Crop Yield Prediction Strategy using IITM-IMD Extended Range Prediction System

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Introduction

❖The economy and livelihood of people of West Bengal state are vastly dependent on rice cultivation as rice occupied nearly 53% of cropping area as well as crop production. However, the majority of the crop growing area is under rainfed ecosystem, and especially Kharif rice, which is harvested usually in June-July months highly dependent on monsoon rainfall .

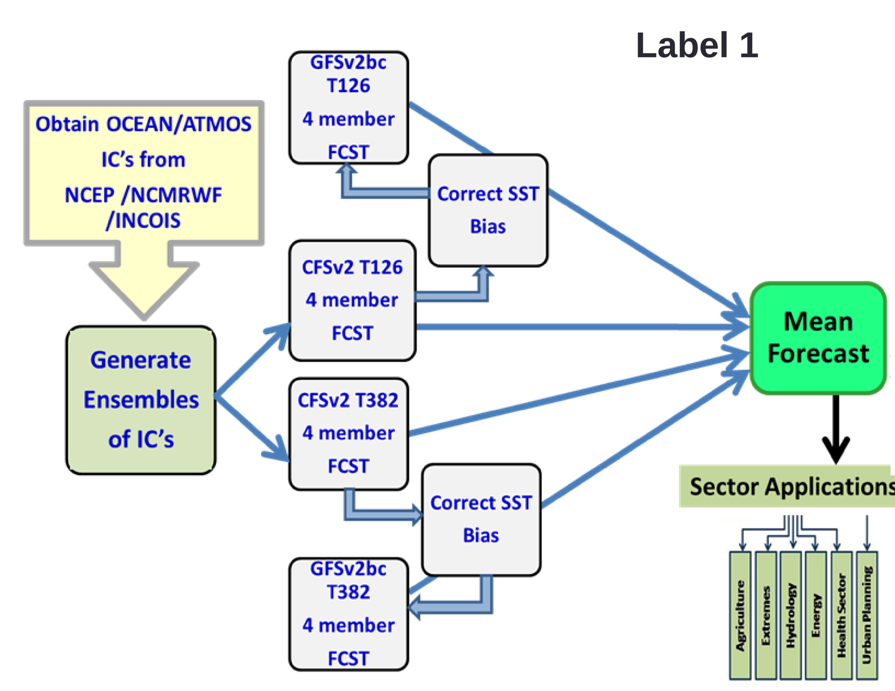
❖To cope with the adverse impact of various extreme weather phenomena on crop production, the development of yield forecasting model is necessary before the actual harvest of the crop. Providing advance information on crop yield may play a crucial role in decision making and reducing damage from undesirable events.

❖Decision Support System for Agrotechnology Transfer (DSSAT) developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) group provides a common platform for various crop weather models.The crop models available under DSSAT include Crop Estimation through Resource and Environment Synthesis (CERES) models for different crops like rice, wheat, maize, sorghum, etc..

Crop Yield prediction using meteorological variables

- ➢Different weather variables (precipitation, incoming solar radiation, maximum, and minimum temperature etc.) play major role in crop models. Hence, crop yield prediction is possible by incorporating weather forecasts into crop models.
- ➢Prediction of crop yield may be made at the beginning of crop growing season or later stages through the incorporation of historical climatology of meteorological data .
- ➢Use of seasonal forecast is another alternative but it provides a quantum of a rainfall for the season as a whole. Monthly as well as weekly variability of seasonal forecast is not prominent, which may in turn affect various stages of the crop.
- ➢Hence, the incorporation of sub-seasonal/extended range forecasts for crop yield estimation may be a useful alternative.

IITM-IMD ERP ensemble prediction system



Multi-model ensemble prediction system comprising 16 ensemble members obtained from Climate Forecast System (CFSv2) and the stand-alone atmospheric component of CFSv2 (i.e., GFSv2).

