SESSION 4.1:
SOLUTIONS FOR RESILIENT FOOD AND NUTRITION SYSTEMS ON-FARM

Sustainable intensification: Decoupling resource use from socio-economic benefits in southern Africa

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Abstract

Sustainable intensification of agricultural production is needed to feed 10 billion people who have limited land and water resources in a changing climate. In Africa, enormous investment in irrigation schemes has resulted in a build–fail–rebuild cycle that has trapped farmers in poverty. The Australian National University and partners have been supported by ACIAR in 'Transforming Irrigation in Southern Africa' (TISA) from 2013 to 2023, to reboot failing small-holder (average farm size = 0.5 ha; ~15,500 farm households) irrigation schemes in Mozambique, Tanzania and Zimbabwe. We intervened in two ways. First, farmers were provided with simple-to-use soil monitoring tools – the Chameleon and Full Stop (https://via.farm/) – to manage their water application and soil fertility. Farmers at the head end of canals reduced their water application by half to two thirds, increasing crop yields and generating many other benefits. Second, in a social process, farmers formed agricultural innovation platforms. They identified, prioritised and fixed problems that they could influence, including to: grow more profitable crops, lower input costs, better access markets, and in some cases, undertake further processing. This increased household incomes and catalysed many other benefits. For example, during the COVID crisis, food insecurity in TISA schemes was much less than for non-TISA schemes. This is analogous to the resilience required under a changing climate. The TISA project illustrates that:

1. Agriculture systems are complex and require multiple social and technological investments to become more sustainable and profitable;
2. Empowering farming communities and businesses is key to building profitable agricultural systems that deliver lasting benefits;
3. Significant decoupling of resource use from production is possible and this increases resilience to shocks; and
4. Long term (10 years) of research for development investment by ACIAR into community driven research has enabled lasting change.

I have been invited to present a case study on sustainable intensification, to draw out a few lessons. The case study is a program called Transforming Irrigation in Southern Africa (TISA), funded over the last decade by the Australian Centre for International Agricultural Research (ACIAR). This project has been a great partnership between Australian and African research organisations.

The context here is that we have spoken about the need to grow more food for an increasing population, and yet land and water are limited. Irrigated agriculture is one way to produce more food, more reliably, if water supply can be controlled.

However, in Africa there has been a momentous failure of smallholder irrigated agriculture, and so the top-down capital-intensive engineering and technology solutions for building those irrigation schemes have largely failed. I would put that down to some very silly policies, such as directing farmers to grow cheap grains on some of the most expensive farmland in Africa. That has resulted in extensive use of water for very low yields, where farmers are unable to make a profit and have used these irrigation schemes for subsistence agriculture rather than for securing food supplies for these countries. There has been a build–fail–rebuild–fail sequence. Donors build the infrastructure; national governments build the infrastructure. It fails. A decade or two later somebody comes back to pour the concrete again.

