Modelling the integration of long fallows into cropping systems for adaptation to climate change in the Mediterranean environment of Western Australia

C. Chen [a], **N. Ota** [b], **B. Wang** [c] **and A. Fletcher** [a]

[a] *CSIRO Agriculture and Food, Wembley, Western Australia*
[b] *CSIRO Health & Biosecurity, Wembley, Western Australia*
[c] *NSW Government Department of Primary Industries, Wagga Wagga Agricultural Institute, Australia*
Email: chao.chen@csiro.au

Abstract: Climate change characterized by warmer temperatures, alterations in rainfall patterns and increased extreme weather events has occurred globally and all these changes are likely to continue into the future. Continuous changes in climate could challenge the cropping suitability of crop species and reduce crop productivity and yield stability. The dryland cropping region of Western Australia characterized by a Mediterranean-type climate (cool, wet winters and hot, dry summers with large year-to-year variability of precipitation) is projected to become warmer and drier. Currently a continuous cropping rotation dominated by wheat is typical in this region, which would be further challenged in terms of productivity, profitability, stability, and viability. Appropriate selection of crop sequences will be of importance to cope with climate change. Long fallow, a practice of leaving a paddock out of production for an entire growing season, was once used to accumulate soil water and mineral nitrogen for subsequent crop in crop sequencing and deal with problems of weeds and diseases reduce incidence of weeds and diseases. It may have an adaption potential under future climate in regions of low and unreliable rainfall such as Western Australia.

In this study, a widely used crop model (APSIM), linked with 26 General Circulation Models (GCMs) with one Shared Socioeconomic Pathway (SSP585) and economic analysis, was used to explore: 1) how the climate change would affect dryland wheat cropping in the wheatbelt of Western Australia; 2) whether/how long fallow could be integrated into wheat cropping system in this region. The potential adaptation of long fallow into wheat-based cropping system was assessed by comparing four fixed rotations (fallow-wheat, fallow-wheat-wheat, fallow-wheat-wheat-wheat, and fallow-wheat-wheat-wheat-wheat) and four flexible sowing rule-based rotations (the land was fallowed if sowing criteria was not met) with continuous wheat.

The simulation results show that future climate change would have negative impacts on both yield and economic return of continuous wheat cropping in Western Australia. Wheat after fallow out-yielded and out-profited wheat after wheat under future climate. But integrating fallow into wheat cropping system with the above fixed rotations patterns would lead to yield and economic loss. By contrast, cropping system in which fallowing took place when sowing condition could not be met at a certain time would achieve comparable yield and economic return to continuous wheat. We highlight strategic integration of long fallow into cropping system in a dryland Mediterranean-type environment would have a great potential to cope with future climate change. These findings can be extended into other Mediterranean crop regions in Australia and beyond.

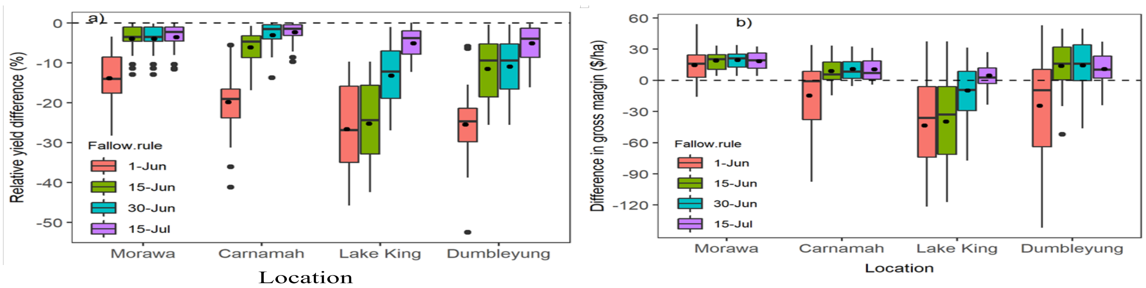

Figure 1. Difference of yield (a) and economic (b) between wheat cropping system with strategic fallow (1-Jun, 15-Jun, 30-Ju, and 15-Jul indicate that the field would be fallowed when sowing rule was not met by 1-Jun, 15-Jun, 30-Ju, and 15-Jul, respectively) and without fallow (continuous wheat)

Keywords: *Long fallow; cropping system; APSIM; climate change*