Section 1 – Introduction to the course

Phil Woodhouse is Professor of Environment and Development at the Global Development Institute, at The University of Manchester. He was the lead researcher on the Studying African Farmer-Led Irrigation project.

After training as an agricultural scientist at Oxford and Reading, Phil worked in Mozambique for eight years for the National Agronomy Research Institute and the Food and Agriculture Organisation of the United Nations. After returning to the UK he was first based at the Open University and subsequently at Manchester. He has undertaken research in a number of countries in Francophone West Africa, southern Africa, and East Africa.

Watch the video here: https://www.youtube.com/watch?v=S6-RWtirK6E

Video transcription

Welcome to our introductory course on farmer led development of irrigation.

Early in my career when I was working as a soil scientist in tropical Africa, it became very clear to me that water management was central to any improvement of soil productivity, not least because the variability of rainfall – both from year to year and across the course of any given rainy season.

And so for a number of years I've been undertaking research on how farmers – small scale farmers – in Africa are adapting their land and water management both technologically, socially and economically, to deal with changing agricultural circumstances.

A long running theme in this work is the extent to which when you observe what farmers are doing in the field, it diverges greatly from the expectations of policymakers. In particular, farmers seem to be much quicker to identify new opportunities and to respond to them than agricultural planners seem able to imagine.

So when I began to read research reports of rapidly expanding irrigation by small scale farmers in central Mozambique I was very keen to collaborate with the researchers who'd been leading this work in Wageningen University in the Netherlands.

When we got talking, we realised that this kind of thing was going on in many different places throughout sub-Saharan Africa. So together with colleagues of mine here in Manchester, with Hans Komakech in Tanzania and with Angela Manjichi in Mozambique, we formed a team to investigate this phenomenon of farmer led irrigation development in more detail and to engage policymakers in government and elsewhere in discussion of what should be the response to it.

This became a three year project which we call Studying African Farmer-Led Irrigation.

This course was conceived after we had run a couple of two week workshops in Tanzania. The workshops were oversubscribed and we wanted to find a way to share more widely at least a summary of the lessons and discussions that had taken place.

Of course this short online introductory course can only provide a summary of the many practical and policy questions which are raised by the phenomenon of farmer-led development of irrigation in

Africa and we encourage you to sign up to the SAFI network which is hosted by Hans Komakech and his colleagues at WISE futures in Arusha in Tanzania.

Recognising the potential of farmer-led irrigation with Dr Hans Komakech

Dr Hans Komakech, centre leader of WISE Futures and researcher in the Studying African Farmer-Led Irrigation project, explains the growing realisation of the potential for farmer-led irrigation.

Watch the video here: https://youtu.be/AqIQUg8a_As

Video transcript:

I think there is now an awakening moment that irrigation development could be best done by farmers. In the past, the strong focus was on how government-led large schemes could contribute to the African Green Revolution – but the high cost of, and the challenges with, those schemes made people turn away from irrigation in Africa; it made it difficult for people to come back to irrigation.

But later there was a realisation that actually farmers have been taking the initiative of irrigation development further, and that this irrigation development by farmers is actually contributing enormously to economic development, employment and food security.

So now people realise that farmer-led irrigation could actually be the way to go to solve some of the issues of agricultural crop production.

Of course there are still elements of thought around how you engage with that process. Is it about technology? Is it about the process? Some people look at it as a vehicle by which they can promote some of their ideas on cheap technology, because we know that, for most of these farmers, skills and technologies have contributed quite a bit, e.g. the arrival of solar panels which are low-cost, or the arrival of diesel pumps. But for the most part I think farmers react to markets, and technology has enhanced the opportunity to produce for the markets and that is the area which many people are now interested in.

Of course governments have also supported this initiative with some of the things that have taken place, either by roads or through developments in some of the policies that have also enhanced the capacity of farmers to invest in their agriculture.

But it still leaves that gap there in the understanding of whether farmer-led is more about technology or is about engaging with the process in which farmers can be supported to enhance their agricultural production.

Section 2 – Changing perspectives on African irrigation

In this section you'll learn about:

- the history of irrigation in Africa
- the history of participatory irrigation design
- how the lessons of the past can help you understand irrigation today.

Irrigation in Africa has been influenced by international factors, such as colonial priorities, changing donor policies and export prices, as much as domestic policies and government strategies. The following historical overview helps to explain how the current context has emerged.

Colonial Administration: 1900 – 1950

European colonial administration was formally imposed in much of sub-Saharan Africa at the end of the 19th century.

Colonial investment was guided by demand for industrial raw materials. Irrigation development was focussed on large-scale engineering schemes to produce cotton such as:

- the Gezira in Sudan, constructed in the 1920s on the Nile,
- the Office du Niger built ten years later on the river Niger in Mali.

