Excellence in Practice (EiP) awards 2022

Transforming small irrigation farm businesses and their irrigator corporations from underperforming to sustainable business units.

University of South Australia (UniSA) Business

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Executive Summary

A partnership of seven organisations (providers) from Australia and Africa developed and implemented a theory of change using learning and development interventions to transition irrigation farm businesses and their irrigator corporations from dysfunctional to profitable business enterprises. A two-pronged approach was adopted. The first intervention was soil and nutrient monitoring tools to facilitate farmer learning about soil moisture and nutrient dynamics for improved irrigation decision-making. The second intervention was Agricultural Innovation Platforms (AIP), which functioned as spaces for innovation and learning. The AIPs facilitated the identification of barriers to improve productivity and profitability and implemented interventions to overcome them and initiated an iterative cycle of learning, increased profitability, development toward sustainable business enterprises. The project implementation was funded by the Australian Centre for International Agricultural Research (ACIAR) and the partner organisations.

The project was entitled '*Transforming Irrigation in Southern Africa*' (TISA) and initially operated in six irrigation schemes in Tanzania, Mozambique and Zimbabwe (2013-17). The two-pronged approach was implemented in partnership with farm businesses, irrigator corporations, extension officers, local stakeholders and local, district and national government institutions. Based on the success of the approach, it was out-scaled in the three countries (2017-22.) TISA now works with 15,500 farm businesses and 42 irrigator corporations and has up-scaled to include AIPs at regional and national levels.

The partnership between the seven organizations, the farm businesses, irrigator corporations and local stakeholders proved to be very successful and has been sustained across the implementation period. The learning and development interventions have proved to be very effective and impactful. Reflecting this, the funding agency has extended the project twice and a tenth year has just been approved.

The two-pronged approach has reduced water use, time spent irrigating and conflicts over water among farmers, within households and with downstream users, and it has increased yield, farm business profitability and non-farm income. This in turn has increased farmers' willingness and ability to pay water fees and participate in scheme maintenance. This has increased the viability of the irrigator corporations and the effectiveness of the supply infrastructure. It has also increased value-adding business opportunities and job creation within the local communities.

The Submission

1. Introduction

UniSA Business and the Centre for Values, Markets and Inclusivity (CMVI), University of South Australia, Adelaide. UniSA Business is a leading business school, nationally and internationally. Our outstanding achievements in teaching and research are recognised through:

- Accreditation by the globally significant Association to Advance Collegiate Schools of Business (AACSB);
- accreditation by EFMD Quality Improvement System (EQUIS);
- the Excellence in Research Assessment process with respect to both impact and quality;
- the success of our alumni.

CMVI seeks to combine specialist skills and multidisciplinary perspectives to provide innovative and enterprising solutions that support inclusive and sustainable communities locally, nationally and internationally. It specifically seeks to resolve global development and governance issues in populations experiencing inequity and develop incentives for business and non-for-profits to develop, monitor and report on socially responsible enterprises.

UniSA Business has partnered with the following on the TISA project:

- Fenner School of Environment & Society, Australian National University, Canberra, Australia's leading research university.
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international research organisation that conducts agricultural research for development in Asia and sub-Saharan Africa (SSA).
- Ardhi University, Tanzania specialises on economics, management, earth sciences, business, environmental science and technology and social science.
- The National Irrigation Institute, Mozambique is a government institution that oversees agriculture and aims to plan, develop, exploit and manage land and water resources for efficient and sustainable agricultural production.
- Faculty of Agronomy and Forestry Engineering, Universidade Eduardo Mondlane is the oldest and largest university in Mozambique with about 40,000 students.
- The Food, Agriculture and Natural Resources Policy Analysis Network, Pretoria, South Africa, is a pan-African network that provides independent evidence to inform policy.

In this case study

The clients are the small farm businesses and their irrigators' corporation who owns the challenge. At the end of the case study there were 15,500 small farm business clients and 42 irrigator corporation clients across three countries in Africa, speaking at least seven different languages. Hence, it is logistically not possible to get the clients to sign the Authorship declaration. Instead, the form is signed by the seven partners and the funding agency.