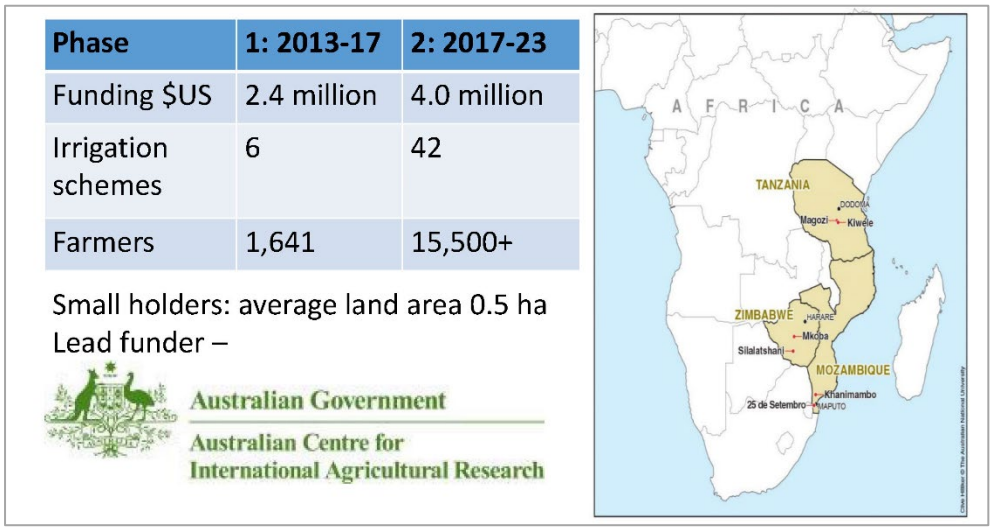

Figure 1. Overview of the program 'Transforming irrigation in southern Africa' (TISA).

The TISA program

In the Transforming Irrigation in Southern Africa (TISA) program we have sought to engage irrigation communities, to rely on their knowledge and help identify solutions that could increase both yield and profitability – which are not the same thing – and, we hoped, decouple production from resource use. The program is active in Tanzania, Zimbabwe and Mozambique (Figure 1) on irrigation schemes for an average farm size of half a hectare. Currently we are working directly in 42 irrigation schemes with around 16,000 farmers, and scaling out and up from there.

We have made two interventions. The first is technological – some tools, developed by Dr Richard Stirzaker at CSIRO in Canberra, that have put the power of information into the farmers' hands (Figure 2). The farmers now can *see* whether there is enough moisture in the subsoil around their crops. If so, they can stop watering. These people are farming in semi-arid areas. When we arrived to begin the project, farmers were 'drowning' their crops by over-watering, washing away the nutrients. That had an enormous cost in terms of their labour and in terms of poor yields.

Our second intervention is 'agricultural innovation platforms' – a term that simply means 'talking to the farming communities and helping them model ways of identifying their problems, and their opportunities, and prioritising them'. The example in Figure 3 is a pair of sketch-maps of an irrigation community, with the 'before' – their current situation (left side) – showing lots of doom

and failure; and the 'after' (right side) – where those farmers envisaged their community could be in five years. We helped them to stop wanting their government to do something, and instead we helped them focus on things that they could directly influence themselves: for instance, negotiating with the input suppliers to buy in bulk and lower the costs; and physically talking to the people who bought their produce to find out what they actually wanted and when, so that the farmers could increase their returns. This combination very quickly led to some very radical changes in farming behaviour.

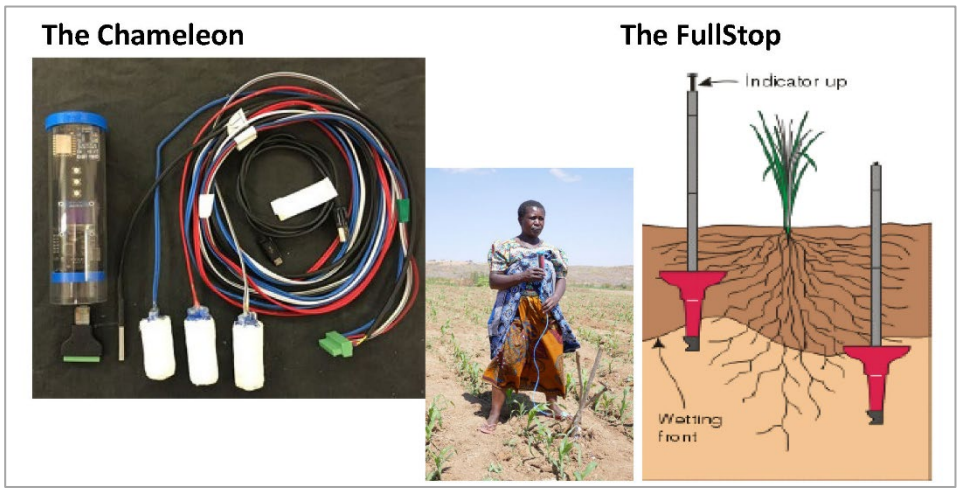

Figure 2. Intervention 1: Simple-to-use soil monitoring tools that increase learning & crop yields, by Dr Richard Stirzaker, CSIRO, https://via.farm/.