"Sign announcing the Office du Niger near the Markala dam in Mali". Source: Wikipedia, CC BY 2.0

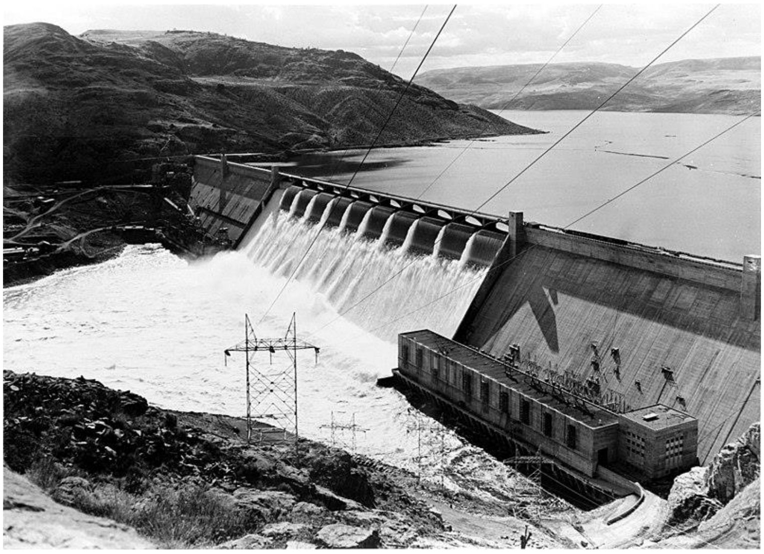
In both these schemes small-scale cultivators were allocated plots as tenants of a (colonial) state corporation responsible for managing the scheme, supplying inputs and buying the produce.

Although irrigation development by European settlers was commonplace in African colonies, pre-existing local African systems of irrigation were largely ignored (or in some cases banned as environmentally damaging) by colonial administrations.

Late colonial and early independence administrations: 1950s – 1960s

As African countries began to achieve independence in the 1950s and 1960s, irrigation was increasingly based on the example of the United States. This was seen as the most technically advanced country.

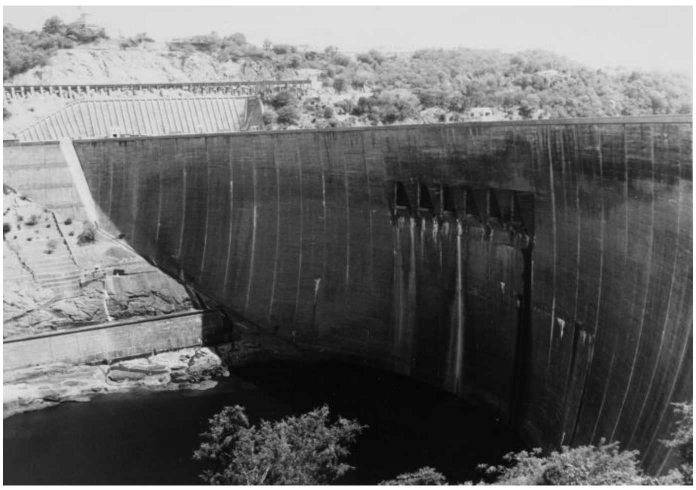
Economic development, particularly in the western states of the US, had hinged on construction, especially after 1930, of some 8000 major dams for irrigation and hydropower funded by the US Federal government.



Grand Coulee Dam on the Columbia River, Washington State, US. Source: Office of War Information Photograph Collection (Library of Congress)

Consequently, as Africa approached independence from colonial rule there was a boom in dam construction, including:

- the Akasombo on the Volta in Ghana
- the Kariba on the Zambezi in Zambia-Zimbabwe,
- and the use of large-scale irrigation as a framework for rural settlement schemes (e.g. the Mwea scheme in Kenya).



The Kariba dam. Source: Wikimedia Commons.

Much of this was funded through bilateral or multilateral development finance. Irrigation was seen as a means to achieve nation-building, by modernising agriculture, increasing export earnings and improving food self-sufficiency. Engineering was the key lens through which the feasibility and viability of irrigation was assessed.

A history of irrigation design approaches for smallholder farmers in sub-Saharan Africa: 1970-1990

Post-independence: 1970s and 1980s

Rapid population growth accompanied the post-war economic boom and food shortages led to concerns about agricultural productivity. In the mid-1960s India imported cereal but the success of 'green revolution' technology transformed the country to achieve self-sufficiency by the early 1970s. Similar successes followed in South-East Asia in the 1970s and Bangladesh in the 1980s.

This 'green revolution' relied on a technological package that included improved varieties of wheat and rice capable of producing heavy yields of grain when irrigated and supplied with large amounts of fertilizer. This often resulted in double the amount of cereal harvested per cultivated area.

In the 1970s there was significant investment in irrigation in Africa seeking to replicate the Asian green revolution.

Irrigation. Sourced: Levi Morsey, Unsplash.

1980s and 1990s

By the 1980s it became clear that many irrigation projects had not replicated the Asian success. This was true for large-scale schemes of thousands of hectares which were run (as in colonial times) by government agencies. These government agencies operated and maintained the infrastructure and supplied inputs such as seed and fertilizer to small-scale tenant farmers. The government agencies deducted a payment for these services from the farmers' harvests.