The providers are the seven partners who have identified the challenge and developed the proposal setting out solution to overcome the challenge

The funding agency is the Australian Centre for International Agricultural Research (ACIAR) who based on the proposal from the providers have agreed to fund the implementation of the solution.

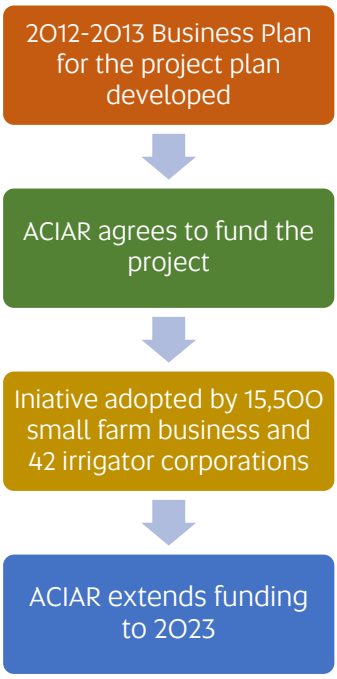
2. The Challenge

About 80% of food in SSA is produced by small farm businesses often within small-scale irrigation schemes operated by the irrigators or as irrigator/government partnerships. Production of food for subsistence often has the highest priority with surpluses sold at the market. These irrigator corporations are, in essence, not-for-profit social enterprises, which are responsible for the operation and maintenance of the irrigation infrastructure. For several reasons, these organisations have largely failed to sufficiently maintain the infrastructure; hence, the schemes are largely underutilised and often enter a cycle of refurbishment/degradation/refurbishment.

The failure of the small farm businesses and their irrigator associations are interlinked. The dual focus on subsistence and business has resulted in farmers growing staple foods with limited market value, while irrigation increases production costs and the financial risk of crop or market failure. Farmers are poorly connected to markets for inputs and outputs and therefore the cost of production and transport of produce to markets is high. Consequently, farmers' ability to pay water fees and their willingness to participate in scheme maintenance is low. As infrastructure declines, water supply becomes less certain, which further discourages farmers from paying and participating in maintenance work. As schemes provide water using a fixed roster, irrigators water when water is supplied whether it is needed or not. This causes leaching of fertiliser below the rootzone and reduces crop yields (Bjornlund et al., 2017).

The business challenge is fundamentally owned by the individual farm businesses and the irrigator corporations but is clearly interconnected with government institutions, donors and NGOs. The farm businesses and their corporations have very limited capacity to address the challenges and governments often depend on donors and NGOs. These organisations have traditionally addressed these challenges individually and in isolation. This approach has largely failed as the challenges are complex and interconnected.

3. The Commitment



During the 2012-13 period a partnership was formed to develop a business plan to address the challenges. A theory of change was developed to transform failing smallholder irrigation schemes (Pittock et al., 2020).

A proposal was made to ACIAR to fund the project: 'Increasing irrigation water productivity in Mozambique, Tanzania and Zimbabwe through on-farm monitoring, adaptive management and Agricultural Innovation Platforms" from 2013-17. The partnership proved very committed, and the project had significant impact (section 4). ACIAR therefore extended the project from 2017-21 and renamed it TISA. TISA has since been extended by another year to July 2022.

Reflecting the commitment and efficiency of the partnership ACIAR has just committed funding for a tenth year to July 2023 to explore the ability of the TISA approach to assist small farm businesses to adapt to climate change.

A total of 15,500 small farm business and 42 irrigator corporations across Mozambique, Tanzania and Zimbabwe are committed to be part of the partnership and attend workshops, focus groups, participate in farm surveys, install and use monitoring tools in their fields, maintain field books of their operations, participate in AIP meetings and establish test plots to demonstrate farming practices. Government departments, regional councils and extension officers, have committed significant human resources to assist in the implementation of the approach.

ACIAR has committed AUD$7.9M over the ten-year period and partner organisations have made in-kind contributions of AUD$4.65M. See Appendix 1 for details.