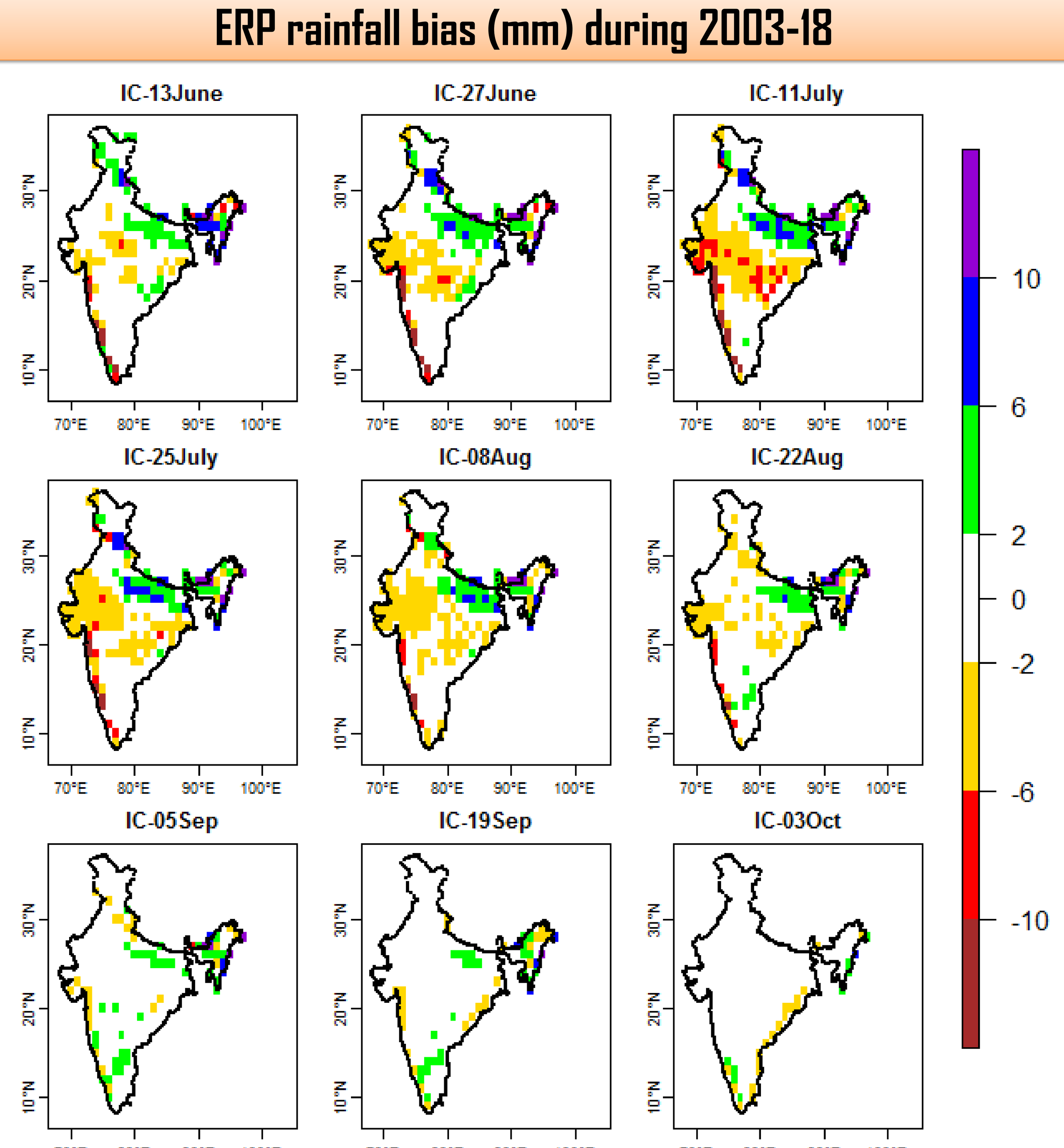
Objectives

- The present study examines the applicability of ERP products through CERES-rice model to predict Kharif rice over Gangetic West Bengal.
- The aim of the present study is to see the sensitivity of crop yield using the state-of-the-art ERP outputs over the climatological forecast.
- This study advocates the use of ERP for better yield prediction which will provide better information to the stakeholders and decision-makers.

