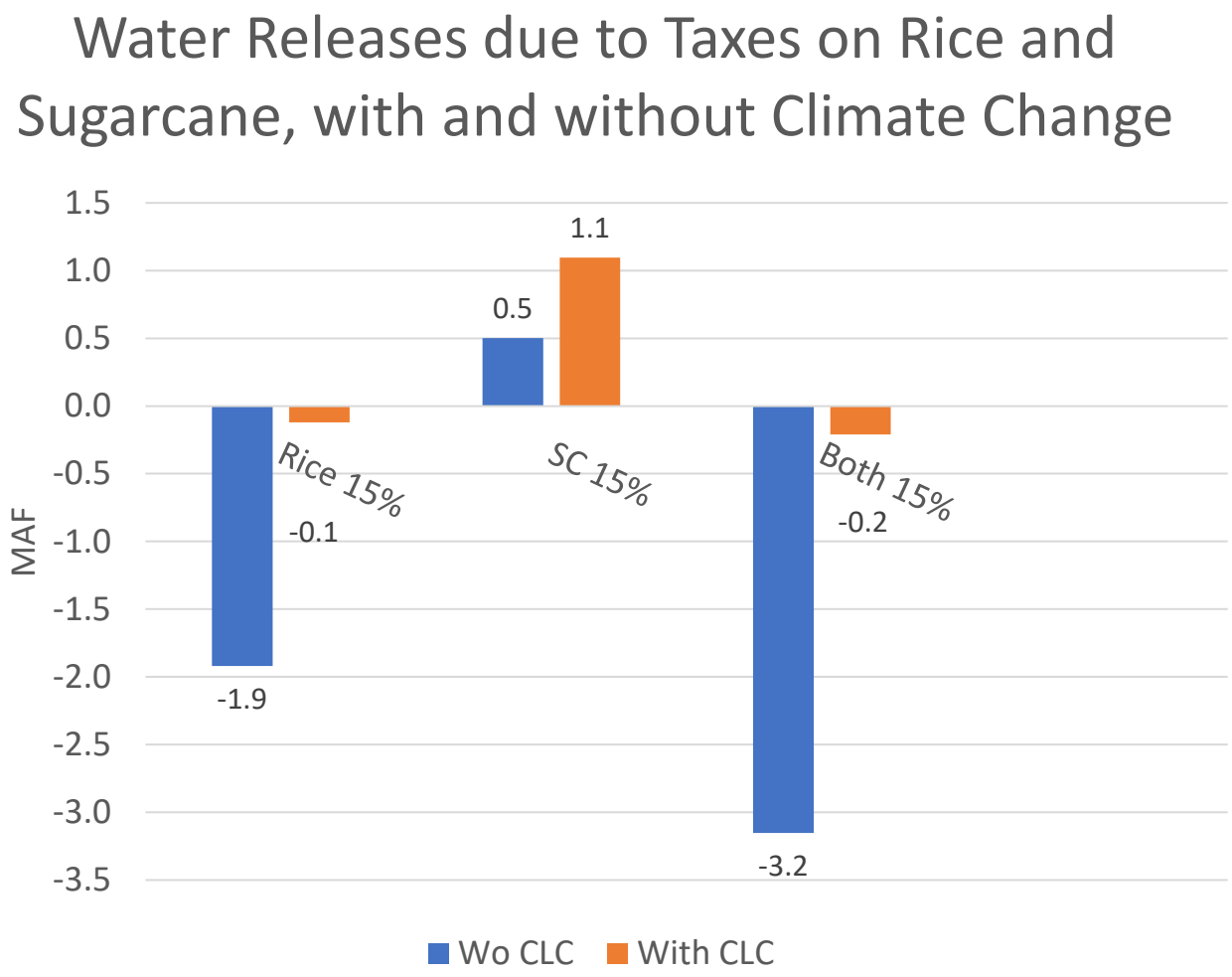




Annual Water Releases from Tax policy, with and without climate change



Extensive substitution exists

Effects across crops and taxes in Sindh:

- When Rice acreage drops 15% in Sindh: 0.41 MAF out of rice, but 0.29 MAF into fruit and 0.13 MAF is released
- When Cane acreage drops 15% in Sindh: 1.38 MAF out of cane, but 0.60 MAF goes into rice, 0.13 MAF in cotton and 0.31 MAF into HV crops, so just 0.26 is released.

Effects across crops and taxes in Punjab:

- When Rice acreage drops 15% in Punjab: 3.20 MAF out of rice,, 0.88 MAF into cotton, 0.76 MAF into HV crops and 1.31 MAF is released

- When Cane acreage drops 15% in Punjab: 3.18 MAF out of cane, but 1.35 MAF goes into rice, 1.04 MAF into cotton and 1.58 MAF into HV crops, and 1.08 MAF is ***added***.