4. The L&D Initiative

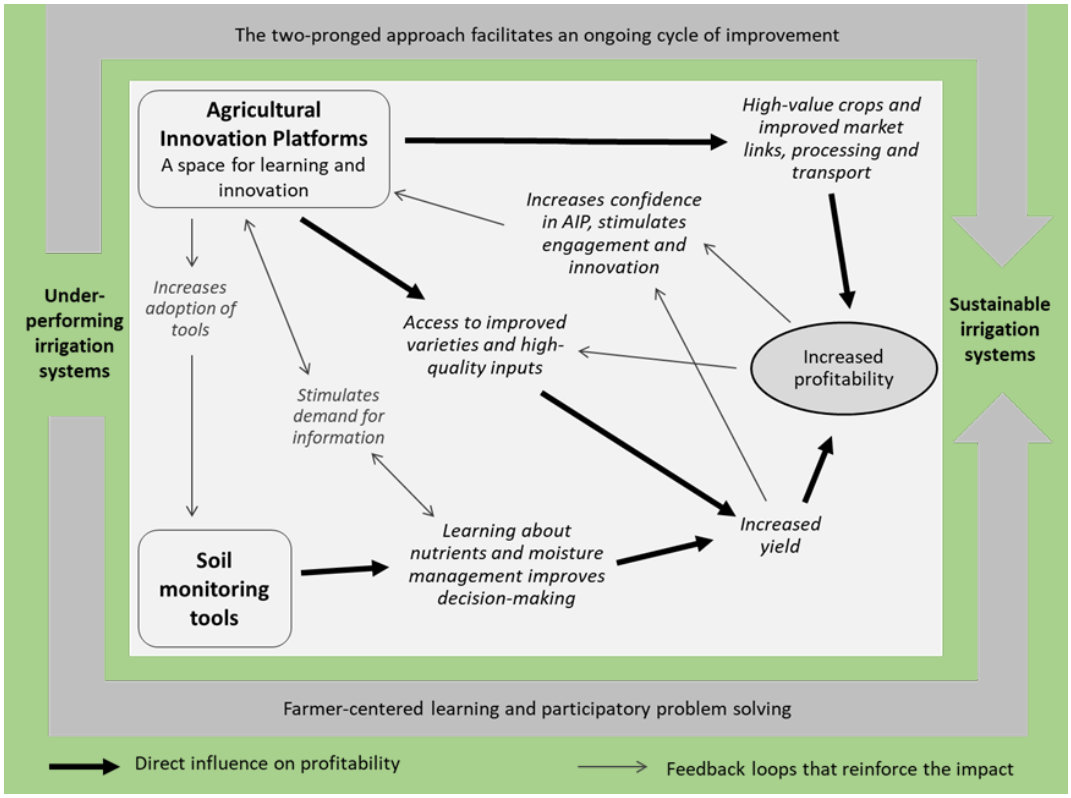
The diversity of challenges experienced by small farm businesses and their irrigator corporations and the breadth of stakeholders, means that there is no single solution to transitioning schemes to improve profitability.

A two-pronged participatory approach was therefore taken to deal with the complex set of challenges, which simultaneously employed two interventions as entry points to stimulate learning and development.

The first was technical, soil moisture and nutrient monitoring tools and the second was socio-institutional in the form of AIPs.

The tools provide a deep learning and understanding of water-nutrient dynamics. This allows farmers to make more informed decisions about water and nutrient management, which leads to critical changes in behaviour and practices and results in improved yield. The AIPs facilitate the identification of challenges, their root causes, and opportunities to address them. As such the AIPs act to remove the constraints that prevent farmers acting on the monitoring results and facilitates the use of and learning from the tools and translate this into increased yield and profitability. Figure 1 shows how the two interventions combine to generate increased profitability.

Figure 1 The two-pronged TISA approach



Implicit within the approach is recognition that traditional agricultural extension approaches have used training to disseminate new information and technologies. However, attendance at a training event does not guarantee learning. Rather, learning-based approaches that allow for experiential learning will foster critical thinking and support innovation in agricultural systems (Parry et al., 2020). The opportunity to learn and then adapt is put into the hands of the farmers and AIP stakeholders who have previously been disempowered from identifying and creating change.

