Irrigated agriculture using wells and pumps in Kahe ward, Kilimanjaro

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To the reader

This booklet is the result of a research done in Kahe ward in January and February of 2016. We, two researchers from Kenya and the Netherlands, did research on irrigated agriculture with pumps and wells in the villages of Miwaleni, Kisangesangeni and Oria. We are part of a larger group of researchers doing research on irrigation in Tanzania and Mozambique. The objective of the research was to learn about irrigation systems started by farmers, about their benefits and challenges and about how the government interacts with these systems. We interviewed farmers who use wells for irrigation as well as leaders in the three villages. We also talked to people of the Pangani Basin Water Office and the Zonal Irrigation Unit of Kilimanjaro. We observed how people farm, which technologies are used to irrigate, and read about the history of Kahe.

In this booklet, you can read the results of our research. Most importantly, we found that:

- Using wells and pumps, farmers are less dependent on unreliable rain or limited river water
- Farmers with a well harvest more maize, and are more likely to grow high value crops
- The biggest challenge for farmers is the cost of agricultural inputs and fuel
- Insufficient agricultural extension work means that farmers do not get the necessary support in dealing with pest and diseases
- Not all farmers can benefit equally: those who are rich benefit more than those who are poor, because
  - They can afford the agricultural inputs and labourers needed for high value crops such as onions and tomatoes
  - They do not have to use middlemen and can take their crop to markets with better prices
  - They often do not grow maize, and can plant early in order to sell their crops at higher prices

We would like to thank all farmers who participated in our interviews for their time, their energy and their patience. We are also grateful to local leaders for supporting us, and to the representatives of the Pangani Basin Water Office and the Zonal Irrigation Unit for taking time to talk to us.

Indeed, water is life.

Chris de Bont and Muthio Nzau
Research area

Kahe ward lies 12 km south-east of Moshi town, in the Kilimanjaro region in northern Tanzania. It is part of the Pangani River Basin, and falls within the Northern Irrigation Region. It has roughly 19,000 inhabitants and is comprised of eight villages. In this research, we focused on three of those villages: Miwaleni, Kisangesangeni, and Oria. Combined these account for 12,000 inhabitants, with the majority of people living in the town centre of Oria (Kahe town). The mean annual precipitation is 365 mm, with most rain occurring between March and May. Agriculture is the main source of income for most villagers. There is a road connecting Kahe and Moshi town, as well as a road connecting Kahe to the Moshi-Himo highway. The closest major market is in Moshi town. Kahe town has a Savings and Credit Co-operative Society, but no bank.

The ward has a long history of irrigation development, both by farmers, companies and the government. The main water sources in the ward are the Rau River and the Miwaleni Springs, which feeds into the Dehu River. In the 1960s, the government planned to build a groundwater irrigation scheme in Miwaleni. In this scheme, water would be pumped from deep boreholes and distributed by canals to irrigate the land of smallholder farmers. This never happened, and instead the water from the spring is used by the TPC sugar estate and the smallholder irrigation schemes of Mawala and Kimwangamau. The Rau River only carries water during the rainy season, because water is abstracted upstream by the Lower Moshi Irrigation Scheme. There are both deeper and shallow aquifers, the extent of which are not precisely known.
Irrigation history of Kahe

Until the 1980s, the Rau River was used for irrigation by smallholder farmers in Kahe, who dug their own canals (see map). After this, the river dried up for large parts of the year due to upstream developments. One of these developments was the completion of the Lower Moshi Irrigation Scheme (LMIS) in 1987, a rice irrigation scheme designed and funded by the Japanese aid organisation JICA. Next to this, upstream villages relying on the Rau River also kept expanding their irrigated areas. As a result, farmers in the research area (who are the most downstream) relied on rain-fed agriculture from the mid-1980s, until rains became insufficient for growing maize even in the main rainy season. This happened during the 1990s, and the rain continues to be unreliable.
Wells for irrigation

