ACIAR POLICY BRIEF
Research findings with policy implications

Benefits to Australian farmers from the ACIAR funded program Sustainable Intensification of Maize—Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) Program

KEY MESSAGES:

SIMLESA benefits to Australian rural industries not otherwise available include:

- New capacity, skills and research infrastructure
- New systems analysis tools and data sets
- New genetics and more sustainable practices
- New public private partnerships and funding

SIMLESA’s benefits to Australian rural industries derive from investments in research capacity, capabilities and facilities, resulting in the creation of new empirical and theoretical knowledge that is helping Australian and African farming systems, along with spill overs on Australian private businesses and institutions.
BACKGROUND

The sustainable intensification of dryland agricultural systems in high- and low-income countries faces different, though equally challenging, and complex problems requiring new science and the application of more integrative and trans-disciplinary approaches (Rodriguez and Sadras, 2011). On one hand, the limited availability of resources (e.g., land, finance, labour) and the lack of access to inputs, product markets and infrastructure constrain the opportunities and incentives smallholder farmers have to change and improve dryland agricultural systems. On the other hand, in Australia, our best farmers are reaching the point where further increases in yield become uneconomical, too risky (Sadras and Rodriguez, 2010) or inconsistent with environmental outcomes (http://www.agriculture.gov.au/water/quality). This is taking place in a world where the number of hungry people reached record levels in 2009. Despite a slight recovery in 2010, malnutrition among the world’s poorest remains higher than that when the 1996 World Food Summit agreed to a hunger-reduction target. The medium-term outlook indicates that agricultural output in the coming decade will not match that of the previous decade, i.e. annual growth will fall from 2% in 1999–2008 to 1.7% in 2009–2018 (OECD-FAO, 2009) while the expected increase in the world population is 40% by 2050 and climate changes will become increasingly more evident and serious (Parry et al., 2005). The challenge is then to increase food production by 70%, or nearly 100% in low-income countries, by 2050 to cope with the expected increases in population and food demand. Though different pathways are likely to contribute differently to meeting these targets in Africa and Australia. Understanding and actioning upon differences and similarities have the potential to generate learnings and benefits across both continents. Below we present a brief account of SIMLESA’s benefits to Australia’s rural industries, summarised in terms of benefits from: New capacity, skills and research infrastructure; New systems analysis tools and data sets; New genetics and more sustainable practices; and New public private partnerships and sources of funding.
ACIAR’s R4D investments benefit Australian Universities and build research capacity: Australia is presently in fourth place in the top ten destination countries with a 6% share of the number of global students. From the early 1990s, the Australian international student sector has grown exponentially. Particularly with the drop in the value of the Australian dollar and changes to visa requirements the industry resumed growth in the 2013–14. Australia’s income from international students peaked at $16.2bn in 2009, and reached ca. $19.7bn in 2016. Other benefits to the Australian University sector include that international student fees contribute up to 16% of the total operating revenue (over $25b); many international students are professionals who are able to work part-time in Australia; their purchase power aids the Australian economy—shopping, housing, children’s education, etc.; international students provide cultural enrichment while in Australia, and are strong ambassadors of Australia when they return to their country.

New systems analysis tools and data sets

- New capacity and capabilities in the management and analysis of big data and modelling: ACIAR has an extensive track record in supporting the development of capabilities and skills and the development of emerging technologies. A typical example has been the development of numerous modules of the Agricultural Production Systems Simulator (APSIM, www.apsim.info). Though previous work was limited to the development of single crop applications, particularly maize and pulses simulation models, the SIMLESA program further invested in APSIM to develop capacity to dynamically simulate single and multiple farms, and the farmer (Rodriguez et al., 2014; 2017; 2011). The new APSFarm-LivSim model is the only available model to provide researchers the capacity to more holistically simulate benefits and trade-offs from alternative practices, cropping systems and farm systems between production, economic, risk and environmental sustainability objectives across networks of farms, and communities. An important feature of APSFarm-LivSim is its capacity to be linked to baseline surveys, so that each individual farm in the survey can be simulated. Benefits to Australia from the development of APSFarm are found in the application of the model to Australian cropping and mixed cropping and grazing farm businesses, in participatory modelling exercises run across numerous QAAFI lead projects, and new spin off projects in collaboration with Qld DAF, Qld DSITI, the DNA-CRC program, and the private sector (Radicle Seeds and Southern Cross Exports).

Description of the new APSFarm-LivSim model developed by the QAAFI team for the SIMLESA Program to simulate cropping and livestock systems in smallholder households (Rodriguez et al., 2011, 2014 and 2017).
New genetics and more sustainable practices for Australian farmers

- An increased diversity in the genetic pool available for maize breeding programs: Farmers from Queensland and Northern Australia require specifically adapted germplasm and agronomic practices that are better suited to the local environmental and market conditions. The SIMLESA—QAAFI team imported drought tolerant maize lines from CIMMYT’s program that were crossed with local testers, selected and evaluated in replicated trials against Australian commercial hybrids. The imported lines out yielded local commercial hybrids and showed better plant phenotypes when grown in rainfed conditions at low plant populations. Some of these materials will be used by commercial seed companies to develop specific adaptations to Australia’s agro-ecologies.

