# Assessment of uncertainty cascaded through climate and crop model simulations for rice crop over Thanjavur region of South India

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## 1. Introduction / Overview

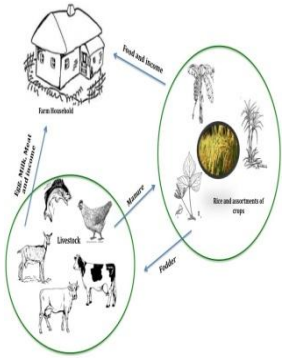
A study is undertaken to assess the uncertainty cascaded through climate and crop model simulations for rice crop over Thanjavur region (Fig.1) of South India, under AgMIP protocols. Uncertainty in climate models are studied through 20 GCMs that used delta approach to produce weather variables. To study the impact of projected climate on crop yields, outputs from 5 climate models viz., CCSM4, GFDL-ESM2M, HadGEM2-ES, MIROC5 and MPI-ESM-MR were utilized in crop simulation through DSSAT and APSIM model. Result derived from integrated assessment of rice in Tamil Nadu is presented here.

Fig.1. Study area

## 2. Rice based Farming Systems in Thanjavur

- The major crops cultivated in Thanjavur district are Paddy, Pulses, Gingelly, Groundnut and Sugarcane. Paddy is the principal crop grown majorly in NEM season. Pulses like Blackgram, Greengram and cash crops like Cotton and Gingelly are grown in rice fallows.
- Livestock such as goat, cow and poultry plays a significant role as an alternative livelihood option, regular employment and income generation activity.
- Farm household, agriculture and livestock components are complimentary and depend on each other on day-to-day basis (Fig.2).

*Fig. 2. Rice based Farming System*




## 3. Uncertainty in Climate Projections

**Fig.3 Northeast Monsoon rainfall projected by twenty models**

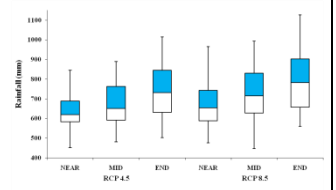



**Fig.4 T Max during NEM projected by twenty models**

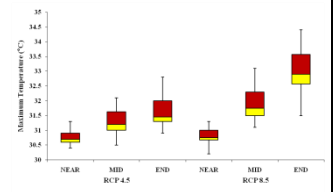
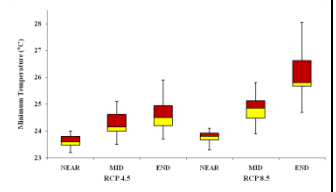


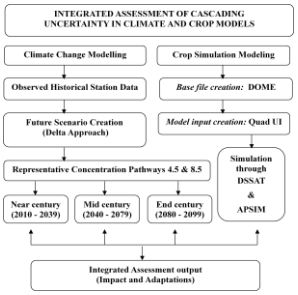

**Fig.5 T Min during NEM projected by twenty models**




- In Thanjavur, future rainfall is projected to vary between -15.3 to 31.0 per cent, -20.4 to 36.1 per cent and -3.4 to 80.7 per cent during near, mid and end century respectively.
- Irrespective of the models and scenarios, the possible increase in the maximum temperature is found to be 0.3 to 1.5 $^{o}$C, 0.6 to 2.0 $^{o}$C and 0.8 to 4.6 $^{o}$C during near, mid and end century for Thanjavur (Fig.3)
- The possible increase in minimum temperature might be from 0.2 to 1.2 $^{o}$C, 0.2 to 2.1$^{o}$C and 0.7 to 5.2 $^{o}$C during near, mid and end century (Fig.4).
- Southwest Monsoon (SWM) exhibits higher range of increase in both maximum and minimum temperature than Northeast monsoon (NEM) in all the future timescales (Fig.5).
- On comparing the maximum and minimum temperature, the rate of increase in minimum temperature is higher than the maximum temperature

## 4. Integrated assessment through crop models

**Integrated assessment of uncertainty cascade**

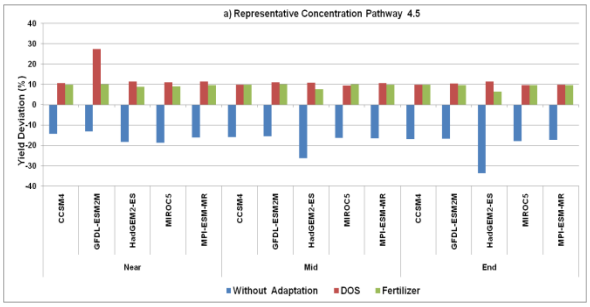



The effect of climate model uncertainty cascaded through crop model uncertainty affects the yield of rice crop simulated. Scenario and model wise yield has been depicted in Figure 6 (a and b) and Figure 7(a and b). Analysis was performed irrespective of scenario and model to know the possible range of future changes with certainty.