During 2013-17 the two learning and development interventions were introduced in six small-scale irrigation schemes—two in each of Tanzania, Mozambique and Zimbabwe—to test their effectiveness in transitioning the schemes and their farm businesses from dysfunctional to sustainable businesses. During the second phase (2017-22) the approach was out-and up-scaled and is now in more than 42 irrigation schemes with scheme, district and national level AIPs. TISA experienced significant buy in by Government based on the experience from the first phase. Especially in Zimbabwe, the government has worked actively with TISA to train their extension officers throughout

Zimbabwe to implement the TISA approach. Many NGOs and their staff have received training from TISA and are now using the tools other schemes.

The tools

The soil monitoring tools were developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to stimulate farmers' learning about soil moisture and nutrients dynamics. The tools are easy to use and the results can be easily understood by semi-literate farmers.

Farmers received two tools:

i) Chameleon™ Soil Water Sensors (Figure 2); and
ii) FullStop™ Wetting Front Detector (Figure 3). An electrical conductivity meter and nitrate test strips are also supplied. Twenty farmers in each scheme had the sensor array installed in their plot and they shared one Chameleon™ reader.

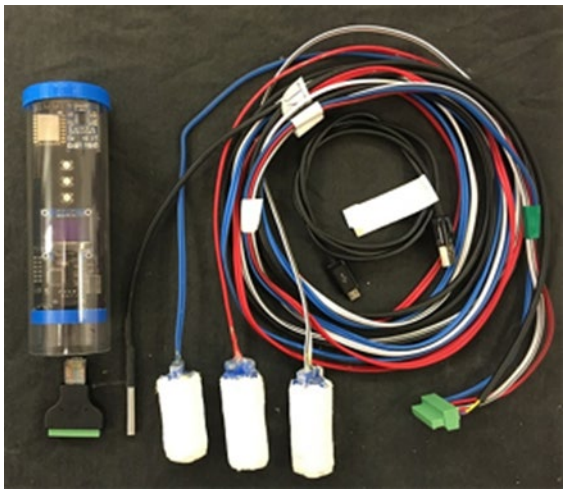


Figure 2 Chameleon™ soil moisture sensors and reader (Photo: VIA Farm website) and farmer demonstrating the use of the Chameleon (Photo courtesy Karen Parry)

The Chameleon™ is an inexpensive resistance-type sensor that measures soil tension. Three Chameleon™ sensors are included in an array to measure the top, middle and bottom of the root zone. The sensors are buried permanently in the soil and connected to an aboveground plug. Each array has a temperature sensor to allow correction of the resistance reading. The Chameleon™ reader has a coloured light for each sensor, which shows blue, green or red, depending on the soil tension at the particular depth:

- blue indicates soil layer is wet (tension is less than 20 kPa)
- green indicates soil is moist (tension is between 20-50 kPa)
- red indicates soil layer is dry (tension is greater than 50 kPa)

The colours are displayed by inserting the sensor array plug into the reader. Colour provides a common language about a plant's ability to extract moisture from the soil. Importantly, because the sensors measure soil tension, calibration is not required for soil type. Information on water availability enables farmers to avoid water stress, waterlogging and fertiliser leaching, and learn about the value of rainfall. Farmers receive information to make better irrigation decisions and understand the seasonal progression of crop root depth and moisture needs in the soil profile.

The FullStop™ enables the measurement of soil nitrate and salt levels. The funnel-shaped devices are buried at approximately one-third and two-thirds of the depth of the crop's roots (Figure 3). As water moves down the soil

profile and reaches the wetting front detector, it is funnelled into one or both devices depending on: amount of water applied, soil type and initial soil moisture. When sufficient moisture enters the device the indicator above the surface rises, telling the farmer that a soil water sample has been captured. This is then extracted (using a rubber tube and syringe) and tested for nitrates and salinity. For a full discussion of the tools see Stirzaker et al. (2017).