Pattern Correlation of Rainfall simulated by ERP

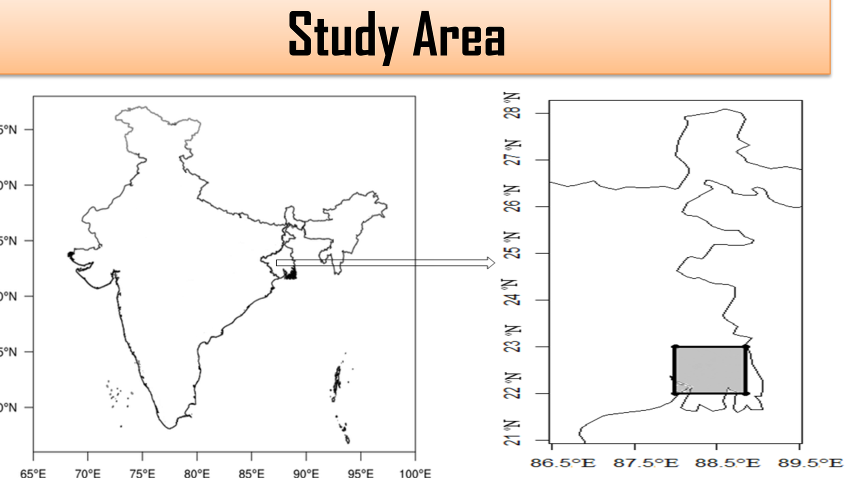
IC	Week1	Week2	Week3	Week4	4 Weeks
June13	0.87	0.91	0.80	0.85	0.75
June27	0.89	0.91	0.80	0.82	0.69
July11	0.87	0.91	0.80	0.78	0.55
July25	0.89	0.87	0.80	0.78	0.60
Aug08	0.79	0.78	0.68	0.56	0.63
Aug22	0.54	0.68	0.81	0.54	0.65
Sep05	0.53	0.74	0.79	0.67	0.72
Sep19	0.57	0.36	0.64	0.37	0.77
Oct03	0.71	0.76	0.47	0.37	0.78