Farmers in Kahe first started using wells for irrigation in the early 2000s. Wells which were dug before that time were for domestic use or the construction of a house. Now almost all wells outside Kahe town are used for irrigation. Before, a few people were using KickStart treadle pumps (‘MoneyMakers’), but nobody saw this as a serious way of irrigating. People would not be able to irrigate more than half an acre, because the work was so tiring. Now farmers use petrol pumps, and are able to irrigate larger areas with less labour. Using the wells and pumps, farmers grow a variety of crops. Some grow maize and beans, and use irrigation to make sure they harvest well. Others have started growing tomatoes next to their maize, and again others farm tomatoes and onions for business only. What a farmer can grow depends on how much money he or she has, because inputs are expensive and loans difficult to get.
Almost all farmers use a pump of Chinese origin which they buy at dealers in Moshi town at a cost of 250,000-350,000 TSH. In addition, they need a suction pipe, which costs 10,000 TSH per meter. Most farmers also use either a flexible delivery hose (100,000 TSH for 50 meters) or a delivery pipe (2,500 TSH per meter). The costs of a well vary strongly and depend on how much farmers do themselves, how deep the groundwater is and whether they encounter any rocks while digging. Some farmers dug the wells themselves, while others hired local labourers to do so. The maximum price is about 1.5 million TSH, but most paid 500,000 TSH or less.

**Summary of costs**
- **Pump:** 250,000 – 350,000 TSH
- **Suction pipe:** 100,000 TSH
- **Delivery pipe:** 50,000 TSH
- **Well digging:** 200,000 – 500,000 TSH
- **Total cost:** 600,000 – 1,000,000 TSH
Well and pump technology

A well typically irrigates 1-3 acres, although it can go up to 9 acres if several pumps are used on the same well. The most common pumps used have a 3 inch diameter outlet and a capacity of 5-6 horsepower. The size of the pump limits the area, not the water availability of the well. This might change in future if more farmers start pumping groundwater, extend their growing season or start using larger pumps. Most farmers use their well for one or two days a week for irrigation.

Changes have been made to the design of the wells over time. For example, a round well is less likely to cave in than a square well. Also, when you dig a chamber next to the well, you can put the pump closer to the water level. If you put it closer to the water level, the pump is less likely to break down and it uses less fuel. If the pump needs to lift the water over a longer distance, air bubbles form. These bubbles enter the pump and lead to noise, small water flow, high fuel consumption and damage to the pump.

The chamber and the well are generally dug separately, to prevent destabilising the well and to stop the walls from caving in during the rainy season. The chamber is less common in flood prone areas, because it would be costly to reinforce both the chamber and the well with bricks and cement, which is needed to prevent the well from caving in during floods.

If you have a chamber, your pump uses less fuel, makes less noise, gives more water and is less likely to break down
Factors influencing irrigated agriculture

Because of the wells, almost all farmers have access to irrigation water. This means that it has become possible to grow high value crops, and go from subsistence farming to commercial farming, while raising the agricultural productivity – some of the main objectives of the Tanzanian government in the field of agriculture. However, water alone is not enough to achieve this. Access to land, inputs, markets, knowledge and support are important factors in being a successful farmer. In the next sections, we describe whether these things are available for farmers in Kahe.
Land

Kahe is attracting more and more people who are interested in practicing commercial agriculture. Some are farmers elsewhere, but many are businessmen who see agriculture as an investment. They rent land per season or, on rare occasion, buy it, and grow onions, tomatoes and other high value crops. This increased interest in land has raised land prices, both for buying and renting. The price for one acre of land has more than doubled during the period in which people started irrigating from wells.

Having a well on your land does not only raise the sales price, it also increases the amount you can ask for seasonal rent. Before the start of groundwater irrigation, land would lie fallow for most of the year. Now, suitable land is irrigated and cultivated year-round, often by renters. Before the well, land would be rented out at 50,000 TSH per acre per season, while now it is common to pay 100,000 TSH. Although this is a good development for farmers with more land than they can farm, it creates a problem for those with insufficient land. Local farmers lose out compared to those who can easily afford the rent.