There was also limited success in many smaller schemes of a hundred hectares or less where a community or group farmers shared a pump to deliver water from a river or lake.

Reasons for the lack of success included:

- **inappropriate technical design;** there was often insufficient knowledge of hydrological conditions, including existing water use by small-scale farmers

- **high cost, low performance;** a lack of market linkages (power supply, input and output market failure) , land tenure conflicts.
- **and a need for designs to better serve small-scale irrigators;** a lack of understanding of how irrigation fits with wider livelihood strategies.

These observations about shortcomings in African irrigation fed into a broader international political narrative in the 1980s that saw state-run activity as inherently inefficient and/or corrupt, exemplified by 'top-down' control by government irrigation agencies.

This view sought to introduce market incentives by 'turnover' of irrigation management from government agencies to associations of farmers and commercial suppliers of goods and services. As in other parts of the world, such 'structural adjustment' measures were pursued in many parts of sub-Saharan Africa.

Such efforts to reduce state control in irrigation aligned with other contemporary discussions about how much 'experts' and scientists truly understood local development contexts. Rural people's indigenous knowledge was validated through participatory appraisal and planning systems developed by researchers such as Robert Chambers.

A Rapid Rural Appraisal was developed to understand what farmers were doing. Research looked at the farmers' systems, what was required, what labour was available, and then design was undertaken. Irrigation practitioners started to become more farmer-focused when proposing designs and structures. At the same time, reports published by FAO highlighted the extent of unofficial irrigation in sub-Saharan Africa.

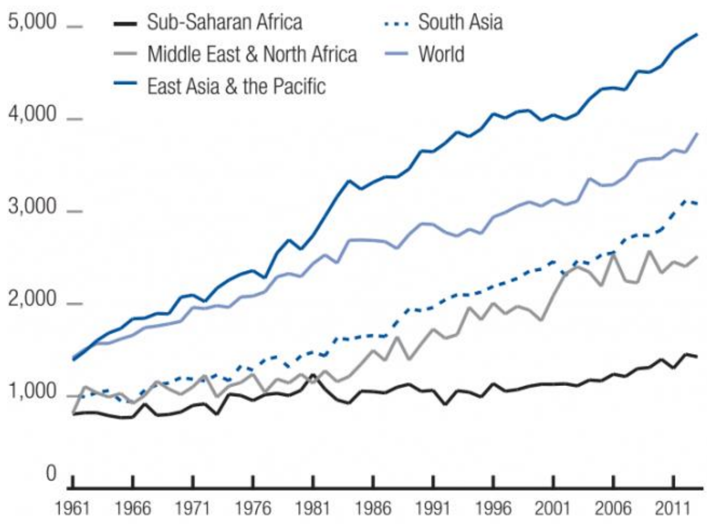
A history of irrigation design approaches for smallholder farmers in sub-Saharan Africa: 1990 – present day

A ‘lost decade’: 1990s

The early 1990s saw a growing critique by irrigation engineers of under performance of irrigation engineering design specifically in sub-Saharan Africa. This led to major efforts to re-think how engineers should work with small-scale farmers using more ‘participatory’ methods. Lucas Horst at Wageningen University in the Netherlands led an exemplary initiative on this.

There was widespread concern that African agriculture was stagnating and falling behind Latin America and parts of Asia. However, as international food commodity prices were falling and it was still relatively cheap to import food to the large coastal cities of Africa, agriculture did not get the investment it needed.

Figure 1: Cereal yields by region, 1961–2013
Kilograms per hectare



Source: World Bank, 2015.

As a result, there was a hiatus in irrigation and agriculture investment by both national governments and international donors in the 1990s. Instead, policy focused on institutional and regulatory reform in order to achieve ‘integrated water resource management’ (IWRM) to mediate competing demands for water at the scale of major river basins, with a strong emphasis on water conservation.

Early 2000s

At the turn of the century, new continent-wide initiatives promoted the need for improved agricultural water management.

For instance, the African Union’s development program, the New Partnership for Africa’s Development’s (NEPAD’s) Comprehensive Africa Agriculture Development Programme (CAADP) identified irrigation development as one of the focus areas for pursuing increased and sustainable productivity in agriculture. The UK government's Commission for Africa in 2005 also advocated massive investment in irrigation development.

The CAADP promoted the revision of national irrigation policies and an increase in national agricultural budgets.

Thanks to this continent-wide approach, investment in irrigation rapidly increased despite the problems of the previous decade.

In 2006, a rising oil price and a boom of biofuel production (supplied by cereal and oilseed crops) created a rapid rise in food prices. This exposed weaknesses in the functioning of international food markets to increase trade in times of scarcity. There was a sudden interest in food production and investors became interested in what was seen as profitable, irrigable, land.

Source: Jatropha, by UnconventionalEmma, Flikr CC BY-NC 2.0

Foreign governments and commercial investors attempted to acquire large tracts of land in areas where land was cheap, often in Sub Saharan Africa. This was widely criticised as threatening to displace existing communities – a process known as 'land grabbing'. The availability of water for irrigation was a critical factor for investors.