- The future yield of rice with current cultivation practices was impacted by the climate change. A consistent decrease in yields ranging from -3.4 to -39.2 per cent was projected
- Altered sowing window showed a positive response in yield with an increase ranging from 1.8 to 55.6 per cent.
- Fertilizer adaptation also had a positive response with increase in yield ranged from 2.0 to 15.5 per cent,
- Both the adaptation strategies consistently increased the yield. On comparing adaptation strategies sowing window alteration had better response than supplemental fertilizer application.

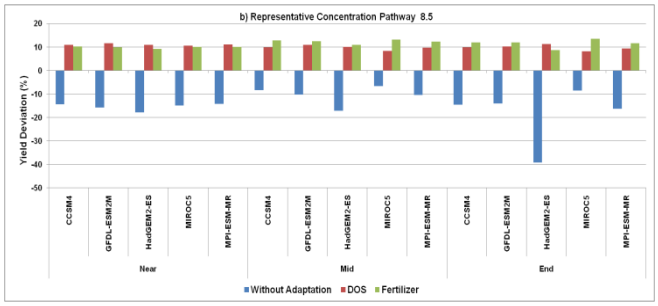
## RCP 4.5 through DSSAT

Fig.6a Rice yield variations simulated for RCP 4.5 through DSSAT



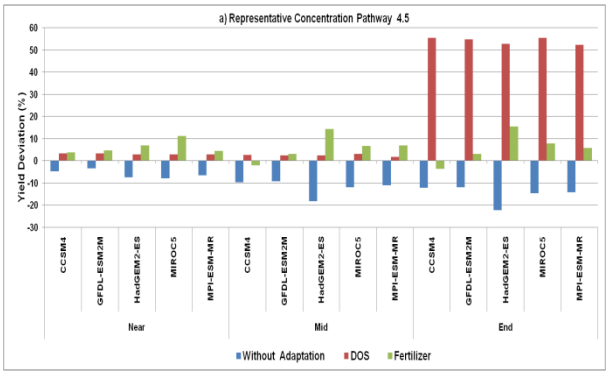

## RCP 8.5 through DSSAT

Fig.6b Rice yield variations simulated for RCP 8.5 through DSSAT



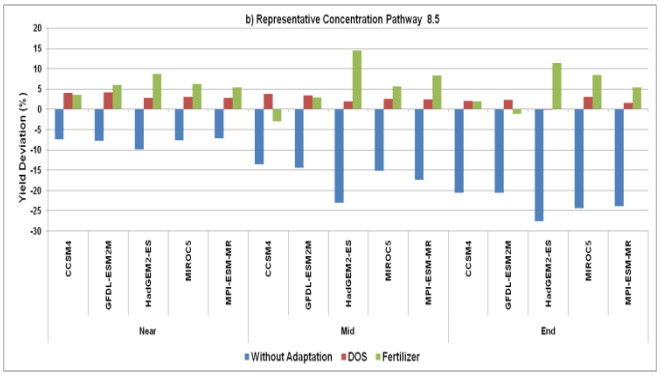
## RCP 4.5 through APSIM

Fig.7a Rice yield variations simulated for RCP 4.5 through APSIM




## RCP 8.5 through APSIM

Fig.7b Rice yield variations simulated for RCP 4.5 through DSSAT




## CONCLUSION

From the study, it could be concluded that the mean change scenarios obtained through delta approach can successfully be employed in integrated assessments. Multi-model assessment can bring certainty to these uncertain projections by giving a range of expected conditions. Among the climatic parameters, maximum and minimum temperatures are projected to continuously increase over time. Rainfall is also projected to increase, but with different magnitude in the Northeast and southwest monsoon seasons. Higher rainfall increase is expected in future during NEM compared to SWM in Thanjavur. The yield of rice crop is negatively impacted by future climate under current cultivation practices. Crop specific adaptation practices such as altering the sowing window and supplemental fertilizer application can be successfully employed to minimize the impacts of climate change.

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