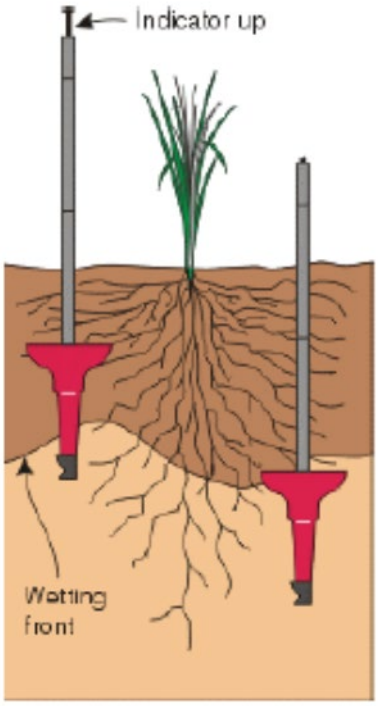
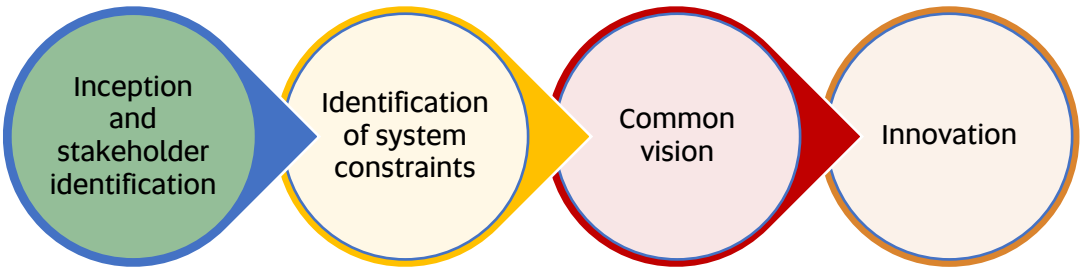


Figure 3 Placement of two FullStop™ devices (Photo: VIA Farm website)

The farmers maintain a detailed record in their field books of the readings from the tools as well as farm inputs, yield and the prices received for their crops.

The AIP

The AIP process consists of four stages. Each is not necessarily one specific meeting; several meetings may take place within each stage (For a full discussion see van Rooyen et al., 2017, 2020 and Bjornlund et al., 2020, Bjornlund et al., 2018).



First, **inception and stakeholder identification**. Participants articulate their interest and clarify their role and responsibilities for developing new and improved ways of doing business.

Second, **identify system constraints**, which helps understand, the interconnectedness of the problems and the feedback mechanisms between them. For example, limited access to inputs leads to poor yields, which results in poor returns. Similarly, poor markets lead to low income and reduced incentives to invest in inputs. Participants are divided into groups (farmers, technical support staff, private sector and government) to list and prioritize challenges and opportunities, determine the root cause of each challenge, and identify solutions and critical partners to implement them. The AIP facilitator prompts the groups to think comprehensively to ensure that significant challenges are discussed; and the stakeholders move beyond a generic articulation of a challenge and its cause. Participants were asked to repeatedly consider the 'why' question to analyse and identify the root causes and viable potential solutions. Finally, the groups reunite to discuss, clarify and confirm their findings and identify who will implement the solutions.

Table 1 provides an example of the outcome of this process.

Table 1 The challenge of low prices for rice in the Magozi scheme

Challenge	Root causes	Solution	Partners who can assist
Low price of rice	Lack of a joint market for farmers to sell rice	Farmers must organize and sell their rice collectively	Farmers
	Flooding the market with small quantities of different varieties	Store rice in a warehouse while waiting for better prices Grow fewer varieties	Iringa District Council
	High transportation costs	Grow varieties that are in high demand and grow fewer varieties for bulk sale	Financial institutions e.g. non-governmental organizations, Member of Parliament
	Selling paddy instead of rice	Acquire and install rice hulling machines	Ministry of Agriculture, Food Security and Cooperatives
	Imported rice sold at low prices compared to domestic prices	Adopt expert advice on growing, processing and marketing	Savings and Credit Cooperative Society
		Advocate that the government give priority to locally produced rice	Private investors (rice hullers).