![Graph showing yield and days to anthesis of maize hybrids](image)

Yield and days to anthesis of two commercial (727 and 1467), and eight SIMLESA derived maize hybrids grown in Gatton Australia.
Increased farmers’ exposure to the use of short legume cover crops during fallows: Nitrogen fertilisers represent the largest cost to Australian grain growers, while legume cover crops have the potential to supply biological nitrogen, in addition to suppress diseases and weeds. However, industry uptake of the technology is limited due to the lack of information on suitable legumes for farmers to use as ‘break crops’ for weed, pest and disease control, and as sources of nitrogen input. Results from a collaboration between SIMLESA and Conservation Farmers Inc, showed that field peas grown for as long as 60 days during summer fallows has the potential to sustainably contribute to the N nutrition of subsequent sorghum crops.

The effect of alternative cropping sequences with and without the use of mineral fertilisers on sorghum yield. 0, 50 and 100 indicate the proportion of mineral nitrogen added relative to farmer’s recommendation and indicate a potential contribution of ca. 30kg N/ha from the cover crop.
Novel multi-crop cropping systems designed to maximise rainfall and radiation capture in summer dominant cropping systems: In first instance crop production and yield depend on the ability of crops to use key resources i.e. rainfall, temperature, solar radiation and nutrients. However, when these production resources are concentrated into a few months of the year, such as in Australia’s northern grains growing region, cropping systems centred on single crops (i.e. a single crop per field per year) waste large proportions of resources, and are highly susceptible to losses by deep drainage, runoff, and evaporation. The QAAFI-SIMLESA team quantified the benefits from an intensified cropping systems that involves multiple crops grown on the same area of land during the same season. Results showed that relay cropping mungbeans into a maize crop between maturity and harvest, doubled land productivity and increased gross margins by up to a 1.5-fold (i.e. with maize yield = 9.4t/ha, mungbean yields = 1.6t/ha).
Novel triangular crop designs maximise ground cover, save water and suppresses weed competition in Australia: In the northern region rainfed maize is grown at low plant populations to reduce crop water use early in the season. When planted at low plant populations (2–3 pl m⁻²), commercial hybrids tend to produce tillers that use water and nutrients and produce no yield, and the crop shows poor competitive capacity with spring weeds. The QAAFI-SIMLESA team showed that twin row triangular configurations in maize can increase yields by modifying the tillering habit of commercial hybrids, achieving full ground cover earlier, increasing rainfall harvesting, and the competitive capacity of the crop against spring weeds (McLean, et al., 2017).

Proximal sensing increases the efficiency and efficacy of large scale agronomic experimentation: Monitoring large on-farm agronomic experimentation is time consuming and costly, requiring new tools that can speed the capture of high quality data at low cost. Of particular importance is the determination of crop characteristics such as established plant populations, above ground biomass, leaf area, and biomass. Empirically measuring these traits requires onerous investments in limited resources (cash and labour), and extend processing times and analysis timeframes. In addition, due to labour and cost constraints, typically only small areas of each trial plot are monitored, at only a single or a few times in the cycle of the crop. The use of drones equipped with a range of imaging systems provide the opportunity to assess crop / plot characteristics at greater detail, at increased frequency and lower cost. The MSc studies of QAAFI-SIMLESA student James McLean showed that drones mounted with multi spectral cameras feeding automatic image analysis software can be used to collect precise information from large trials.
Australian SIMLESA PhD student concludes that farm debt in Australia constraints farmers investment, levels of productivity and profits: Understanding what makes a successful farmer can help inform practice change, gaps in information, and investments in ‘cash strapped’ R&D programs. Using farmer interviews and crop modelling approaches the diversity in performance of seventy-five sorghum fields, in terms of water and agronomic nitrogen use efficiencies, yield and gross margin across the Darling Downs, Australia was studied. Results showed that farm businesses having debts of more than 1,525 AUS/ha under-invested in inputs, and had lower gross margins due to N limitations, when compared to farms having lower debt levels. Results highlighted similarities to African systems, together with opportunities and constraints to increase yields and profits in Australia and Africa.

New public private partnerships and funding

Developing Northern Australia CRC: Similarities between the climate and soils of Northern Australia and Eastern and Southern Africa, prompted the SIMLESA-QAAFI team to liaise with Radicle Seeds (https://www.facebook.com/radicleseedsaustralia/). Radicle Seeds and Southern Cross Exports (http://southerncrossag.com.au), both farmers’ owned companies to apply SIMLESA technologies to the development of Northern Australia. Radicle Seeds recently started breeding and releasing maize and sorghum hybrids to the Australian market and are considering expanding their markets into Africa. The company is based in Central Queensland and has a focus in the development of hybrids specifically adapted to sub-tropical and tropical environments. Given the similarities in between SIMLESA and Northern Australia environments the SIMLESA-QAAFI team engaged in public-private partnership through a $1.3M DNA-CRC project (https://www.business.gov.au/) with Radicle Seeds. This partnership will (i) use SIMLESA (CIMMYT) maize genetics and systems modelling tools to breed better adapted maize and sorghum hybrids; (ii) develop the required genotype by management combinations and decision support tools; and (iii) develop the value chains required to support the expansion of agriculture in Northern Australia. The expected outcome of this SIMLESA spin-off is an increased profitability and resilience of farmers, communities and rural businesses in Northern Australia.
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PREPARED BY:
A/Prof Daniel Rodriguez
Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland
Ed.rodriguez@uq.edu.au
203 Tor Str Toowoomba Australia

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