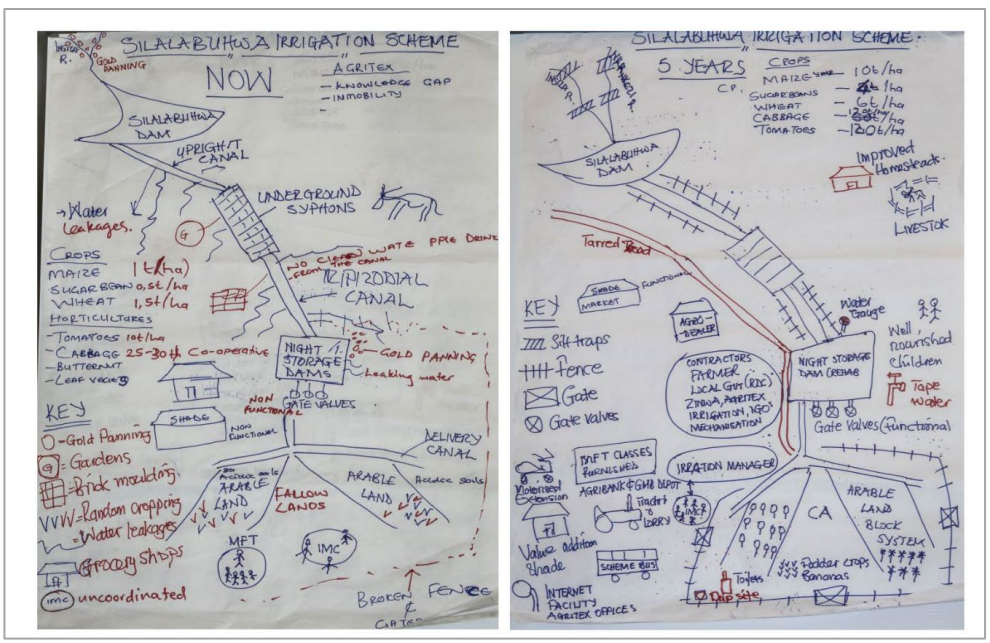

Figure 3. Intervention 2: Agricultural innovation platforms (AIPs) with communities increase farm profitability. Examples of the current situation (left) and desired situation (right) produced from the visioning exercise in Silalatshani, Zimbabwe. *Source: van Rooyen* et al. *2017*.

Results

The change in irrigation frequency is one measure of water use. You can see from this example in Mozambique the interval of watering increased from nine days to around 15 days on average (Figure 4). Much less water being applied.

As you may know, if you don't drown your crops you are likely to increase their yield – and indeed this was the case. Green maize yield, for example, increased from around five tonnes per hectare to over 15 tonnes per hectare (Figure 5).