Applied Water equivalents

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We derived \estimates of applied water (AW) from the simulated values of consumptive use (CU) and other known relationships from Young et. al. 2019. We used 40% groundwater and 60% surface water. Eimaated Evaporation losses as 50% of beneficial use, yielding:

$$AW = 1.5*CU/.756$$

We implement these calculations for three estimated consumptive use values:

- **The simulation of sugarcane and rice:** **3.15 CU MAF = 6.25 AW MAF,**
- **The rice simulation alone:** **1.92 CU MAF = 3.88 AW MAF**
- **A 30% tax on rice, sugarcane, and cotton:** **4.35 CU MAF = 8.63 AW MAF**

SECTION 1-C

Impact of Reduction in Rice and Sugarcane on Production, Income, and KCAL

Impact on Production

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PROVINCES	Change in Production, with Hist Scenario					
	Base			15% ↓ in Rice Acr.	15% ↓ in Sugarcane Acr.	15% ↓ in Rice & Sugarcane Acr.
	2014	2030	Change	Change	Change	Change
Punjab	2,308	3,677	1,369	-18.7	19.7	-6.5
Sindh	642	1,003	360	-9.3	7.9	-8.4
Other Province	402	716	314	-2.9	5.5	2.4
TOTAL	**3,353**	**5,396**	**2,043**	**-30.8**	**33.1**	**-12.5**

Increase | Remain Same | Decrease

Impact on Income

HOUSEHOLD GROUP	Change in Income In % changes					
	Base			15% decrease in Rice	15% decrease in Sugarcane	15% decrease in Rice & Sugarcane
	2014	2030	% Change	Difference	Difference	Difference
Rural Farm Poor (RFP)	379	752	4.28	0.02	0.08	0.05
Rural Farm Non-Poor (RFNP)	5,682	10,747	4.29	0.01	0.08	0.05
Rural Non-Farm Poor (RNFP)	1,005	1,575	2.81	-0.05	-0.03	-0.03
Rural Non-Farm Non-Poor (RNFNP)	1,879	3,235	3.40	-0.05	-0.01	-0.02
Urban Poor (UP)	1,248	1,852	2.67	-0.05	-0.04	-0.03
Urban Non-Poor (UNP)	11,715	17,709	2.58	-0.05	-0.05	-0.04

Impact on KCAL

CROPS	Change in Nutrition, with Hist Scenario- % of Kcals				
	Base		20% decrease in Rice	20% decrease in Sugarcane	20% decrease in Rice & Sugarcane
	2014	2030	Difference	Difference	Difference
CEREALS	50.8	50.1	0.36	0.21	0.70
MEAT	4.1	5.3	-0.03	0.02	-0.01
DAIRY	14.2	11.4	0.12	0.10	-0.07
VEGETABLES	3.5	1.9	-0.10	-0.08	-0.04
FRUITS	2.0	1.0	-0.04	-0.02	0.01
OIL	14.6	15.1	0.32	0.69	0.51
DISCRETIONARY (Sugar)	10.9	15.2	-0.63	-0.92	-1.11

SECTION 3

Other: Applied Water Levels, Environmental Flows, and Other Policies

Effects of Alternative Policies

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Crop	Combined SC and Rice	SC Rice Cotton - 30 30 30	Diff. (Col. 3 – 2)	Fertil-izer (35%)	Diff. (Col. 4 – 2)	Scaled Based on CWR	Difference (Col. 5 – 2)
Wheat	12.6	12.8	0.2	12.4	-0.2	14.7	2.1
Rice	12.4	14.1	1.6	14.2	1.8	13.7	1.3
Cotton	16.5	10.2	-6.3	11.8	-4.7	11.9	-4.6
Sugarcane	8.3	9.6	1.4	9.0	0.8	7.1	-1.2
Maize	0.8	0.8	0.0	0.8	0.0	0.9	0.1
Other crops	7.9	8.2	0.3	8.2	0.3	7.7	-0.2
Vegetables	5.7	6.5	0.8	6.3	0.6	6.6	0.9
Fruit	6.0	6.8	0.8	6.7	0.7	6.8	0.8
Total	**70.1**	**68.9**	**-1.2**	**69.5**	**-0.7**	**69.4**	**-0.7**

Last Comments

Is it possible to get significant water out of agriculture with appropriate strategies/policies? YES! But!

- Will depend on substitution among crops in agriculture
- Strength of demand for better nutrition
- Choice of policies
- Nature of climate change .

To finish this paper, we will add effects of:

We expect to make these extensions simply, with just modest data presentation additions.

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Thank You!