Higher agricultural prices (and hence increased costs of food imports) also re-energised pan-African efforts to improve agricultural productivity. International bodies and African governments dismissed concerns about 'land grabs' with promises of new technology, increased training and job opportunities. They sought rapid agricultural expansion through foreign investment in large-scale farming. Governments made ambitious plans for irrigation to increase agricultural productivity on a large scale by creating special planning powers in development areas and 'growth corridors' such as the Beira corridor in Mozambique and the Southern Agricultural Growth Corridor in Tanzania – SAGCOT.

However, also in this period, growing evidence emerged of dynamic, private irrigation, on a small scale (between 0.5 and 5 hectares), where individual farmers used pumps to irrigate commercial crops. 65,000 pumps were imported into Ghana alone between 2003-2010.

Much of this small-scale irrigation is unofficial and not recorded in official statistics. However, improvements in remote-sensing satellite technology have enabled analysis of images that have greater resolution – improving from 10km in 2006 to 10m in 2016. Thanks to the emergence of satellite data and improved resolution, studies by IWMI showed that irrigated area in sub-Saharan Africa is actually two or three times greater than previously thought.

Growing recognition of the importance of irrigation initiatives by small-scale farmers in transforming agricultural livelihoods in sub-Saharan Africa has prompted international support for 'farmer-led irrigation development', exemplified by the World Bank:

Watch the video here: https://youtu.be/GMarUG0EeKo

Finally, it was realised that the problem of irrigation design was rooted in practitioners' approaches to understanding farmers.

A growing number of irrigation engineers recognise the importance of involving farmers in the process of irrigation design. They have begun trialling participatory design and farmer management, and exploring more bottom-up, grassroots approaches that recognise farmers' own technical knowledge.

Farmer-led irrigation development throughout the years

Throughout the different decades described previously, farmers' irrigation initiatives have been consistently ignored or cast aside as unproductive and inefficient.

When recognised in policy, farmer-led irrigation development is equated with informal irrigation, and therefore in need of infrastructural and institutional formalisation.

In spite of this, farmers have continued to expand irrigated areas, often with little external (financial) support, and have contributed to increased food security and economic development on a regional scale.

Key messages:

- Irrigation in Africa has been influenced by international issues (such as colonial priorities, changing donor policies and food prices) as much as domestic (national policies and government strategies).
- Across Africa, the disappointing results of official irrigation schemes funded by government and international development agencies have improved in recent years. But large-scale developments tend to be slowed by barriers to large-scale land acquisition and extended timeframes for infrastructure construction. Farmers' irrigation initiatives are commonly more dynamic. Even though farmers' irrigation initiatives have not been systematically mapped or recorded, there is increasing evidence that, in aggregate, they cover much larger areas than was previously assumed.

Suggested further reading:

Designs for Sustainable Farmer-Managed Irrigation Schemes in sub-Saharan Africa: https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8164.pdf

Costs and Performance of Irrigation Projects: A Comparison of sub-Saharan Africa and Other Developing Regions: http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB109/RR109.pdf

Water for wealth and food security: Supporting farmer-driven investments in agricultural water management: http://www.iwmi.cgiar.org/Publications/Other/Reports/PDF/Water_for_wealth_and_food_security.pdf

Acknowledgements:

- Chris de Bont, Stockholm University, Sweden
- Phil Woodhouse, Global Development Institute, The University of Manchester

Section 3 – Defining farmer-led irrigation development

In this section you'll learn about:

- How to define farmer-led irrigation development, and
- How to identify farmers' irrigation initiatives.

What is farmer-led irrigation development and how does it differ from other forms of irrigation development?

Put simply, farmer-led irrigation development is an irrigation development process that is initiated by farmers.

We define 'farmer-led irrigation development' as a process in which small-scale farmers drive the establishment, improvement and/or expansion of irrigated agriculture, often in interaction with external actors. These external actors' include: neighbouring farmers, agro-dealers and traders, craftspeople, agriculture extension agents, irrigation engineers, administrative authorities, local and national policy makers, civil society and development aid agents.

Farmer-led irrigation development can:

- take place at different scales,
- be used to grow a variety of crops,
- rely on various technologies and governance arrangements.

Examples of farmer led irrigation development

In the following images you will see a number of scenarios which depict farmer-led irrigation development. Each image is followed by a short description explaining what has been implemented.

Harding, Rowena. “Farmer-led Irrigation Development. Tanzania.” 2018. NEF.

Farmers started this irrigation system by digging earthen canals from the water source to their fields. Later, they actively requested government support to line certain sections with cement, to reduce the need for maintenance and prevent water loss.

Harding, Rowena. “Farmer-led Irrigation Development 2. Tanzania.” 2018. NEF.

When rivers used for irrigation dried up, farmers started using shallow wells and petrol pumps to irrigate. By putting the pump closer to the water level, farmers’ saved on fuel and reduced the need for maintenance, leading to a “chamber” being dug next to the wells. Farmers grow maize, beans and vegetables, often for the market. There has been no government involvement.