Third, and central to the success of the AIP process, is development of a common vision for the scheme. Participants work in their groups to develop pictures of the current and future state of the irrigation scheme and their community. The facilitator stimulates forward thinking, as this can be difficult for people who have not been able to 'dream' about a different future. The desired future picture expresses what stakeholders perceive to be achievable within a five-year period but is not limited by whether a clear pathway towards the vision is available. The visioning process places farmers aspirations in context and the support services and private sector can adjust their strategies to accommodate them. Finally, the participants develop a narrative of how they envisage their scheme can move from the present to the future situation. This is helpful as it allows the AIP's stakeholders to think in terms of process and not only the technological interventions. This facilitates the development of a contextual environment so that the scheme can best utilise technological and policy interventions.

Fourth, the innovation stage. Here, stakeholders who have identified problems in common are brought together to identify improved business strategies. The resulting solutions and innovations draw from the diversity of knowledge and perspectives of the participants. They are tested by the stakeholders themselves and adapted and placed into the local context to improve system efficiency to benefit all stakeholders.

The diversity of stakeholders allows for the emergence of different solutions, opportunities and activities that support the transition process. Some activities may be within the control of the AIP stakeholders to implement, while others are larger system challenges associated with policy, infrastructure, markets and knowledge. The stakeholders discuss the challenges to determine what can be addressed by the AIP and associated organisations and the appropriate sequence of activities. In some cases, issues may need resolving before priority activities can be implemented. Care is taken to structure activities in such a way that incentives for behavioural changes are clear and direct. Importantly, this stage results in shared ownership of a holistic set of solutions achievable in a realistic period.

Innovation implementation is an iterative process of testing, evaluating, learning and adjusting. Depending on the activity, sub-groups of stakeholders will focus on individual tasks, resolve challenges and test innovations. Most of the innovation process takes place outside the AIP meetings. Groups report back to the AIP on their activities, which enables progress to be tracked, maintains momentum and transparency to foster trust in the process and allow stakeholders to learn and adapt from the experience. Examples of AIP processes, interventions and outcomes are described in Bjornlund et al. (2020).

5. The Impact

The farmers learnt very quickly from using the tools. When the Chameleon™ reading was constantly blue in the rootzone, the soil water extracted from the deepest FullStop™ had high levels of nitrates. Farmers understood that they had overwatered, and, in the process, they had lost expensive fertiliser as it was now below the rootzone and inaccessible by the plants. Within six months, farmers had started significantly reducing their irrigation. Farmers' learning from the tools was communicated to the other farmers during field days, test plots and during focus group/workshop discussions (for a full discussion of the learning processes see Parry et al, 2020).

The AIPs implemented several initiatives to ensure that increased production resulted in increased profitability:

i) introduced new crops and varieties and demonstrated them in test plots;
ii) connected farmers to markets to find cheaper and better-quality inputs and achieve better prices for outputs;
iii) addressed the issue of poor-quality inputs, e.g. in Iringa in Tanzania, the local Council hired an inspector to test the quality of inputs sold by the main suppliers;
iv) facilitated collaboration between farmers and governments and NGOs to fund value-adding facilities, e.g. the Tanzanian government paid the material for a rice storage shed and a rice mill, while farmers provided labour and some building material for the storage shed and the mill house; and
v) introduced new rice varieties and planting densities and obtained agreement between the farmers to grow fewer rice varieties.

The combined impact of iv and v has resulted in increased farm income as farmers now sell milled instead of paddy rice. They now store the rice until prices increase, and then sell in bulk, which attracts better prices and reduces transport cost. Further, NGOs in Zimbabwe were stimulated to provide processing equipment such as an oil press and packaging equipment.

The combination of the tools and the AIP started an iterative virtuous cycle of increased production and income of farm businesses and the flow on effect on communities and irrigation corporations (Figure 4). These outcomes have been extensively reported (Moyo et al., 2017, 2020; Mdemu et al., 2017, 2020; Chilundo et al., 2020; de Sousa et a. 2017; Manero, 2017; Manero et al., 2020; Bjornlund et al., 2018)).

Selected highlights of the impact of the two-pronged approach:

1. Increased farmer learning resulted in:

- Reduced water use and nutrients leaching;
- More than 50% reduced their irrigation frequency;
- Interval between irrigation events increased from 1.4 to 9 days;
- Reduced the duration of each event and used fewer syphons;
- Time saved watering. Households saved 3 to 19 hours per cycle. Farmers have invested this time in improved farming practices or non-farm small businesses to diversify their income stream: hair dressing, baking, brick making, charcoal making, fishing etc.

