Technical Note on Homestead Farm-ponds for Micro-scale Irrigation in the Eastern Cape of South Africa

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Borewell water lifting. @Sarvesha Kumara / iStock

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World Bank Support to Eastern Cape Provincial Government

Technical Note on Homestead Farm-ponds for Micro-scale Irrigation in the Eastern Cape of South Africa

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Consultant Note

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1. Context of technical solution

Accelerating impacts from climate change have added to severe drought and flood cycles in South Africa, worsened by COVID-19 impacts on the economy, rising unemployment and escalating food prices. The Eastern Cape province is the second poorest in the country (78.7 percent poverty rate) and suffers endemic unemployment (45.8 percent). It also has the highest share of South Africa's small farmers (19 percent with half being women) and communal land (58 percent). Yet agricultural activity and productivity are very low.

The eastern half of the Eastern Cape has substantial available natural land and water resources. A need for development thus coexists with resource availability and intensive agricultural interventions, supported by irrigation, could help reduce poverty and unemployment. Recent studies supported by the World Bank to identify agricultural water development potential focussed on the eastern half of the Eastern Cape (Figure 1) listed three main opportunities. This note elaborates on the technical aspects of the homestead farm-pond and rainwater harvesting irrigation system, first described in context of the other solutions, followed by brief elaboration of the technical elements and costs.

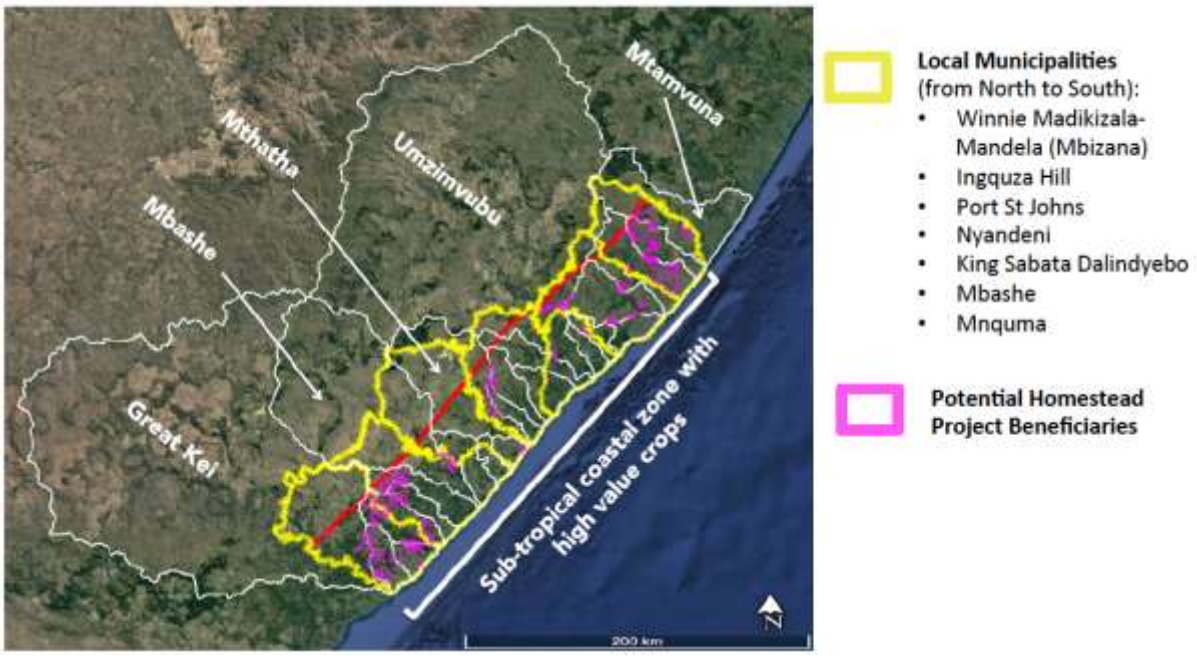


Figure 1: Eastern half of the Eastern Cape with the high-potential sub-tropical area of the coastal strip.

2. Main outcomes from prior studies

Initial studies identified opportunities for driving agricultural and local economic development based on land and water availability, and market potential. A focus on orchard crops (macadamia and avocado) and horticulture, centred around partnerships with private-sector and groups of local farmers was considered as the best option to pursue. Smallholder farmers face insurmountable challenges in the sophisticated, vertically integrated, and corporate agriculture environment that dominates in South Africa. PPPs address the need for skills, aggregation facilities, private finance contribution and market access, and present an opportunity for individual outgrowers to be linked into high-return value chains. Framed within this broad

PPP approach, land and water availability was investigated leading to the following three geographically-situated opportunities:

Consolidated farming blocks on communal riparian land: Available blocks of land under customary tenure are available alongside the main rivers that could support irrigation farming of high-value crops at a scale potentially attractive to an agribusiness partner (200 to 500 Ha in a localised vicinity in multiple sub-blocks). Water, rather than land, was found to be limiting and the estimated available area is between 9 000 to 11 000 Ha. The viable area is located within the 50km coastal strip where run-of-river water is available for irrigation. Customary land holdings would need to be consolidated.