Harding, Rowena. “Farmer-led Irrigation Development 3. Tanzania.” 2018. NEF.

On land previously farmed by a European settler and later by a state owned company before being abandoned, a group of ten small-scale farmers began irrigated production using a pre-existing canal to bring water from a stream flowing down a mountainside. Commercial crops of tomatoes and cabbages are grown, often on contract with local traders. In recent years farmers have been contracted to produce green beans and ‘baby corn’ for export.

Five years ago the system was selected for upgrading by a World-Bank funded project that installed an additional pipe up the mountainside enabling sprinklers to be driven by hydrological pressure.

Harding, Rowena. “Farmer-led Irrigation Development 4. Tanzania.” 2018. NEF.

Farmers have started irrigation using locally-available and affordable tools and materials and grow rice for the market. They organise their own water division and maintenance, and work together with (government) engineers and craftsmen to improve their infrastructure.

Harding, Rowena. “Farmer-led Irrigation Development 5. Tanzania.” 2018. NEF.

Using low-cost watering cans, farmers have started irrigating commercial crops such as cabbages. Although one plot may be small, the cumulative area under this type of irrigation can be much larger. The low initial investment costs make this technology accessible to everybody.

Harding, Rowena. “Farmer-led Irrigation Development 6. Tanzania.” 2018. NEF.

In the above image, an individual farmer from the city has purchased land in a rural area, drilled a borehole and installed a large pump. He has employed workers to cultivate for him and will sell his crop at the end of the season.

What can we classify as farmer-led irrigation development with Ramson Adombilla

Ramson Adombilla, an irrigation engineer from the CSIR-Savanna Agricultural Research Institute, Ghana, talks about how he sees farmer-led irrigation development and whether something as simple as a watering can may be classed as farmer-led irrigation development.

Watch the video here: https://youtu.be/QwFIqYNKAos

Video transcript:

Farmer-led irrigation development – it falls within the domain of the initiator – so the farmer leads the development of the scheme and also any improvements. So basically because of handicaps in our resources, farmers normally practise the traditional surface irrigation methods and of course a watering can is also a surface method – though it is traditionally nature [via rainfall] but its efficiency is high when you compare it to other practices.

So basically what farmers do is they look at the availability of local materials (and I think a watering can is very available to farmers in all regions of Africa) so basically that is always the first door to call at for farmers' irrigation.

Of course you have other sources of practising, such as the furrows systems of irrigation, but I think what defines farmer-led irrigation development – it is the person who initiates the process – in this case it is the farmer and not any other person.

Farmer-led irrigation development in official statistics

Farmer-led irrigation development is extensive and increasing, yet remains largely unreported in official statistics.

In dominant narratives and statistical data, small adjustments made by farmers – for instance when supplying water to crops during dry spells in the rainy season – do not qualify as irrigation.

Statistics on irrigation in sub-Saharan Africa is compiled by the UN Food and Agriculture Organisation (FAO) using data supplied by national governments. The FAO's AQUASTAT database records four main categories of irrigation and drainage development. These are:

1. equipped for full control irrigation
2. equipped for (partial control) irrigation
3. water harvesting and
4. non-equipped cultivation in flood recession areas and in wetlands (Table 1).

Although the categories are inclusive of a broad range of types and degrees of water control, in practice the recorded data are often incomplete.

There are a number of reasons for this:

1. Data are generally obtained from agricultural census surveys, with the current version of AQUASTAT intended to be accurate for 2005 or as close to that year as possible. This makes currently available data over one decade old.
2. The FAO defines 'equipped for irrigation' to be man-made activities or actions that control the water movement. While this definition includes irrigation using a bucket or watering can (see below), it does not explicitly include individual pumping systems or irrigation weirs made from stones and branches. Such irrigation technologies would often correspond to farmer-led irrigation development initiatives but are classified as 'non-equipped' and often go unrecorded by governments. The area cultivated with water harvesting techniques is not captured at all in the database and so is excluded.
3. Although categories exist for "flood recession agriculture" and "non-equipped cultivated wetland areas and valley bottoms" only a few countries actually report cultivated areas in these categories. For example, in the period 2008-2017, only four out of 49 countries in sub-Saharan Africa reported on flood recession and only six reported on non-equipped cultivated wetlands.

So, although AQUASTAT categories formally provide space for documenting areas under farmer-led irrigation development, in practice these activities are often not recognised or recorded as irrigation by national government agencies. They are missing from AQUASTAT which reflects national statistics that tend to ignore these activities and focus on donor- or government-funded initiatives in the form of 'schemes'.