ERP rainfall bias (mm) during 2003-18

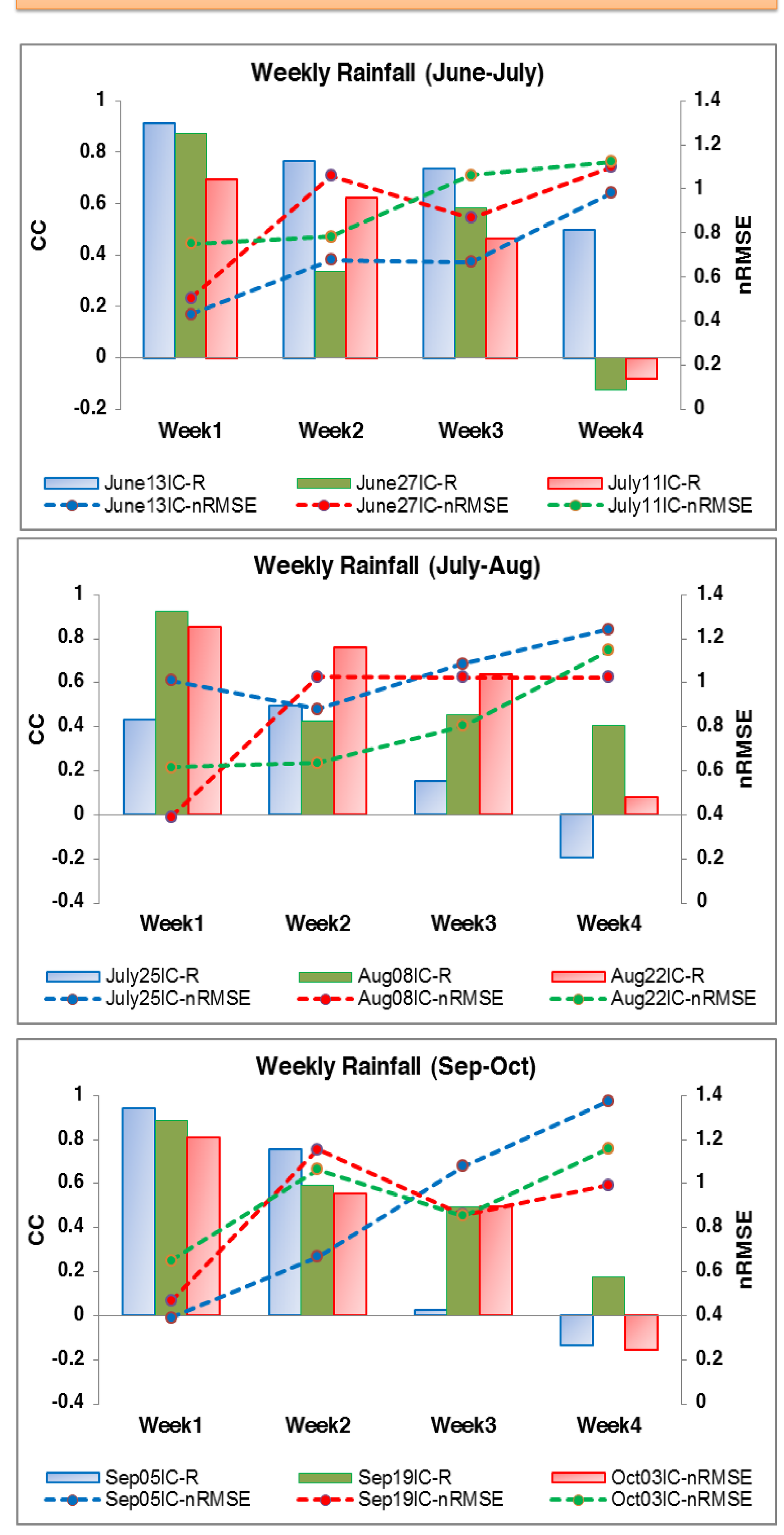


$$\text{Bias}=\sum_{i=1}^{n} ERP_i - Obs_i$$

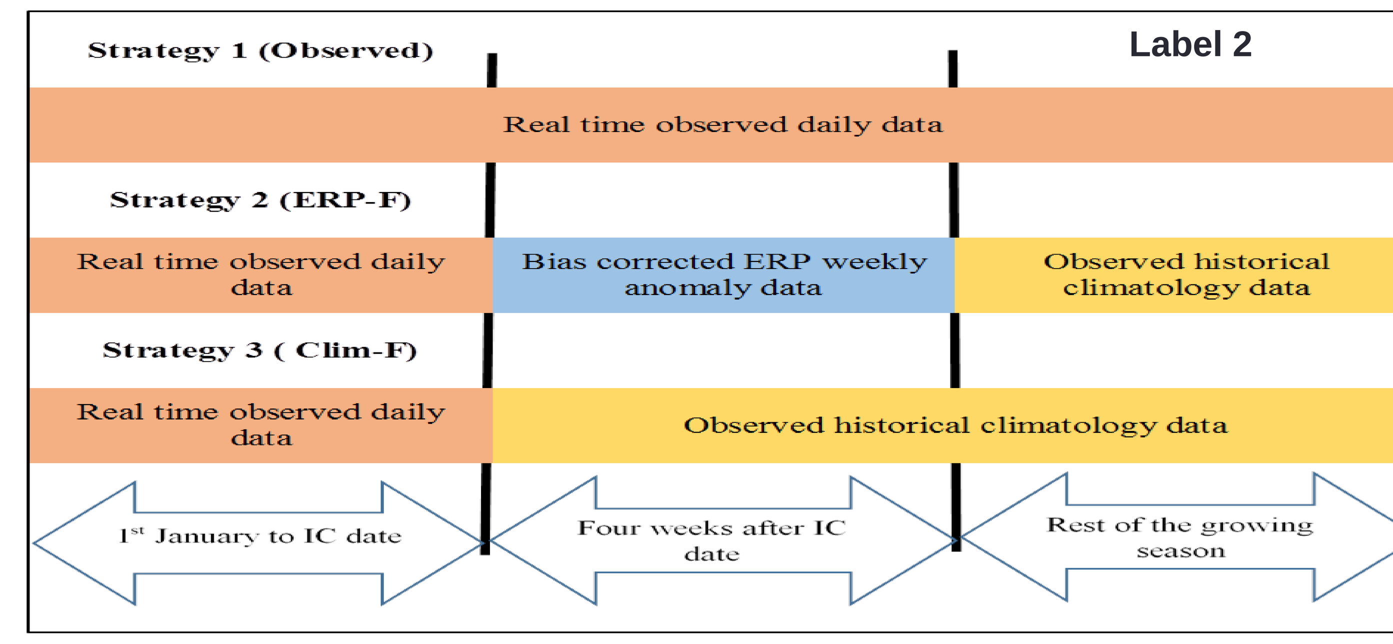
