The paradigm of climate change impacts and adaptation in farming systems, income and poverty of western Indo-Gangetic Basin

AgMIP The Agricultural Model Intercomparison and Improvement Project

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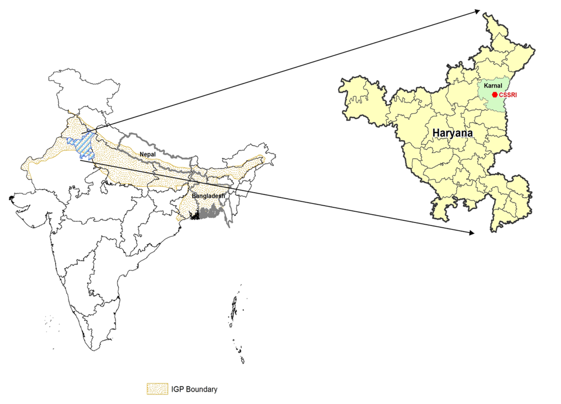
USDA UKaid from the British people

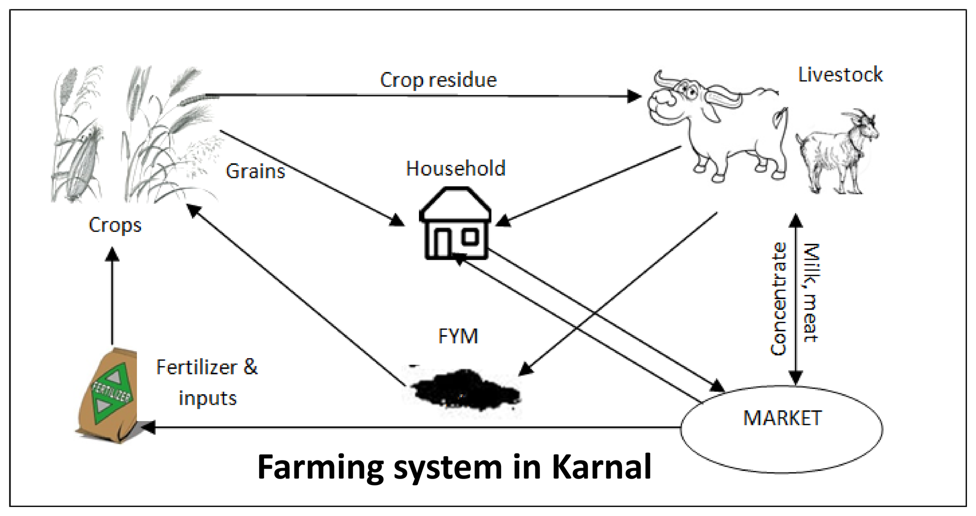
1. Introduction

•Climate Change impacts are visible in IGB with extreme heat effects and erratic rainfall.
•Extreme heat effects (>34°C) could lead to wheat leaf senescence and reduce wheat yield by 50% in IGB (Lobell et al., 2012: NCC; Asseng et al., 2011: Glob Change Bio).
•Increase in temperature could shorten the maturity period of rice leading to decline in rice productivity (Mishra et al., 2013: Sci Tot Envt: 2013).
•Mixed systems where crops & livestock are integrated are expected to harm seriously due to climate change impacts (Thornton et al., 2009:AgSyst; Thornton & Herrero; 2014 Glob Food Sec)
•The food security in the IGB is threatened by climate change impacts thereby exacerbating the poverty in the region.
•Site specific adaptation packages are needed to overcome poverty and secure food security in region (IPCC, 2014).