Table 1. Categories of Irrigation and drainage development recognised by Aquastat

1. Area equipped for full control irrigation:	1A – Surface irrigation furrow, borderstrip and basin irrigation (including submersion irrigation of rice). Manual irrigation using buckets or watering cans. 1B – Sprinklers 1C – Localized irrigation e.g. drip	Reported in official data for formal schemes
2. Area equipped for irrigation	2A – Equipped lowland areas (i) Cultivated wetland and inland valley bottoms equipped with water control structures for irrigation and drainage (intake, canals, etc.); (ii) Areas along rivers where cultivation occurs making use of structures built to retain receding flood water; (iii) Developed mangroves and equipped delta areas. 2B – Spate irrigation (sometimes referred to as floodwater harvesting) uses the floodwaters of ephemeral streams (wadi).	Reported in official data
3. Water harvesting (no data included on spatial extent)	Areas where rainwater is collected and either directly applied to the cropped area, and stored in the soil profile or in a water reservoir	Not reported in AQUASTAT
4A. Flood recession cropping area non-equipped	Areas along rivers where cultivation occurs in the areas exposed as floods recede and where nothing is undertaken to retain the receding water.	Not reported in official data
4B. Cultivated wetlands and inland valley bottoms non-equipped	Wetland and inland valley bottoms that have not been equipped with water control structures but are used for cropping. They are often found in Africa. *They will have limited (mostly traditional) arrangements to regulate water and control drainage*.	Not reported in official data

Source: FAO. 2016. AQUASTAT Main Database, Food and Agriculture Organization of the United Nations (FAO).

Collecting data on farmer-led irrigation development

Once you are aware of farmer-led irrigation development and the fact that it is unreported, you can start to get more insight into where it takes place, what it looks like, and what its impacts are. To do this, you can for instance use satellite visible spectrum or radar images, specific questionnaire apps such as Open Data Kit (ODK), and government reports.

Using satellite imagery and remote sensing to identify farmer-led irrigation development

Satellite imagery analysis by the International Water Management Institute (IWMI) has produced findings suggesting that, across sub-Saharan Africa, irrigation may be two to three times more extensive than previously thought. In some countries, such as Ethiopia, it is even greater.

Satellite imagery isn't a perfect solution. For example, it may not always distinguish between irrigation and natural vegetation. But even when it is unable to provide an accurate estimate of the extent of irrigated agriculture, it still provides valuable information to help us understand the presence of irrigated agriculture.

Satellite. Source: SpaceX on Unsplash

Mapping farmer-led irrigation development is more challenging than registering large-scale government projects that have fixed infrastructure. Not only are farmers' irrigation initiatives expanding more rapidly than can be captured by typical surveys conducted at 5-year intervals, but development of irrigation will also expand and contract in response to variations in water availability (i.e annual rainfall variation). Therefore, the frequency of mapping is much more important for farmer-led irrigation development than the rather static government-initiated irrigation projects.

How one project used radar imaging

- The Studying African Farmer-led Irrigation (SAFI) project has undertaken a pilot study using radar imaging data from ESA Sentinel-1 satellites to estimate areas of paddy rice in a number of regions in Tanzania.

- High-resolution (10 metre) images available since September 2016 provide images at 12-day intervals that are unaffected by cloud cover.
- GPS coordinates for sites of irrigation, observed from the ground, were used to identify data points with which to 'train' an algorithm to recognise a time-series 'signature' of reflected radar signals for irrigated crops over the course of a growing season.
- The extent of an irrigation 'signature' is then mapped at a regional scale.

The pilot study suggests that the areas with a radar reflection pattern characteristic of irrigated (paddy) rice are between three and ten times larger than the areas of irrigation recorded in agricultural census data. The discrepancy is likely due to farmers' initiatives in controlling water for paddy cultivation being overlooked in surveys.

Using geographic information systems to identify farmer-led irrigation development

If you want to identify large areas of land that may be irrigated, but which have not been identified in official reports, then geographic information system mapping may be able to help.

A geographic information system (GIS) is a framework for gathering, managing, and analysing data. GIS integrates many types of data. It analyses spatial location and organises layers of information into visualisations using maps and 3D scenes. GIS can also help identify what crops are being grown as well as whether irrigation is taking place.

QGIS is an open-source GIS application that you can download and use free of charge. Their website provides many tutorials and training materials so that you can get started on your own.

Collecting data on farmer-led irrigation development when you're in the field

Government reports, or satellite mapping can give you some information about the occurrence of irrigation in an area. But to help you understand irrigation activities being carried out by farmers themselves, you'll need to speak to the farmers to get greater information about their crops, the irrigation procedures, how they are managed, the impact irrigation has – and much more.

To collect this data, you can use tools such as the Open Data Kit (ODK) application on your phone or tablet, which can make it easier to collect, process, and analyse data than paper-based surveys.

Using Open Data Kit you can:

- Create a questionnaire form for use on mobile devices;
- Fill out the online form in the field, which is then transmitted to an online database;
- Store, view and retrieve aggregated data for analysis;
- Have accurate information about the site where you did the interview, because of GPS links to real-time mapping and monitoring.

Key messages:

- Farmer-led irrigation development is a process in which farmers initiate the establishment or improvement of irrigation.
- Farmer-led irrigation development is characterised by the central role of farmers' own initiatives, and cuts across existing irrigation typologies defined on basis of scale, technologies, crops or governance arrangements.
- Stakeholders in irrigation need to be alert to recognising farmer led irrigation development, as it often takes place informally and does not always match the dominant definitions of irrigation.
- Technologies can allow us to gather information from the field and analyse land use.