Agri-business Estates: Two large blocks of land are currently held by Magwa and Majola states that were previously state-owned but were handed back to communities under the land-reform process. Water is available for up to 2 000 Ha of irrigation of orchard crops but the costs related to distance from water and large elevation difference makes these two options unfavourable.

Homestead Farms and RWH storage ponds: An estimated 3000 Ha of land is available with the homestead boundary (unit size between 0.5 to 2Ha) in the sub-tropical coastal strip where high-value crops can be grown. Individuals could pursue orchard crop production intercropped with high-value vegetables in an outgrower mode, linked to the agribusiness entity farming on the larger blocks as above. Irrigation water can be supplied by farm ponds (supplied by rainwater harvesting ditches) of approximately 200 cu.m in size Figure 2, to support 0.2-0.3 Ha of intensive irrigation production.

3. Technical features of the Homestead Farm Pond System

Rainwater harvesting interventions for farm ponds intercept surface runoff from the surrounding vicinity (including roads, roofs, overland flow etc.) with cut-off ditches that drain water to the farm pond. A detailed hydrology, runoff and storage assessment has been conducted for the area.

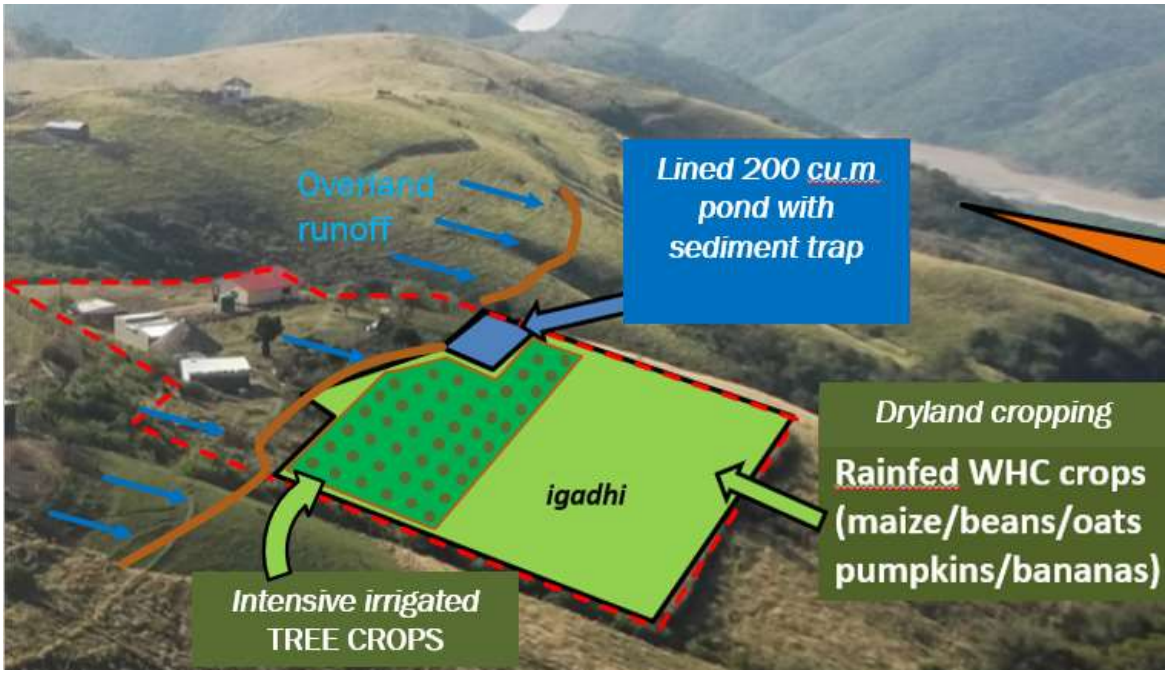
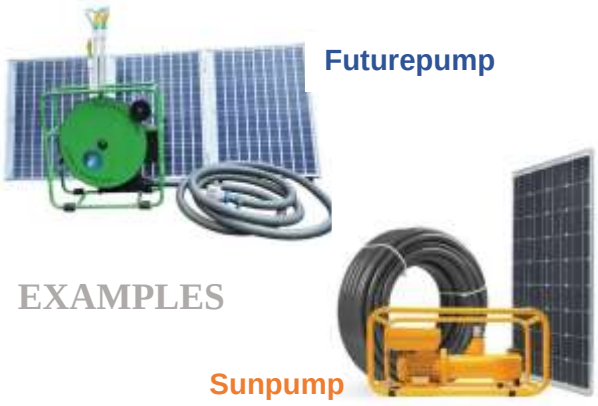


Figure 2: Schematic of homestead production unit with farm-pond and RWH diversion trenches

The approach has been used in multiple similar contexts across Africa (Kenya, Ethiopia, Ghana among other – Figure 3) to support high-value intensive crop production at homestead level The main technical elements of the system are listed in Table 1, and illustrated with photographs.