2. Farming systems

•**Study area:** Karnal district of Haryana state of India in western IGB:
•**Farming system:** Pervasive Rice – Wheat system and other minor crops (sugarcane, sorghum, maize etc) and livestock.
•**Farm survey data:** 100 farms randomly selected from the database of Cereal System Initiatives for South Asia (CSISA) project.
•**Assumption:**
Wheat: PBW 343 & Rice: PR114
Mixed crop and Livestock: crop yield decreased by 20% & milk yield decreased by 20% per lactation (Thornton & Herrero, 2014: GFS)

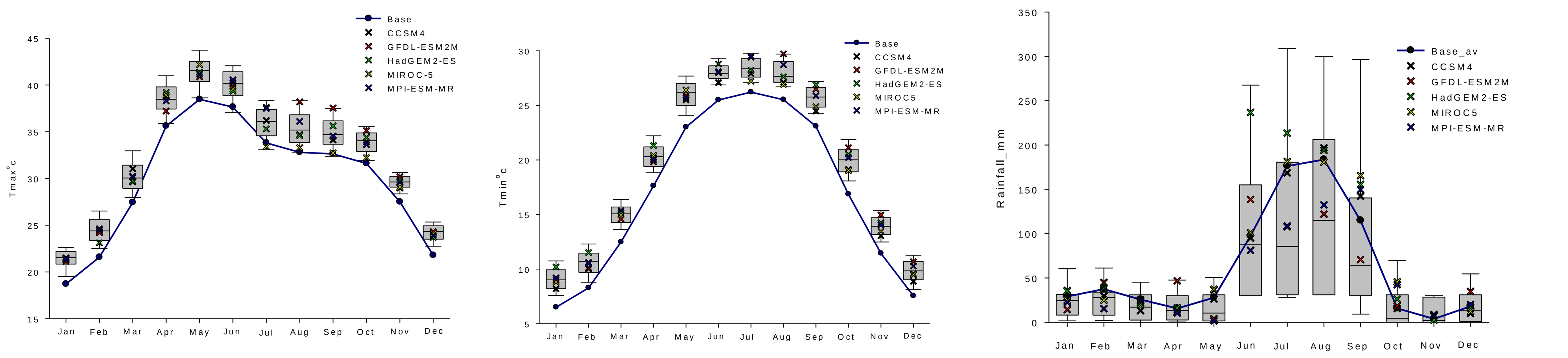


Farming system in Karnal

BAU RAPs parameters used in analysis

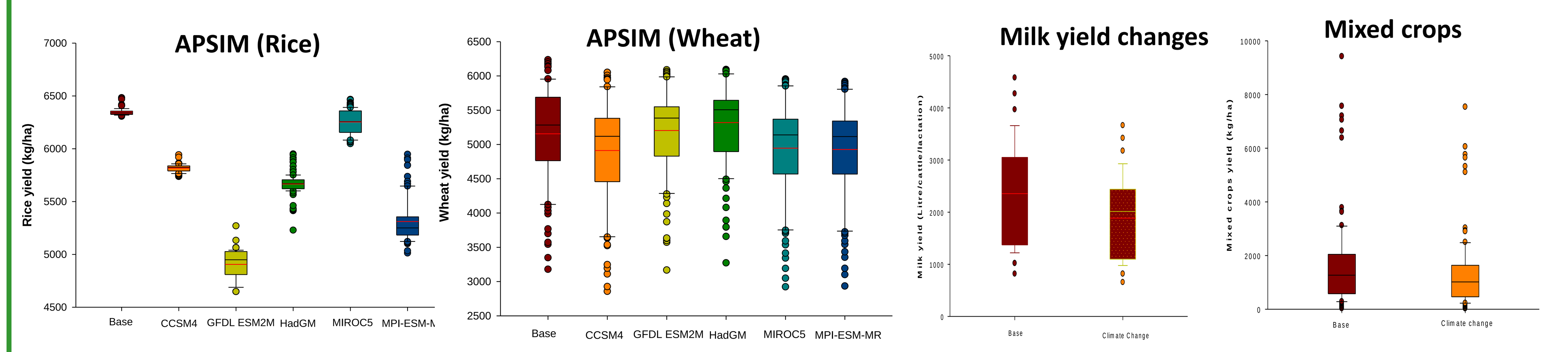
Ground water depletion	Mechanization
Farm size	Inputs price
Labor availability	Inputs subsidy
Family size	MSP
Livestock holding	Technology
Off farm income	