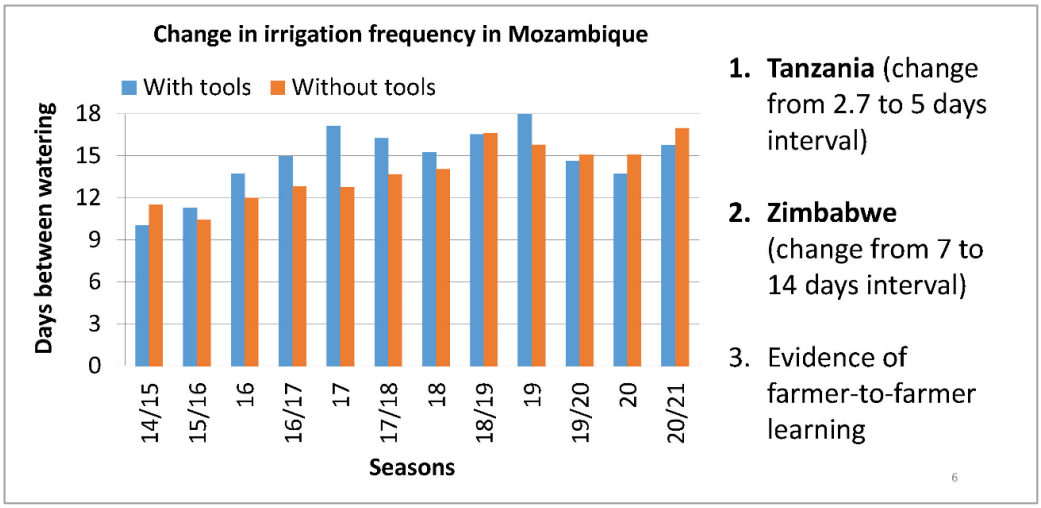

Figure 4. Changes in irrigation frequency (2014–2020) in the three countries.

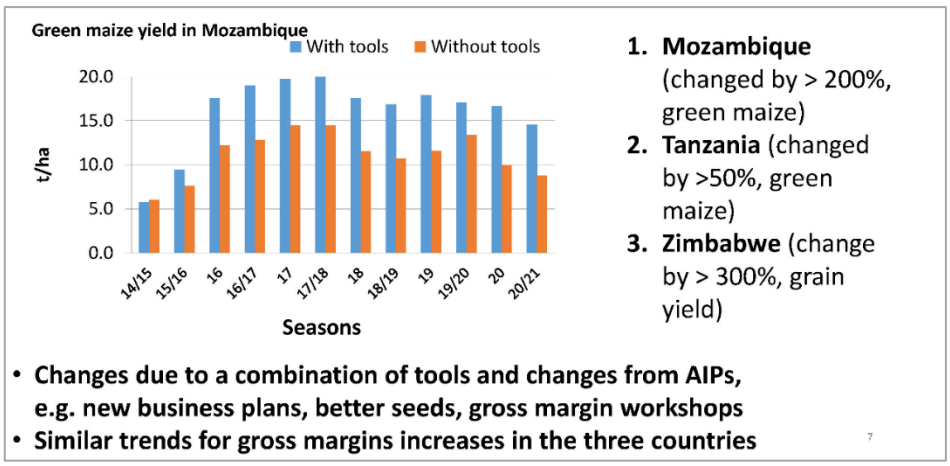

Figure 5. Changes in yields of green maize (2014–2020) in the three countries.

But of course, simply increasing the yield doesn't increase the profitability of the farming system if all you do is flood the market. Therefore, a very important aspect of this program was the social innovation. Technological intervention alone for intensification fails unless there is *also* social intervention to manage the system. In this case, that meant changes such as staggered plantings so that produce was available over longer periods of time.

Figure 6 summarises some of the intensification benefits that resulted from those interventions, including: several ways in which less water was applied; less energy used by irrigators who use electric pumps; increased crop yields. A major benefit was the labour saved: most farmers saved between half a day and three days per week and could spend that time on other productive activities, such as investing in off-farm activities and further diversifying their system. There was more efficient use of fertilisers. One big benefit that we didn't expect (but should have) was the major reduction in conflict between irrigation areas, between farmers, and within households, and that unleashed a 'tidal wave' of collaboration to make these systems even more effective.

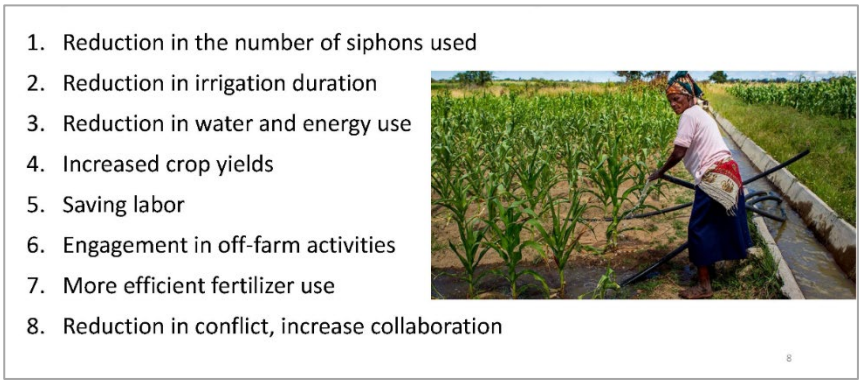

Figure 6. Intensification benefits from interventions in the three countries (2014–2020).