2. Changed mindsets:

- Farmers now perceive themselves as business, rather than subsistence farmers;
- Scheme management committee: abandoned rigid water scheduling;
- Policy makers: abandoned the focus on staple crops;
- Director of irrigation: *"I don't care what the farmers grow as long as they make money."* Consequently, the 1960s staples-focused cropping calendar has been taken down.

3. Changed crop production and income

- Between 50 and 93% of households have changed farming practices;
- Of the households who changed practice, between 77% and 93% increased crop yields;
- increased gross-margins. In Tanzania, the gross margin for male farmers increased by 7% and 21% respectively within the two schemes, while for female farmers it was 34% and 42%;
- Between 50% and 68% say it is now easier to purchase inputs.

4. Improved farmers' livelihoods, food security, nutrition, education and prosperity

- Of households who changed practice, between 43 and 94% increased income;
- Now spend more money on: irrigation and farm inputs (61-73%), education (42-68%) and food (36-72%).

5. Social changes

- Household conflict reduced;
- Conflict reduced between farmers within the scheme and between the scheme and downstream users, which has increased willingness to participate in collective action;
- Between 87% and 100% participate more in scheme maintenance;
- Information needs increased 74% to 89%;
- Greater gender equity in leadership and in household decision making

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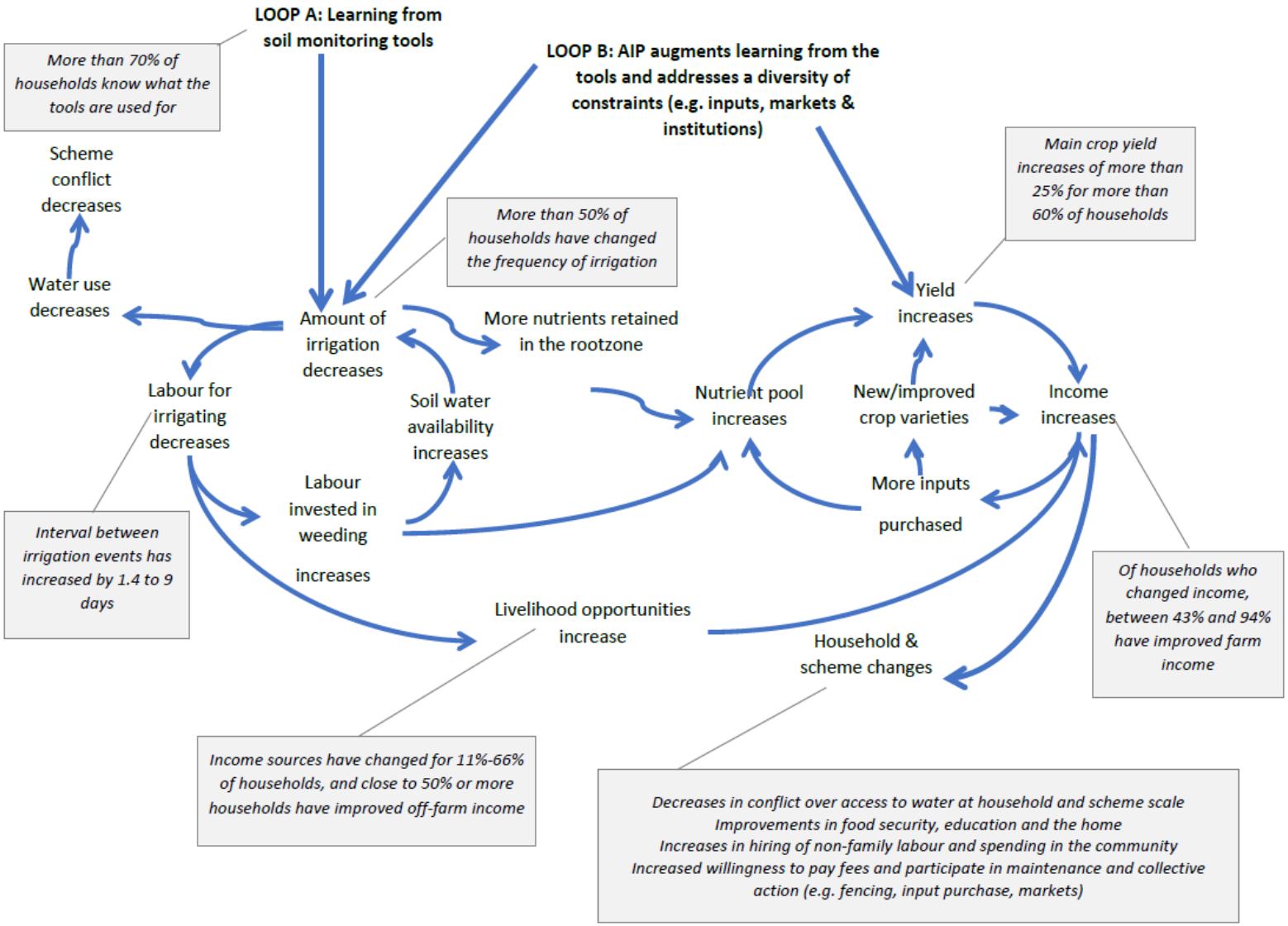