Study Area



Skills of ERP rainfall



Crop Yield Prediction Strategy



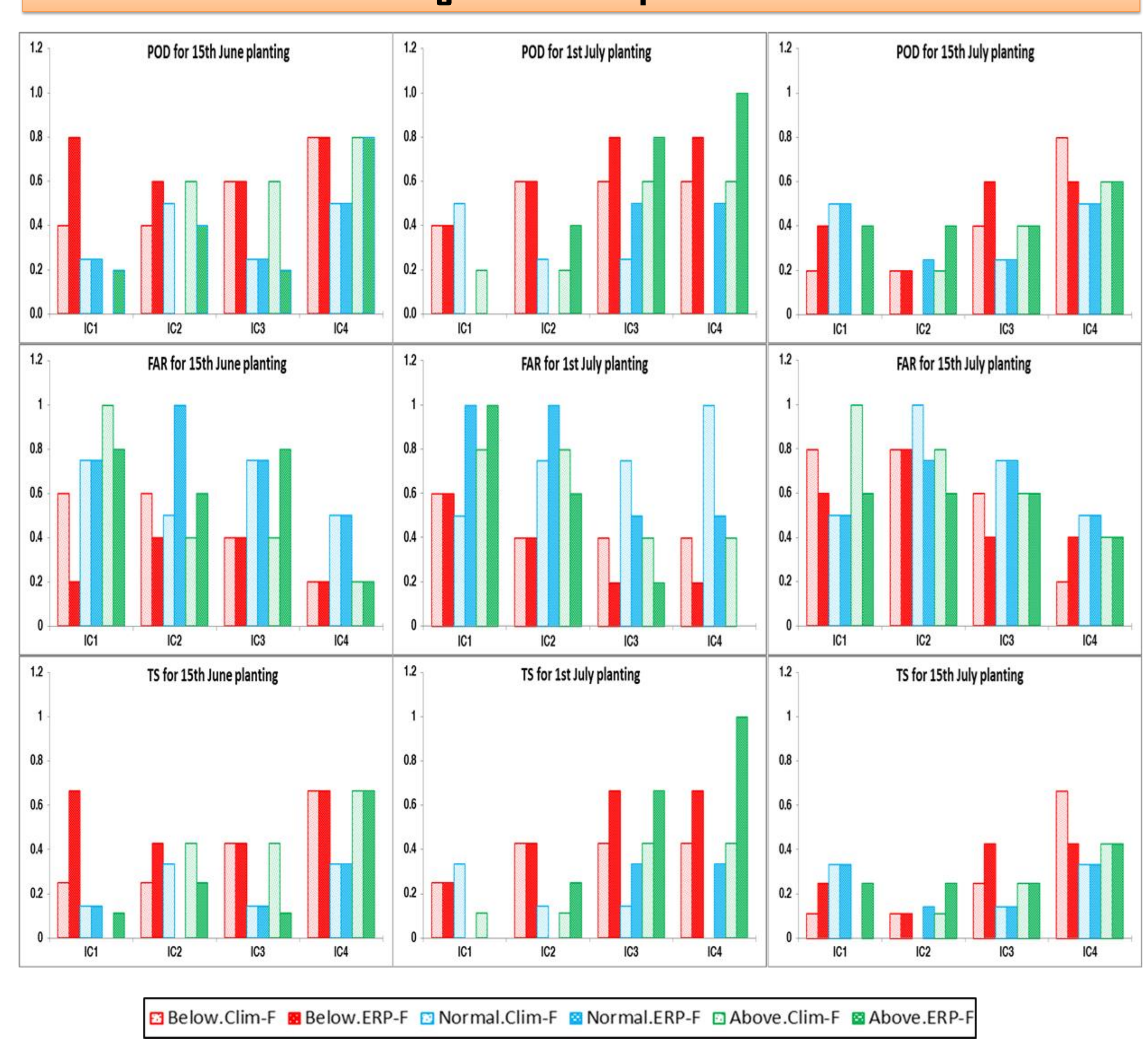
Skills in predicting rice yield during 2003-18

