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Editorial

Systems research helping to meet the needs and managing the trade-offs of a changing world

Facing the challenges of an increasing world population, a changing climate and ever depleting resources, agricultural intensification (Keating *et al*. 2010) is one of the few options for meeting the demand of food security. It is necessary to apply a dynamic and systematic approach to effectively manage the complex agri-eco production and green processing systems. Indeed, farming systems approach for appropriate technology development and simulation modeling is a result of adopting the system thinking by the agricultural research community (Norman *et al*. 1995).

In the middle 1960s, Green Revolution was an exemplified success in Asia and Latin America, where major contribution in the increase of world food supply was made. However, the success of Green Revolution had some conditions (Norman *et al*. 1995): firstly, favorite climate (i.e., adequate rainfall or irrigation availability) and soil conditions; secondly, uniform and suitable farming environment; thirdly, newly bred high yielding cultivars of wheat, rice and maize, which responded well to intensive farming practices; and lastly, commodity market and trade infrastructure were advanced. While regions in Asia and Latin America (the so called green revolution areas) possessed the above conditions, but African and the rest areas of Latin America (the non-green revolution area) did not have the conditions in place. Attempts to extend the green revolution experience to other non-green revolution areas ended with unsuccessful and failure stories.

The negative experience has promoted the newer thinking approach of farming systems in non-green revolution areas, which requires a closer collaboration of researchers with various relevant constituencies and would follow the general procedure of problem/potential diagnosis, design of solutions, test of potential solutions and extension (Norman *et al*. 1995; Norman 2015). This approach could involve multiple disciplinary scientists of social, ecological and agricultural fields. The International Centre for development oriented Research in Agriculture (ICRA) used tools in diagnosis and formed a comprehensive training programme on Agricultural Research for Development (ARD) (Hawkins 2000).

Advances in systems simulation methodology, along with progresses in computing capabilities, information technologies as well as improved data quality and availability have made system simulation a powerful tool for strategy design, process management, ex ante or/and ex post analysis, and scenario/sensitivity analysis. Simulation assisted farming system design has been widely applied in agricultural research and farming practice (APSIM for example) (Holzworth *et al*. 2014; Connor *et al*. 2015). Seeing its great potential and future demand, world farming systems design (FSD) community organized the first International Farming System Design Symposium, which was held in Catania of Italy in 2007 to communicate in 'methodologies for integrated analysis of farm production systems' (http://www.iemss.org/farmsys07/), and was recognized as the 'core' of farming design. The 2nd symposium was held in Monterey of USA in 2009 (http://www.iemss.org/farmsys09/) and the 3rd in Brisbane of Australia in 2011 (http://aciar.gov.au/WCCApaper). The 4th symposium was held in Lanzhou of China in 2013 (http://www.fsd2013.com/) and the key presentations in the conference formed the core papers of this special issue.

The main difference between the 4th symposium and the earlier ones is that some 'outreach' methods (cropping systems research) were emphasized. The purpose was to provide an opportunity for those who were interested in FSD but were not yet interacting with the 'core' and the 'outreach' programs of FSD. The forthcoming programme

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of the 5th symposium to be held in Montpellier of France in September of 2015 (http://fsd5.european-agronomy.org/) also reflects this idea.

Papers in this special collection were collected from some of the presentations in the 4th FSD symposium. Topics of these papers, which include comprehensive and in-depth analysis on the application of system simulation modeling in 'identification of objectives, design and implementation of experimental programs, effectiveness of participatory research with smallholder farmers, implementation of system change and scaling-out of results' in ARD programs (Connor *et al*. 2015), review of the evolution of farming systems research (FSR) and concerns on application of 'formal modeling/ simulation techniques' in low income countries (Norman 2015), strategies for improving crop WUE in dryland farming and importance of soil surface cover (Stewart *et al*. 2015), new method for monitoring land use transition (Xiao *et al*. 2015), simple modeling approach for assessing the economic contribution of forage and livestock improvement options to smallholder farming enterprises (MacLeod *et al*. 2015), ecological impacts and economic performance of conservation agriculture (Chen 2015; Sapkota *et al*. 2015), examples of sustainable intensification management of intercropping systems that tolerant to extreme climate conditions (Mao *et al*. 2015), ecological impact of nitrogen fertilizer in an intensive crop production system (Wang *et al*. 2015), a comparison between organic and inorganic soybean production systems in energy efficiency and econonic return (Zhang *et al*. 2015), and usage of maize stalk as runinant animal fodder (Liang *et al*. 2015), reflect the characteristics of the 4th FSD symposium, which could be another reason of making this collection special.

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