To check that we really did achieve intensification – that is, more crop per drop – one of my PhD students, Michael Wellington, used geographic information systems (GIS) to compare gross primary productivity to evapotranspiration (Figure 7). He was in part funded by the Crawford Fund for his research travel. Congratulations to the Crawford Fund for supporting this excellent research that shows that in functioning irrigation schemes it was possible to produce more food on the same land with less water.

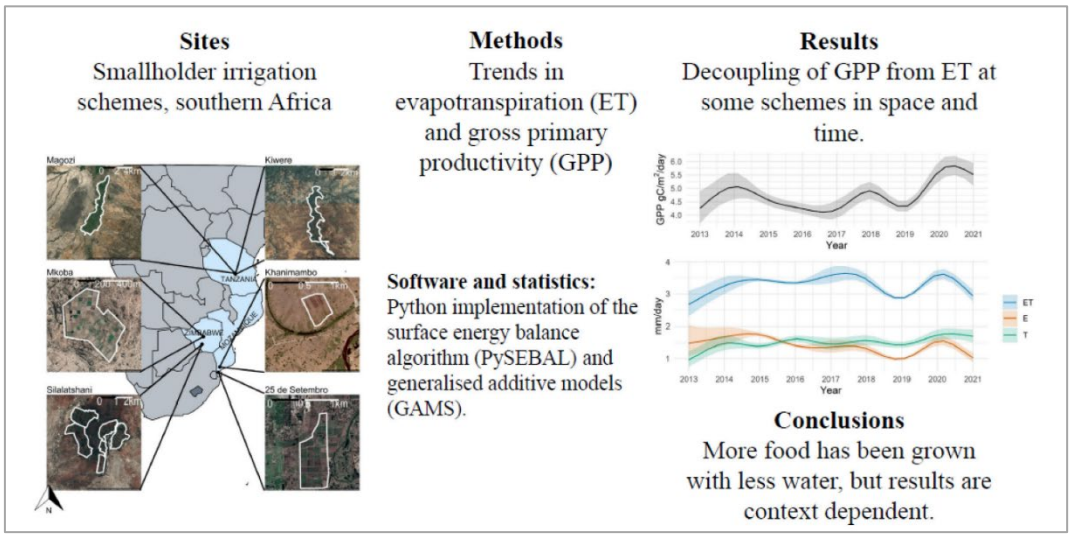

Figure 7. More crop per drop? Independent GIS check. *Source: Wellington* et al*. 2023*.

This program has now catalysed more investment in intensification. There are plenty of bespoke examples, such as one from Kiwere, Tanzania (Figure 8), where farmers are now diversifying their production system by moving into dairy cows based on feed from the irrigation scheme. So we are getting a beneficial feedback of intensification.

Figure 8.

Conclusion

- We believe multiple social and technological interventions are needed to improve sustainability and profitability: that is, a technological intervention alone is not enough.
- It is essential to empower the farming communities and businesses so that they can push against some of the silly policy prescriptions from governments, where needed.
- Significant decoupling of resource use from production is possible, as I think we have shown with water, with the smallholder irrigation schemes, and
- I strongly commend ACIAR for its approach to funding teams doing this kind of research over long periods of time and for being flexible in enabling us to learn and follow new opportunities rather than being unduly prescriptive with that.

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Project website: http://fennerschool.anu.edu.au/research/projects/africa-irrigation-and-water-project-increasing-irrigaton-water-productivity-3

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