

Irrigation revolution: Delivering high yields under harsh climatic conditions in Tanzania

A heavy-laden Fuso truck snakes its way up a village path at half past four O'clock. From the sound coming out of its engine, it is evident the truck is overwhelmed by the weight its carrying—fresh green maize harvested only a few hours ago. The driver's mission is to get back to Dar es Salaam, Tanzania's capital city. It is the 17th day of October, perhaps one of the most hostile months of the year. Around this time in Tanzania, the sun is scorching, the land dry, the air uncomfortably warm, and plant life long dead since the rains ceased in July.

But in Buigiri Irrigation Scheme in Chamwino district in Dodoma; Kiwere Irrigation Scheme in Iringa district; Msolwa Ujamaa Rice Schemes in Kilombero district, a contrasting picture blossoms. Farmers are tending to plots of maize, rice, beans, onions, tomatoes, okra, green and yellow apple pepper. It is from these green islands of life that populations from major Tanzanian cities get food supplies.

Farmers upbeat

Since the introduction of soil moisture content and nutrient level monitoring tools to farmers in these locations, the village folks are upbeat about what they see as a silver lining in a dark cloud. "This year, and for the first time in my life, I am set to earn Tsh 2,311,000 (about US\$1,050) from a single harvest," says Peter Ilumbo from Buigiri irrigation scheme in Chamwino district, Dodoma. "This is because of the knowledge that I got from the VIA project, which enabled me to improve on how I prepare the land, plant, weed and use water." VIA is acronym for Virtual Irrigation Academy (project).

Mr. Ilumbo grew apple pepper on a 0.5—acre plot, followed recommended agronomic practices and reduced the frequency of irrigation from four to only two times a month. This not only enabled him to save the crop from consequences of over irrigation, but also enabled him to save water. "I used to determine how much water was needed by the crop by just looking at the wetness of the top soil. That meant that the soil had to be wet at all times. Since the introduction of the VIA monitoring tools, I have learnt that I was choking the crops with water," Ilumbo notes in retrospection. "No wonder the crops then were thin and yellow. The fertilizer seemed not to help as it often got washed away by excess water, making it unavailable to the plants."



Peter Ilumbo shows off green pepper at his farm in Buigiri, Irrigation Scheme in Dodoma, Tanzania

Lessons learnt

Ilumbo also learnt that over irrigating could result into accumulation of salts in the soil, which is bad for crop health. The reward for his consistent application of knowledge on use of monitoring tools is that he expects to harvest 60 bags of green pepper, which will fetch him Tsh 3,024,000 (about US\$1,375) when sold at average farm gate price of Tsh 700 (about US \$ 0.3) per kg. When he deducts production costs, which according to his records is Tsh 713, 000 (about US\$324), he will remain with a net profit of Tsh 2,311,000 (about US\$1,050).

Monitoring tools did the magic

Ilumbo and the rest of the farming community in Buigiri Scheme wouldn't have taken the decision to reduce the amount of water for irrigating their crops if they had not received tools such as Chameleon readers, sensors and Wetting Front Detectors for monitoring soil moisture levels and nutrient content in the soil respectively. Wetting Front Detectors show amount of nitrate in the soil, while Chameleon sensors display the amount of soil moisture at different soil depths using blue, green and red lights. The lights provide visual interpretations of the moisture levels.

What is VIA?

The Virtual Irrigation academy project was launched in 2015. It is a brainchild of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in partnership with the Australian Centre of International Agricultural Research (ACIAR).

In Africa, the project is being undertaken in Malawi and Tanzania. In Tanzania, it is implemented by the National Irrigation Commission in collaboration with Sokoine University and Arusha Technical College. The Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) coordinates and provides technical backstopping in the two countries. The project is initially planned to work with 120 households and was expected to expand the reach to cover 480 to 1,200 households by 2019.

Box 1: Daudi Mtangi, a youth farmer, Msolwa Ujamaa, Tanzania

Before the introduction of the VIA monitoring tools, the village folks had nicknamed my garden Mtera farm. They were comparing it to Mtera River because the garden was always flooded like a river. The rice often turned yellow and was stunted, resulting into poor harvest. I consider the project a blessing because it has created standard procedures for irrigation and application of fertilizer. I have registered improvement on a 0.5-acre farm from five bags before the project to 11 bags. I earned Tsh 1,320,000 (about US\$600) after selling harvested rice at the peak price of 120,000 (about US\$ 54) this year. From the proceeds, I bought a plot of land to build a house and allocated some funds to renovate my father's house. Besides, I have saved time to help my father in his farm, and work in a sugar factory where I earn Tsh 185,000 (about US\$ 84) monthly. Many youth who were once averse to farming now consider me a role model and have adopted farming.

