CAPABILITY OF APSIM-ORYZA TO SIMULATE LOWLAND RICE-BASED FARMING SYSTEMS UNDER NITROGEN TREATMENTS IN A TROPICAL CLIMATE

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INTRODUCTION

Rice is the most important crop in Asia and the staple food for most of the world's population. Due to the overwhelming importance of this crop, modelling rice-based farming systems will provide valuable help to compare experimental research findings across regions, extrapolate field experimental data to wider environments, develop management recommendations and decision-support systems, explore effects of climate change and adaptation options, and prediction of crop yield. There is an increasing demand for the capability to simulate rice-based cropping systems, especially in Asia. Such a system capability will allow expanded investigation of nitrogen dynamics, crop sequencing, intercropping, crop residue management and soil and water management. Incorporation of the ORYZA2000 rice model (Bouman and van Laar, 2006) into APSIM (Agricultural Production Systems Simulator (APSIM-Oryza) together with recent work on carbon and nitrogen dynamics in transitional flooded/non-flooded systems (Gaydon et al., 2009) has facilitated long-term simulation of lowland rice-based farming systems scenarios. However, the capability of APSIM-Oryza to simulate rice-based crop sequences involving other crops has undergone limited testing to this point and under a variety of crop management practices and cropping systems. In this paper, we detail testing of the APSIM-Oryza simulation model against an experimental dataset involving lowland rice-rice-soybean crop rotation in West Nusa Tenggara Province (NTB) Indonesia.

DESCRIPTION OF MODEL

The APSIM farming systems simulation framework is described in detail by Keating et al. (2003), and the key processes of ORYZA2000 have been well documented (Bouman and van Laar, 2006). Simulation of the transitional (flooded-non-flooded) soil environment and pond processes within the APSIM framework has also been recently described (Gaydon et al., 2009).

RESULTS AND DISCUSSION

The performance of APSIM-ORYZA with and without nitrogen limitation was evaluated using rice-rice-soybean crop sequence data from a field experiment conducted at the Assessment Institute for Agricultural Technology (BPTP) NTB Indonesia in 2007-2008. Three rates of N fertiliser were applied to rice; 0 kg N ha^{-1} (F0), 70 kg N ha^{-1} (F1) and 140 kg N ha^{-1} (F2) and three rates for soybean; 0 kg N ha^{-1}(S0), 12 kg N ha^{-1} (S1) and 24 kg N ha^{-1} (S2). In general, the model satisfactorily simulated the dynamics of crop variables measured (phenological stages, yield and biomass), soil and water variables (ponded water depth, pH, temperature and daily infiltration rate). Simulated biomass matched the pattern of rice growth when nitrogen was not limiting factor (F2), with slight over-prediction under both F1 and F0 treatments for both the first (wet) and second (dry) rice seasons (Fig. 1). A similar pattern was also found with the grain yield of rice (Table 1). The simulated yield of rice has achieved closer agreement with the measured data as N-fertiliser application increased. This is probably due to inadequate simulation of nitrogen immobilisation during residue decomposition following the first rice crop. Simulated biomass of soybean correlated well with the measured data better than rice for both nitrogen limited treatments (S0 and S1) and non-nitrogen limited treatments (S2). The model satisfactorily simulated the dynamics and magnitude of ponded water during rice growth (Fig. 2).

This validation exercise highlighted some areas where improvements might be possible; however we conclude that APSIM-ORYZA would perform sufficiently well to extrapolate our experimental results to different management practices within the study area for longer-term simulation of rice-based farming systems.

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REFERENCES

Bouman, B.A.M. and H.H. van Laar. 2006. Description and evaluation of the rice growth model ORYZA2000 under nitrogen-limited conditions. Agric. Syst. 87:249–273.

Gaydon, D.S., R.J. Buresh, M.E. Probert, and H. Meinke. 2009. Simulating rice in farming systems – modelling transitions between aerobic and ponded soil environments in APSIM. Proceedings of 18th World IMACS/MODSIM Congress. Cairns, Australia. 13-17 July 2009.