There have been hardly any problems in getting renters off the land or collecting the rent. However, tenure insecurity has crept in through a governmental policy to take away land which is not utilized by the owners. Several farmers reported how their land was judged unused, and then sold without their knowledge, or that they feared this happening. In some cases, the land had been left fallow, but this could even happen if maize had been planted. They all connected this to an increase in economic activity in the area.

"Before, you could just ask a friend for land. But now agriculture has become sweet to people. People no longer want to give land for free if they know they can get 100,000 TSH"

Farmer, Miwaleni
This table shows how farmers with little money ($) can afford fewer inputs, get less yield and less profit than richer farmers ($$). They are also not able to grow onions, which give the highest potential profit. In short: if you have no money, you can make no money. Unless small farmers get access to credit or affordable inputs, they can never truly benefit from wells.

### Inputs and markets

Large areas in Kahe ward are now used for the cultivation of tomatoes and onions, but the crops on these fields almost always belong to non-residents who have access to capital (often from other sources than agricultural). They manage to grow these high value crops year-round, to get good harvests and to get good prices for their crops. The reason that few local farmers manage to do the same, is because they have less money to buy inputs and access the right markets.

First of all, cash crops require more inputs in terms of fuel (for pumping water), seeds, pesticides, fertilizer and land preparation. Small farmers do not have the money to afford all these, and loans are difficult to get. Secondly, small farmers have no choice but to sell to middlemen. Since almost all farmers follow a similar cropping calendar to optimize benefits from rainfall, they all harvest around the same time, causing prices to drop. Businessmen have more opportunities to schedule their planting and are able to take their produce to markets in Moshi, Dar es Salaam or elsewhere if farm-gate prices drop.
Education and support

Extension officers rarely visit the area, and neither governmental nor non-governmental actors have provided support or information for farmers using wells. This is becoming problematic, because tomatoes and onions were not previously grown in the area. Without extension workers or irrigation support, farmers are largely farming by trial and error or ask advice from more experienced farm managers who have been employed by incoming businessmen. In many farms, harvests are being spoiled by pests and diseases, leading to the increased use of pesticides. Most of the times it is not clear to farmers which pest, disease or deficiency is affecting their crops, or what the appropriate treatment is for that problem. Their main source of information is the retailer selling these agrochemicals. Several farmers have decided to stop farming tomatoes because of the high level of pests.

Farmers also do not get support in developing their irrigation practices or technologies, and most still simply flood their land. More efficient irrigation could reduce pumping costs and advice on well and pump use could increase their effectiveness.
Farmer showing how his onions are plagued by a pest

Diseased peppers, discoloured and too small
Different farmers have different needs

Not all farmers have equal access to inputs, markets and knowledge. Because of this, there are different groups of farmers benefiting from the wells differently. Each group has its own agricultural practices, its own challenges and its own needs for support. We see there are four main groups: Food, Food+, Commercial and Commercial+.
Food

These farmers grow maize and beans, together with a kitchen garden. They first produce crops for food, and sell what is left over to pay for basic living expenses and school fees. These farmers are not able to grow cash crops such as tomatoes or vegetables, or they are unwilling to take the risk. For some of them the major constraint is not having a pump, but more often they lack the capital for other inputs. They are likely to rent out their land during the dry season, because this is easier and more beneficial than farming it themselves. Almost all woman-headed households fall into this category, due to lack of access to capital and less access to family labour. Most people in this category refuse to take loans from the SACCOS, because they are afraid of losing their homes.