According to Dr. Eliakim Chitutu Matekere, Director for Research and Technology Promotion, National Irrigation Commission, Ministry of Water and Irrigation, Dar es Salaam, a total of 100 farmers are currently being supported by the VIA project to improve farm water productivity and profitability in Tanzania.



Daudi Mtangi, a youth farmer from Msolwa Ujamaa Rice Scheme in Morogoro, Tanzania

Colours that trigger decisions

The project provided beneficiary farmers tools designed to fit their mental model to give an output that is linked to action. Information on soil water suction, nitrate concentration and salinity levels are illustrated by colour signals that represent action thresholds instead of numbers with complicated numerical units. This promotes inclusiveness in the use of the monitoring tools across the gender categories, especially the women and girls who often have low levels of literacy. The farmers were deliberately trained to read and interpret the tools to inform decisions on amount of water, salts and fertilizer needed for the good health of their crops.

As of October 2017, the project had supplied about 4 wifi readers, and installed 80 chameleon sensor arrays and 55 Wetting Front Detectors to farmers to use and to facilitate learning by doing.

Things get better

Monitoring and evaluation information collected indicates that some early outcomes such as reduced conflicts attributed to increased availability of water; improved household incomes; increased yields; new jobs and improved food security are now being realized. Baseline information from two schemes where interventions are underway indicates that only 24 percent of the farmers in the intervention areas said they had sufficient amount of water for irrigation prior to the intervention. About 57 percent said the number and intensity of conflicts was high, while 76 percent believed that production, income and profitability from irrigation were low.



Santina Muna from Buigiri Irrigation Scheme in Dodoma, Tanzania made a fortune from okra

The farmers report that previously they used the appearance of the crop and the look of the top soil to decide when to irrigate. However, as a result of using the monitoring tools, they have now reduced the frequency of irrigation from four to two times a month.

The tools have introduced more or less standard procedures for irrigation and application of fertilizer. Before, fertilizer was washed away due to over irrigation, making it unavailable at the root zone,

Box 2: Santina Muna, Buigiri, Dodoma, Tanzania

Information from monitoring tools has enabled me get net earnings of 2,812,500 (about US\$ 1,278) from okra. Okra is that it is harvested the whole year. In the last year, I harvested 280 buckets on 0.5 acre garden, which fetched about 2,870,000 (about US\$ 1,305) at Tsh 10,250 (about US\$5) per bucket. When I deduct the production costs, I remained with 2,812,500 (about US\$ 1,278). This is all a result of skipping a week before the next irrigation. Because I am confident of a good harvest, I didn't hesitate to invest Tsh 30,000 (about US 13) to establish a dug-out well to sustain the current crop after the main supply dam dried up.

but now the farmers are able to mitigate it. They learnt that targeting amounts that replenish the root zone was critical for plant health and maximizing fertilizer intake. As a result, they have reported 45 percent reduction in fertilizer cost.

Time saved

As a result of applying new knowledge, the farmers are now able to save time for other activities such as grazing livestock, cultivating other crops such as Chinese vegetables, maize, sugarcane etc. Some farmers, especially the youth, work as masons, or in the sugar factory nearby. The women spare time to operate local restaurants and all sorts of enterprises. This means expansion in income generating options. Besides, many youth who were previously averse to farming have been attracted to it by associated technology based solutions. They have learnt to change their choice of crop depending on market information. For example, they strategically grow crops that require much water, but will become scarce in the dry season.

A transformation project

Overall, the VIA project is anticipated in the long run to deliver transformative impact in terms of increased productivity and profitability; sustainable water and salinity management; and improved economic returns from investments in irrigation infrastructure. Specifically, the project is out to see that at least 100 research and extension agency staff are proficient in the use of monitoring tools and engaging in people-centered learning; 1000 irrigation farmers are mentored and assisted to grow high-value crops using simple monitoring tools and learning through adaptive management; and ensure that the Virtual Irrigation Academy approach is embedded in local institutions.

Box 3: Robert Chilewa, Buigiri, Dodoma Tanzania

I am set to earn Tsh 5,124,000 (about US \$ 2,329) from yellow bell pepper from just a 0.5 acre. I have already started harvesting 10 bags monthly. As long as I continue supplying regulated amounts of water, I will harvest for another 7 months. That means 80 bags. Sold at average price of Tsh70,000 (about US\$ 32), I will fetch a gross of Tsh5,600,000 (about US \$2,545) and Tsh5,124,000 (about US \$ 2,329) after factoring in the costs. It is not magic, it is about relying on the Chameleon monitoring tools to determine when to provide water and manage the use of fertilizer.



Robert Chilewa displays colours from a Chameleon Sensor in Bugiri, Dodoma, Tanzania

Weekly uploading of data

Implementation of the project brought on board data collectors who visit the farms weekly to jointly read the monitoring tools with farmers and upload data into the VIA online platforms. The data collectors are within reach of the irrigation schemes and are provided with motorcycles to enable them be at the schemes daily to collect data.