		ERP-F				Clim-F				Obs.
		IC1	IC2	IC3	IC4	IC1	IC2	IC3	IC4	
P1	Avg.	**4526.0**	4563.5	**4366.8**	**4292.6**	4621.8	**4530.9**	4498.8	4300.8	4165.9
	Std.	**458.5**	**472.9**	591.3	**493.4**	23.8	347.7	**538.2**	487.8	503.3
P2	Avg.	4807.8	**4696.6**	**4584.7**	**4526.9**	**4684.9**	4738.8	4659.6	4540.1	4459.4
	Std.	**180.8**	505.9	418.7	**457.8**	132.7	**464.4**	**489.1**	444.8	454.1
P3	Avg.	**4942.9**	**4804.3**	**4820.2**	4689.6	5023.8	4890.0	4875.3	**4681.4**	4610.8
	Std.	**202.6**	363.8	**343.7**	381.0	96.7	**487.8**	341.5	**414.4**	443.3

		ERP-F				Clim-F			
		IC1	IC2	IC3	IC4	IC1	IC2	IC3	IC4
P1	R	**0.03**	0.65	0.53	0.91	**-0.26**	**0.72**	**0.73**	**0.94**
	nRMSE	1.48	1.12	1.11	0.48	1.34	0.99	0.99	0.43
P2	R	**-0.15**	**0.71**	**0.82**	**0.95**	-0.33	0.70	0.74	0.88
	nRMSE	1.34	**0.95**	**0.63**	**0.33**	1.21	2.73	0.86	0.50
P3	R	**-0.04**	**0.24**	**0.70**	**0.95**	-0.63	0.11	0.41	0.91
	nRMSE	**1.31**	**1.18**	**0.84**	**0.37**	1.45	1.50	1.12	0.43

* Bold indicates better skills

Categorical Yield prediction



Summary and Conclusions

- ❑ Overall, ERP-F (refer to label 1 and 2) has been able to reproduce observed mean and variability of rice yield better than clim-F. The changes in statistics of yield with planting date have been better depicted by ERP-F.
- ❑ ERP-F has captured the inter-annual variability of rice yield better than clim-F for 1st July and 15th July planting dates, as evidenced by higher correlation and lower nRMSE values. However, the performances have been poor for both forecasts in the case of IC1. Skills of ERP-F have gradually improved from IC2 to IC4.
- ❑ ERP-F has shown superior skill in identifying categorical events, especially for below and above normal yields better than clim-F.
- ❑ However, the skill of ERP-F in capturing normal yield has not been satisfactory. Nevertheless, from the stakeholders' point of view, anomalous events (below or above) are more critical than normal events. Hence, ERP-F has certainly added value over clim-F.

Acknowledgements

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