Suggested further reading:

Re-introducing Politics in African Farmer-Led Irrigation Development: Introduction to a Special Issue: http://www.water-alternatives.org/index.php/alldoc/articles/vol12/v12issue1/475-a12-1-1/file

Getting Started Using QGIS: https://docs.qgis.org/3.4/en/docs/

Using Open Data Kit (ODK): https://www.google.com/earth/outreach/learn/getting-started-with-mobile-data-collection-using-odk/

Acknowledgements:

- Ramson Adombilla, Irrigation Engineer, CRIS Savanna Agricultural Research Institute, Ghana
- Chris de Bont, Stockholm University, Sweden
- Phil Woodhouse, Global Development Institute, The University of Manchester

Section 4 – Farmer-led irrigation development in Mozambique and Tanzania

In this section you'll learn about the findings of the recent Studying African Farmer-led Irrigation research project in Tanzania and Mozambique.

Farmer-led irrigation development in Tanzania and Mozambique

The Studying African Farmer-led Irrigation (SAFI) project is a partnership between social science researchers and irrigation scientists from Europe and Africa. The project aims to understand whether current investment by farmers in small-scale irrigation could offer a model for broad-based economic growth in rural areas of Africa.

Key research questions

1. What characterises small-scale farmers' own initiatives in developing agricultural water management, and what social and economic changes are associated with them? And how are these socially differentiated (gender, age, ethnicity, etc)?
2. What are the perceptions and responses of agricultural development agencies (government, donors, NGOs, commercial investors) to irrigation developed by small-scale farmers?
3. Can we get more accurate estimates of the total extent of irrigated areas?

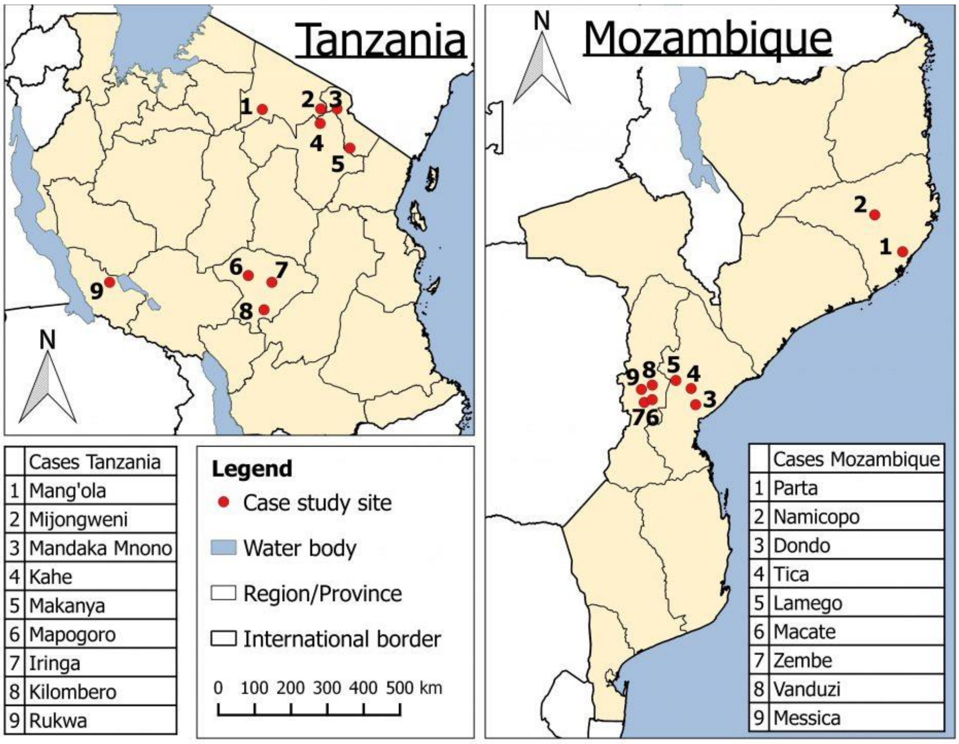
How the research was done

The following methods were used:

1. Field studies of specific cases where farmers influenced the purpose, location and design of irrigation.
2. Field studies used an initial quick characterisation, using group and individual interviews and transect walks, and secondary data to identify the extent of irrigation, its history, and the key people involved.
3. A second phase used in-depth interviews to understand engagement by local and external actors.
4. A third phase undertook a survey of irrigating and non-irrigating households.
5. National-level policy workshops were used to generate dialogue with policy makers and technical advisors about the phenomenon of farmer-led irrigation development.
6. Underlying assumptions among technicians and authorities were identified in analysis of policy documents and implementation.
7. Opportunities and constraints were probed in interviews with policy makers, donors, practitioners and farmers.
8. An analysis of field data was discussed with policy makers.
9. A pilot study was undertaken to explore the potential of analysis by satellite imaging.