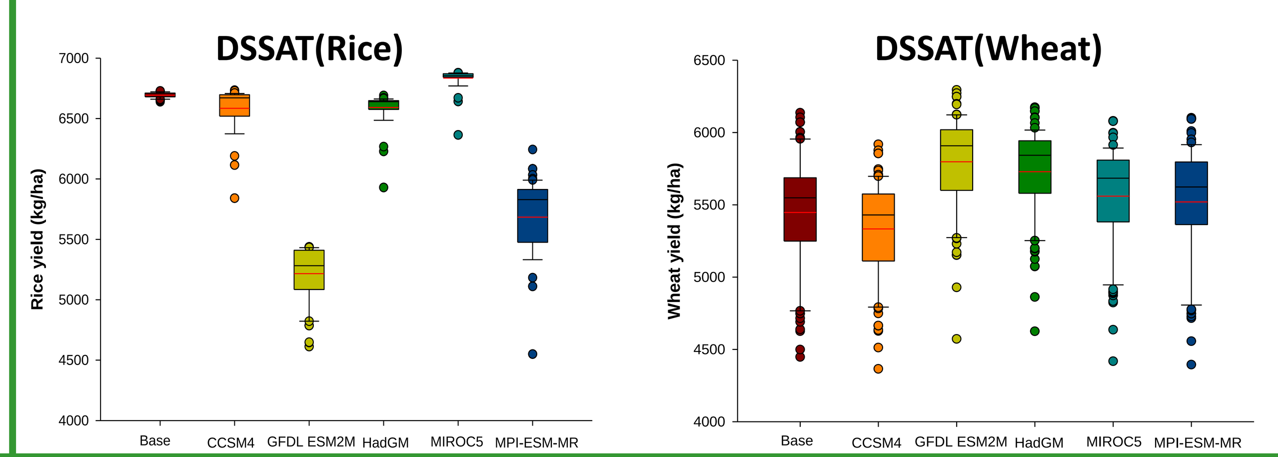
3. Climate analysis



The initial meteorological data for historic period was obtained from Central Soil Salinity Research Institute (CSSRI), Karnal.
Using RCP 8.5, downscaling was done for 5 GCMs as per AgMIP protocols and AgMERRA was used to generate solar radiation for mid period century (2040-69).
All GCMs predicted increase in min and max Temperature with erratic rainfall