Keating, B.A., P.S. Carberry, G.L. Hammer, M.E. Probert, M.J. Robertson, D. Holzworth, N.L. Huth, J.N.G. Hargreaves, H. Meinke, Z. Hochman, G. McLean, K. Verburg, V. Snow, J.P. M. Dimes, Silburn, E. Wang, S. Brown, K.L. Bristow, S. Asseng, S. Chapman, R.L. McCown, D.M. Freebairn, and C.J. Smith. 2003. An overview of APSIM, a model designed for farming system simulation. Euro. J. of Agron. 18:267-288.

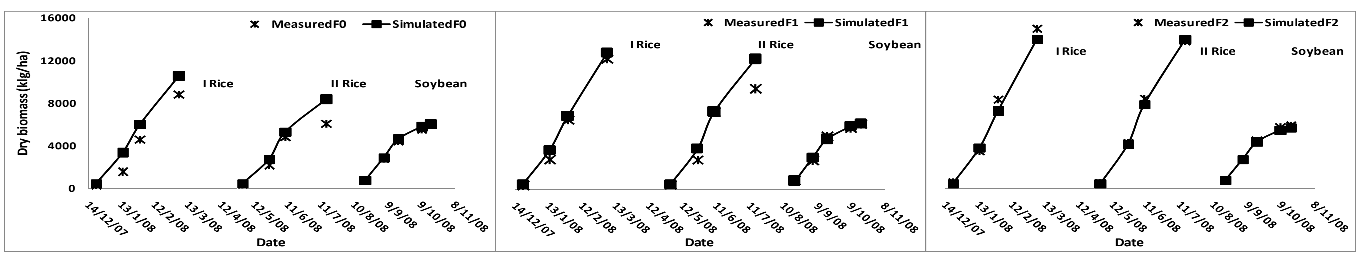

Figure 1. Temporal variation in rice and soybean dry biomass within a one year crop sequence.

Table 1. Measured (m) and simulated (s) yield of rice I and II and soybean within a crop sequence.

Treatment	I Rice (23 Nov 07 - 05 Mar 08)			II Rice (02 Apr - 16 Jul 08)			Soybean (19 Jul - 18 Oct 08)		
	measured	simulated	% (m-s)	measured	simulated	% (m-s)	measured	Simulated	% (m-s)
F0	4025	4968	-23	3683	3448	6	2233	2140	4
F1	6267	6470	-3	5175	5510	-6	2361	2192	7
F2	7842	7368	6	6208	6715	-8	2211	2043	8

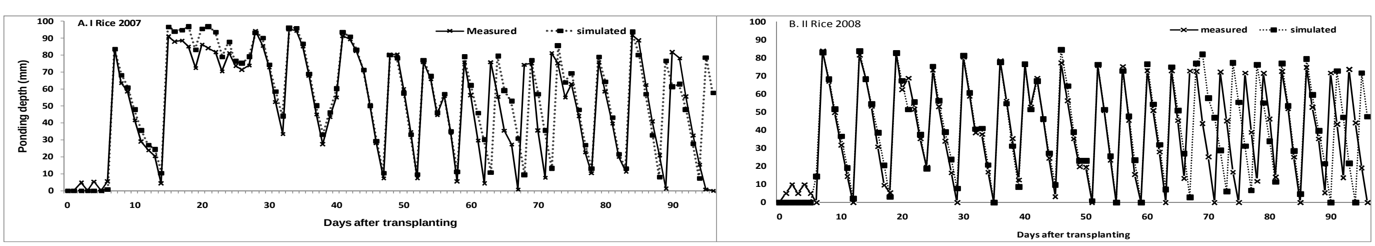

Figure 2. Measured and simluated ponding depth in rice I and II crops during the cropping seasons.