Figure 3: Example of farm ponds in the successful World Bank NARIG Program in Kenya to support homestead intensive production

Table 1: Main technical elements of the farm-pond irrigation system

Lining: Ponds would be lined with 0.5mm HDPE liner to maximise water retention and would be fenced to ensure the safety of children and animals.	
Micro-irrigation solar pump units: Reliable and established micro-irrigation solar units are widely available in South Africa. These - demonstrated as suitable for smallholder applications across Africa. They have low carbon emissions, low operational and maintenance costs, and due to the relatively small-scale of intensive irrigation farming (up to 0.3 Ha) have a low labor requirement that can be provided with family labor.	

On-farm irrigation systems:

Irrigation application techniques would include low-pressure micro-jets for orchards, and spray tubes (low-cost plastic perforated lay-flat strips) for vegetables. Drip irrigation is not likely to be appropriate given the relatively high silt load of harvested water and the excessive need for filtration that results.

Micro-jet for macadamia / avocado

Spray tubes for vegetables or hose irrigation

Soil water management technology:

Soil-water management technology is a highly effective intervention to manage irrigation water within a climate-change context. Use aims to optimise water in the root zone and irrigation efficiency to boost production. The best example of a cost-effective and robust monitoring instrument is the 'Chameleon', developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO) and distributed by the Virtual Irrigation Academy (VIA) based at the University of Pretoria.

Experiences across Sub-Saharan Africa show highly positive outcomes in high profits, reduced labor reduction and healthier crops.

What is the Chameleon Card starter kit?

The Chameleon Card measures soil sensors using colored lights to tell you when to irrigate. The Chameleon Card starter kit (shown in Figure 1) lets you know how hard the plants must work to extract water from the soil. The kit consists of a reader, that looks like a credit card, plus three sensors. The reader on the Chameleon Card has a light (see Figure 2) which changes color in response to the soil water status.

- Blue means the soil is wet (do not irrigate)
- Green means the soil is moist (get ready to irrigate)
- Red means the soil is dry (plant experiencing water stress)

The sensors can be buried in three different fields, or at different depths in one location. Simply touch the wires against the contact pads on the reader and the light will change color to show the soil water status. It could not be simpler.

Figure 1. Chameleon Card starter kit

Estimated costs of the farm-pond irrigation system:

The cost of the farm-pond system capital expenditure would include:

Indicative System Costs	**ZAR**
Pond excavation (mechanized TLB)	R18,000
Pond lining (0.5mm HDPE or similar)	R24,000
Pond fencing (1.2m mesh)	R6,000
On farm irrigation (0.25 Ha)	R13,000
Solar pump/panels (180 Watt with pump)	R17,000
TOTAL (0.3 Ha pond storage, pump and irri system)	**R80,000**

In addition, beneficiaries would have to contribute labor to excavate diversion trenches of up to 100m on either side of the pond, along the contour, to capture water in the RWH system.

4. Conclusions

1. **A rainwater harvesting farm pond irrigation system in the targeted coastal strip of the Eastern Cape can support 0.2-0.3 Ha of high-value orchard and vegetable crops:** The homestead irrigation farm production system is expected to support irrigated production of high-value orchard crops (eg. Macadamia) intercropped with fresh vegetables. Homestead farm sizes (rainfed) in the high potential area of the coastal strip are typically 0.5 Ha to 2 Ha in size, with 0.2-0.3 Ha allocated to irrigation under the proposed system.

2. **Homestead irrigation enterprise is based on an outgrower production model:** The locality of the homestead irrigation farm production would be in reasonably close proximity (15 to 20 km) to a large-scale agribusiness entity willing to support outgrowers. The agribusiness entity could establish on an estate farm or be a PPP on consolidated customary land. Outgrower support would include agronomy and irrigation advisory services, access to inputs, and a secure market for the majority of the crop.

3. **Technical elements of the system:** The hydrology assessment has confirmed water availability from surface runoff interception of a rainwater harvesting system with a pond of 200 cu.m to support 0.2-0.3 Ha of intensive irrigated production. Technical elements include an excavated lined pond, fencing for drowning safety, solar pump and low-pressure irrigation system and earth cutoff trenches for surface runoff interception. Final assessment of irrigated area would depend on the localities rainfall, final crop choice, and the runoff area available.

4. **Capital costs of the system** are estimated to be approximately ZAR 80,000 for a 200 cu.m pond and an equipped 0.25 Ha irrigated area in the homestead.

5. **Requirements for suitability of the rainwater harvesting farm pond irrigation system would include:** Locations were soil-depth is > 1.5m; the homeowner is willing to allocate land to the pond (approximately 150 sq.m); adequate runoff areas are available upslope (noting access to road runoff and drainage ditches enables successful harvesting from smaller areas in more dense settlements); neighbours and traditional leaders are in agreement with harvesting water from communal areas; the lack of potability and associated risks of drinking contaminated water from surface runoff is fully understood).

6. **Benefits from the homestead irrigation enterprise:** The homestead production model has significant benefits for the inclusion and empowerment of women in agriculture. Immediate access to the homestead plot saves women's time and enables effective use of family labor. Benefits include cash generation (through outgrower crop) and food diversity and cash through horticulture, leading to increased nutrition and reduced poverty. Water investments further empower women who are culturally responsible for water management in the homestead.