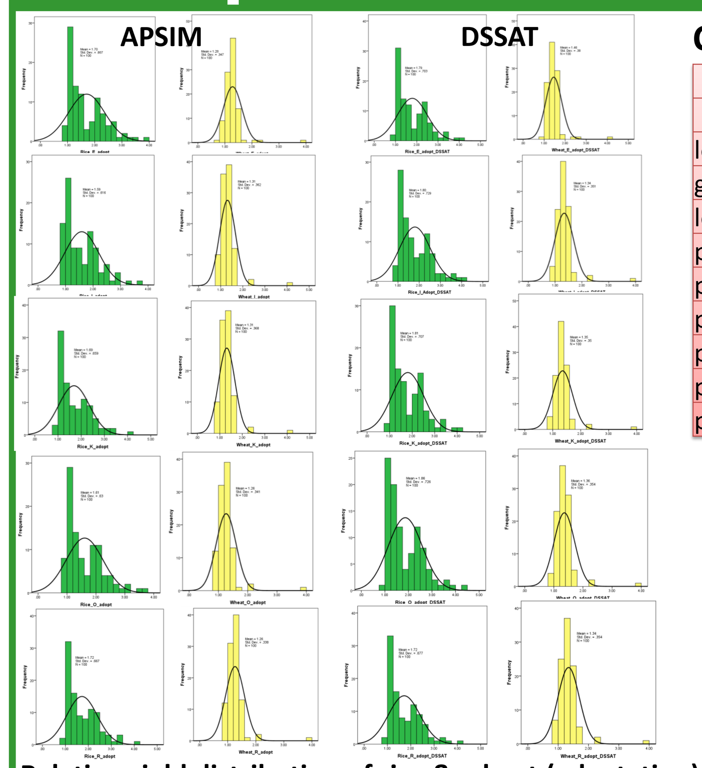
4. Crop modeling



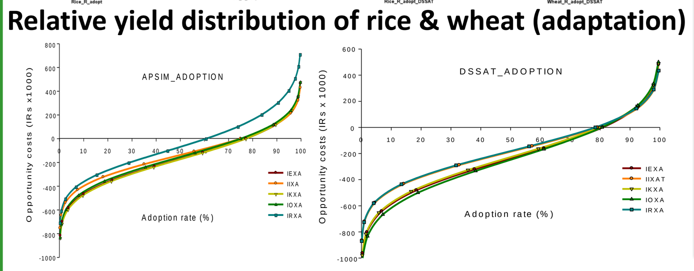


Adaptation packages:
Rice: Short duration high yielding variety
Wheat: 10 days advance seeding
Mixed crops: Drought tolerant variety & increase irrigation freq. (Thornten, 2014)
Livestock: Increase feed supply and better herd management (Blummel et al., 2008)

5. Impacts and adaptation



Relative yield distribution of rice & wheat (adaptation)



Climate Change impacts (TOA-MD results)

	CCSM4		GFDL		HadGEM_2ES		MIROC-5		MPI-ESM	
	APSIM	DSSAT	APSIM	DSSAT	APSIM	DSSAT	APSIM	DSSAT	APSIM	DSSAT
losers (%)	36	32	41	38	34	29	32	29	40	37
gains (% mean Net Returns: NR)	38.8	44.0	33.4	36.0	40.7	47.2	43.4	48.3	34.2	36.8
losses (% mean Net Returns: NR)	-28.25	-29.02	-27.59	-27.7	-28.05	-29.35	-29.0	-29.8	-27.6	-27.6
projected NR without CC (IRS)	124575	126030	123526	123892	124921	126987	125769	127486	123668	124122
projected NR with CC (IRS)	140974	148326	133076	137175	144514	152815	147147	153892	134401	138847
projected PCI without CC (IRS/person)	12759	12705	12790	12781	12749	12672	12717	12650	12786	12774
projected PCI with CC (IRS/person)	14130	14676	13542	13847	14391	15007	14588	15088	13641	13971
projected poverty rate without CC (%)	12.06	12.10	11.94	11.96	12.02	12.15	12.1	12.2	11.9	12.0
projected poverty rate with CC (%)	11.67	11.54	11.46	11.53	11.45	11.41	11.7	11.5	11.5	11.4

Adoption of adaptation packages (TOA-MD results)

Adoption rate (%)	77	81	75	79	77	80	75	81	61	78
projected NR without adaptation (IRS)	141297	149131	133064	137350	144843	153386	147215	154936	134476	138951
projected net returns with adaptation (IRS)	197511	223206	180070	197203	202039	225375	199946	232394	172925	197780
projected per-capita income without adaptation (IRS/person)	14089	14608	13519	13816	14354	14949	14551	15009	13611	13939
projected per-capita income with adaptation (IRS/person)	20184	22471	18663	20258	20569	22699	20251	23351	18809	20286
projected poverty rate without adaptation (%)	11.8	11.7	11.5	11.6	11.5	11.5	11.8	11.6	11.6	11.5
projected poverty rate with adaptation (%)	**5.9**	**5.4**	**6.1**	**5.6**	**5.8**	**5.4**	**6.1**	**5.3**	**6.3**	**5.6**

6. Conclusion

• The outputs from 5 GCMs projected increase in max and min temperature with erratic rainfall.
• DSSAT simulated some gain (1-7%) in wheat productivity for four GCMs, where as, APSIM simulated very small gain (<1%) in one GCM.
• The simulated rice productivity declined in APSIM by 1-23%, whereas, DSSAT simulated gain in yield in one of the GCM by 2%.
• The adaptation packages shift the distribution of relative yields more towards right (>1) and crop productivity could increase by almost 50% for both the models.
• The TOA-MD projected that, over 73% (average) of farming population are likely to adopt the adaption packages.
• At the predicated adoption rate, the per-capita income could improve significantly from IRS 14245 to 20754 (almost 45%) and poverty level could limit to 5-6%.
• Our study focused on adoption of adaptation packages in western IGB.

CIMMYT 1 CSISA 1 ICAR हर कदम, हर डगर किसानों का हमसफर भारतीय कृषि अनुसंधान परिषद Agrisearch with a human touch 2 University of Nebraska Lincoln 3

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