Crops: maize and beans

Main challenge: money for inputs and fuel

Who: local farmers with no (or little) non-agricultural income. Especially: elderly and female-headed households
Maize intercropped with tomatoes

Food+

These farmers are still focused on producing their own food, but manage to grow some cash crops on the side. They are growing maize intercropped with tomatoes or grow a variety of vegetables on a small area. They use fewer inputs than commercial farmers, and at times their crop may fail completely, but they are taking a risk in order to have a chance at higher returns. They sell some of their crops to middlemen or to people in the village, and use the rest for home consumption. They employ people to help with weeding, planting and harvesting, but often still also work as labourers on others’ farms. The money earned helps them to grow their crops. Together with the food farmers, this group represents the majority of farmers.

Crops: maize and tomatoes/vegetables

Main challenges: money for inputs, low market prices

Who: local farmers with limited capital or the ability to take a loan
Commercial

These are most often local farmers who are residents of the area, and who are committed to doing commercial agriculture. These farmers often have land elsewhere, mostly in rice farming areas, or have other sources of non-agricultural income. This allows them to set up the capital intensive cultivation of onions and or tomatoes. They own the land they are farming on, which is generally larger than the landholdings of the previous groups. Next to their own labour, they employ workers for farming activities, and use inputs as required. They are relying on middlemen for the sale of their crops, and often still grow some maize in the rainy season as a source of food.

These farmers are very few, probably less than a handful in the studied villages.

Crops: tomatoes and onions
Main challenges: pests and diseases, markets
Who: local farmers with off-farm income
The final group consists of people from outside Kahe who have gone into farming for business. One of them sells phone accessories, another has a hardware shop, but all of them have seen the financial potential of commercial farming in Kahe. They came to the area because of water security and readily available land. At the same time, the market for fresh vegetables, tomatoes and onions has been growing in both Tanzanian and Kenyan cities. These people rent land and employ workers to take care of the crops. They do not provide labour themselves. Many hire experienced managers, who know how to farm high value crops. They all supply the inputs needed to farm, and pay the workers a salary. Besides their normal employees, they also hire day labourers during field preparation, planting and harvest. Harvested crops are sold in Dar es Salaam, Mombassa and Moshi.

**Crops:** onions and tomatoes

**Main challenge:** pests and diseases

**Who:** businessmen from outside Kahe
Tractor plowing
Labourers packing tomatoes
Carrying pump to the well
Wells are also used for domestic water
Recommendations

For farmers
- Put your pump as close to the water as possible, to save fuel, pump more water and prevent breakdown of your pump
- Try to plant early, so you can get a better price for your crop
- Form an association or cooperative, so you can ask for help from the government and NGOs
- Sell crops collectively to negotiate a better price

For government
- Support farmers through extension work, so they can choose the right crop, apply the right inputs and spend their money well
- Support farmers in setting up a cooperative or association, so they can continue to receive support from different projects. If smallholders develop, the country develops.
- Explore the possibilities for collective groundwater use with deep tubewells
- Further improving the wells and pumps and advising farmers on how to use them and how best to apply water to the fields, can raise productivity and efficiency.

For NGOs
- Support farmers in accessing stable (regional) markets
- Link small farmers to value adding industries
- Set up a system of micro-financing
- Test the water quality of wells in order to know whether this water is safe for drinking and/or domestic use (relating to the use of pesticides and contamination from pit latrines)
- Explore the possibilities for collective groundwater use with deep tubewells

For businesses
- Set up a storage facility and charge for storing harvested crops
- Provide credit to farmers at a small interest rate
- Sell inputs in combination with agronomic advice
- Drill a borehole and sell irrigation water/land to farmers growing high value crops
Acknowledgements

This work was made possible by the Resilience in East African Landscapes (REAL) project funded by the European Union’s Seventh Framework Programme for research, technological development and demonstration; and the Studying African Farmer-led Irrigation (SAFI) project funded by the UK Department for International Development (DFID) and the UK Economic and Social Research Council (ESRC) through the DFID-ESRC Growth Research Programme (DEGRP)