They work with two lead farmers in each scheme, who help them coordinate with 20 other farmers. Their role includes taking readings from the sensors using wifi readers and uploading it on to the VIA website; collecting farmer stories on the use of the tools to track learning; checking to see if water has been collected in Wetting Front Detectors and making nitrate; salinity measurements; and checking the water table and record crop growth. This data is immediately discussed with the farmers. The analysis is discussed with the scheme extension worker and the district level extension officers who have been integrated into the VIA learning community. The data is then uploaded onto the website to be shared with the research facilitator and the project coordinator, who in turn make comments for subsequent discussions at the monthly meetings with all the farmers.

Extension services now more accessible

As a result of this interface, farmers report that extension interventions have become more accessible and effective than before the initiative was

introduced. Integration and regular intervention by support staff from different professions, say the farmers, has exposed them to new ideas.

Motivated to invest

Having realized the benefits, the farmers are now more motivated to make critical investment decisions, which they wouldn't have made when they had limited information. Some farmers were motivated to invest resources in establishing natural wells, when the main water supply source dried up.

Box 4: Sina Mliyuke: Kiwere Irrigation Scheme in Iringa

Before, I could harvest only 12 bags of maize in a season, which earned me Tsh 480,000 (about US\$218). Today, the harvest has increased to 30 bags, which translates to Tsh1, 200,000 (about US \$ 545) when sold at Tsh 40,000 (about US\$ 18). I have reduced the frequency of irrigating from three times weekly to once per week. I have also reduced the amount of fertilizer applied from three times (about Tsh 339,000 or US\$ 154) to only twice (about Tsh 201,000 or US\$ 91) now. Because of these changes, I have spare time to make mandazi (African dough-nuts), which earns me Tsh40, 000 (about US\$ 18) monthly. During the planting and harvesting seasons, I employ seven to eight people in my farm.

“When the community water reservoir dried up, I invested Tsh 30,000 (about US\$ 14) to establish a dug-out well to sustain the crop during the dry period,” says Santima, a farmer from Buigiri Irrigation Scheme. Another farmer; Mr. Peter Ilumbo, bought a motorized pump at Tsh 320,000 (about US\$ 145) to enable him pump water from improvised wells to his garden.

Big yield improvements

Significant productivity changes have been reported by participating farmers in nearly all intervention schemes. According to the chairman Kiwere Irrigation Scheme in Iringa, Mr. Rapahel Myinga, yields have grown by over 50 percent on average as a result of efficient water management and following recommended agronomic practices.



Sina Mliyuka at her onion farm in Kiwera Irrigation Scheme, Iringa, Tanzania

“There is heightened enthusiasm for new markets like Dar es Salaam, Dodoma and Mtwara. Increased quantities have attracted new buyers and everyday a truck comes to the farm to buy green maize and other produce,” says Myinga. “Farmers now have regular sources of income and the village economy is much better, jobs have been created and the number of thieves in the village has reduced.” Indeed, the farmers testify that lead farmers daily employ about 30 to 40 people during labour intensive periods such as weeding and harvesting.

In Msolwa Rice Scheme, farmers observe that yields for rice under low water and labour intensive systems promoted by the VIA are higher than those for framers not using the tools. “This is because farmers in irrigation schemes who are using monitoring tools are able to take full control of desired conditions for the crop,” says Asmini Mkangamo.

Political leaders described, the VIA project as a catalyst to the Tanzanian Agriculture and Food Security Investment plan of 2011, which sets a target of 1 million hectares to be brought under irrigation infrastructure by the end of 2015.



ABOVE: Asmini Mkangamo in her rice garden. Below: Asmini shows off a motorcycle bought from rice proceeds



Written by Ben Moses Ilakut (ASARECA). Originated jointly with Moses Odeke (ASARECA) and Tanzania project leaders, Dr. Chitutu and Dr. Nuru, during interactions with farmers at a monitoring mission in

Box 5: Asmini Mkangamo, Msolwa Rice Scheme

I harvested 23 bags (each of about 150Kg) of unthreshed rice which I sold at Tsh120, 000 (about US\$ 55) per bag, earning Tsh2, 760,000 (about US\$ 1,255). From the income, I bought a motorbike and rehabilitated the family house. The balance was used to buy food and re-invest into the farm. The women have experienced reduction of workload, respect from the community and better family relations due to increasing stakes in the family economy. I have additional time to make *mandazi* (African dough-nuts), which earns me about Tsh 300,000 (about US\$136) as additional income. I also have spare time to participate in the mosque and community banking.

October 2017. All photos taken from VIA sites