Figure 4 iterative virtuous cycle of increased production and income for TISA schemes

6. Reflections and concluding remarks

After nine years of implementing TISA's theory of change and the two-pronged approach, the profitability of the small farm businesses and their irrigator corporations has increased significantly. Farmers see themselves as transitioning from subsistence farming to 'being in business'.

As a result, farmers' livelihoods and food security have improved, and households spend more money on food, education and health. Increased farm income has resulted in hiring more non-family labour, creating jobs for other community members. The introduction of rice mills, storage facilities, farm equipment, oil presses and packaging facilities has opened opportunities for more small business within the community, creating jobs and increasing the prosperity of local communities.

The TISA partnership sees this development as facilitating rural economic development, which is critical for nations to become more prosperous. The partnership is currently working on the next step in this process. Building on the success of TISA, a project is being developed to use irrigation systems as hubs for transitioning the current TISA schemes into circular economies and food systems. This concept includes that all resources available within a local community is used, reused, or recycled within it. This means that agricultural products produced within a community are processed into value-added products within it and that by-products from these processes are used for further value-adding, e.g. the husk from grain milling used as stock feed. Only value-added products should be exported out of the community, retaining jobs and business opportunities within the rural communities for further growth and development.

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Appendix 1: partners in-kind commitment

	Phase I		Phase II		Total
	Amount	Number of staff	Amount	Number of staff	
ANU	$ 271,432.00	2	$ 769,783	2	$ 1,041,215.14
CSIRO	$ 249,649.00	1		0	$ 249,649.00
UniSA	$ 211,952.00	2	$ 669,016	1	$ 880,968.25
INIR	$ 351,450.00	3	$ 77,433	5	$ 428,883.23
Ardhi	$ 87,840.00	2	$ 161,145	5	$ 248,984.95
ICRISAT	$ 453,960.00	5	$ 685,913	4	$ 1,139,872.94
FANRPAN	$ 70,290.00	1	$ 327,396	4	$ 397,685.66
Uni of Pretoria	$ 77,301.00	2			$ 77,301.00
Total	$ 1,773,874.00	18	$ 2,690,686	21	$ 4,464,560.17

Appendix 2 - links to videos about the project

Dr André van Rooyen, Principal Scientist ICRISAT, Zimbabwe	African research partners describe the changes that they have seen and the benefits emerging from the research activities.	https://vimeo.com/190962877
Dr Martin Moyo,Senior Scientist, ICRISAT, Zimbabwe	African research partners describe the changes that they have seen and the benefits emerging from the research activities.	https://vimeo.com/190965617
Mr Paiva Munguambe, Director General National Irrigation Institute, Mozambique	African research partners describe the changes that they have seen and the benefits emerging from the research activities.	https://vimeo.com/191586931
Professor Jamie Pittock, ANU Australia and Dr. Makarius Mdemu		https://web.facebook.com/watch/?v=1348144353451200&__rdc=1&__rdr

Appendix 3: Bibliography, other relevant articles produced by TISA

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