# POTENTIAL RICE PRODUCTION IN THE MUDA IRRIGATION SCHEME

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## Introduction

In a crop production system, where water and nutrients are adequately provided and pests, disease and weeds are controlled, yield is dependent on climatic factors like temperature, $CO_2$ concentration in the atmosphere and radiation as well as the crop's genetic characteristics. Irrigated rice systems like the Muda Irrigation Scheme do however experience frequent water shortages and even drought, resulting in significant yield losses from time to time. Global warming with the associated increase in $CO_2$ level is expected to further aggravate water shortage beside having a direct impact on the potential crop yield Crop growth simulation models can be used to quantify the potential yields possible under different environmental conditions including the effects of drought. The objectives of the study were to investigate by means of a rice crop growth simulation model: (a) The optimum sowing time; (b) the impact of future climate change scenario on the rice yield, net water use and crop duration; and (c) the drought effects on irrigated rice yield in the Muda Irrigation Scheme.

## Materials and Methods

The crop growth simulation model, ORYZA_W (Wopereis et al. 1996) was used in conjunction with 18 years (1978 to 1995) of daily weather data, rice variety MR84 crop data and measured soil physical properties were used to simulate rice growth on the Chengai soil series of the Muda Irrigation Scheme. To determine the optimum sowing time, sowing dates of 56, 63, 70, 77, 84, 91 and 98 day of the year (DOY) for the off season and 196, 203, 210, 217, 224, 231 and 238 DOY for the main season were chosen; these represent a seven-week spread about the recommended sowing date for each season. In total, 15 climate change scenarios were evaluated to determine the impact of the future climatic scenarios on rice production and water requirements. Drought periods of three weeks were induced at a) mid-tillering (6 weeks after sowing – WAS); b) panicle initiation (12 WAS); and c) flowering (18 WAS) stages to determine the effect on the rice yield.

## Results and Discussion

The simulation results show higher mean potential yields for the different sowing dates during the off season which were associated with more radiation, more dry matter and longer crop duration. Conversely, the lower potential yields observed for the main season were attributed to less radiation, less dry matter and shorter crop duration. Yields higher than 10.0 t $ha^{-1}$ at a high probability (80%) were possible in the off season for a wide range of sowing dates i.e. 56-98 DOYS. In the main season, the yields greater than 9.0 t $ha^{-1}$ can be achieved from the sowing dates of 196-238 DOYS with the same probability (80%). There is variability among the predicted rice yields, net water use, crop duration and above ground dry matter production as predicted by the different climate change scenarios. An increase in temperature was found generally to reduce rice yields, and an increase in $CO_2$ level to increase rice yields. The combinations of elevated $CO_2$ levels and temperatures also predicted an increase in rice yields in both seasons where the doubling of the $CO_2$ level was able to offset the detrimental effects of a $4^0C$ rise in temperature. Net water use (NWU) was influenced more by the increments of temperature than the $CO_2$ levels in the both seasons, in particular, increasing by 22% with an increase of $4^0C$ temperature in the off season. Three General Circulation Models (GCM) (Bachelet et al. 1993) predicted rice yield reductions and increased water use by the crop under the future climates. Among these models, the GISS (Goddard Institute for Specific Studies) model predicted the highest yield reduction (22%) and the highest NWU (21%). For the drought effect, yield differences between crops that were temporarily stressed either at mid-tillering or at panicle initiation stage and non-stressed crops were small. However, maturity was significantly delayed. The temporary drought at the flowering stage resulted in large yield reductions and maturity was delayed for two days.

## Conclusions

The off season rice cropping can be delayed with respect to the current sowing date but earlier sowing would be better in the main season. Strategies to overcome the adverse effects of climate change on rice production should include avoidance of any drought stress at panicle initiation stage onwards until grain-filling period.

## References

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