Where the fieldwork was done

The map below shows the location of field-work sites in the two countries studied.



There were nine sites in Tanzania comprising 1361 households.
There were nine sites in Mozambique comprising 1372 households.

A sample of 150 households at each site was initially randomised, based on lists provided by local administrative authorities. However, this was then adjusted to ensure that the sample for each site included a minimum representation of at least 50 irrigating and non-irrigating households. Non-irrigating households were farmers who relied on rainfall only.

About the sites

The sites grew rice, maize, vegetables, beans, onions, tomatoes and bananas – or a combination of these crops.

Some farms had received government investment, others had not. The irrigation sites were all initiated by farmers but sometimes they successfully lobbied the government for support to improve their irrigation systems. This included the construction of more permanent water diversion structures or the provision of funding for lining earthen canals with cement.

Irrigation methods included: motor pumps to draw surface water from rivers or lakes or ground water from wells; weirs to divert streams into canals; lifting water using buckets from a river or well; spreading of flood water across fields (spate irrigation); management of water movement in wetland areas or a combination of these methods.

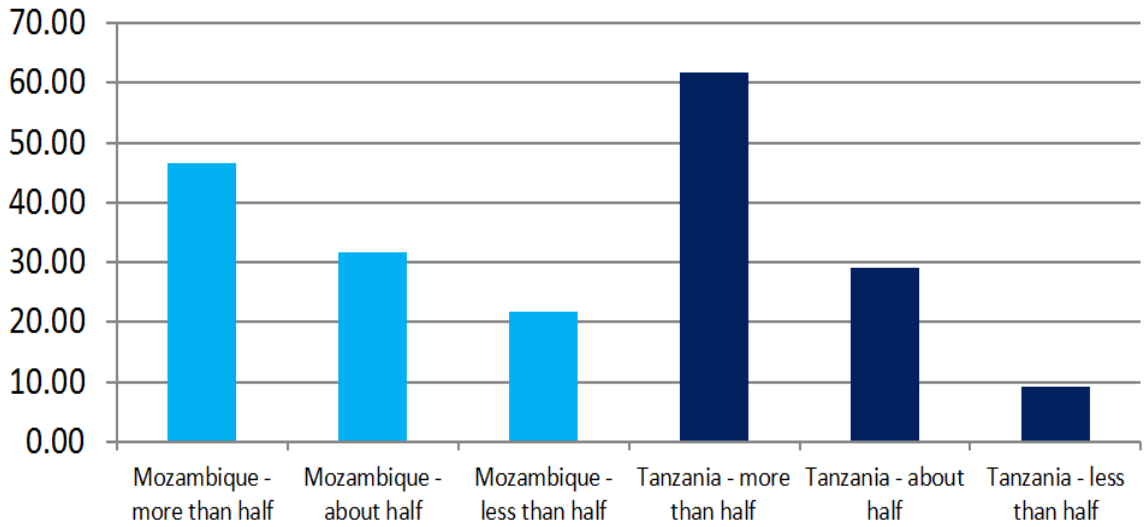
Key household findings

Irrigators generate cash by selling crops at expanding, urban food markets. Commercial trading networks and improved communications are vital for these activities. Mobile phones are increasingly prevalent amongst farmers.

Households that irrigate are wealthier than those that do not, as the graphs below show. But are they wealthy because they irrigate, or do they irrigate because they are wealthy?

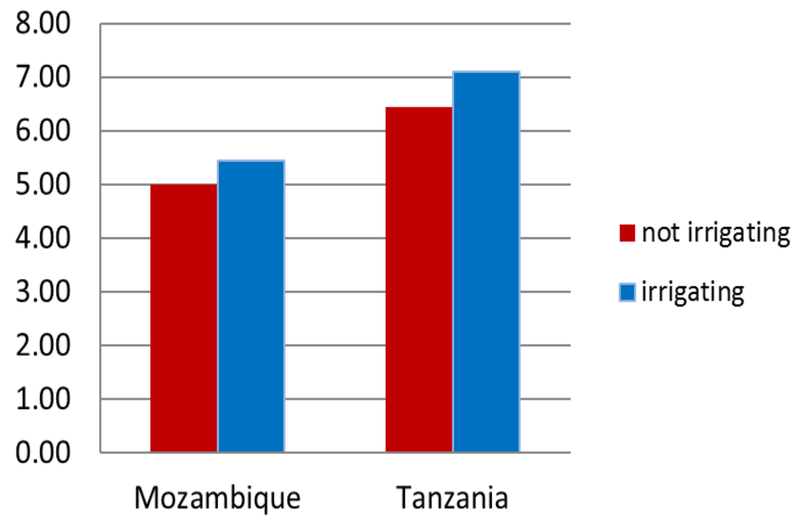
In both Mozambique and Tanzania between 80%-90% of households that irrigate said irrigated crops account for at least 50% of their income. This suggests that irrigating households are dependent on income from irrigation for their higher accumulation of assets.

Contribution (%) of irrigated crops to irrigators' total income



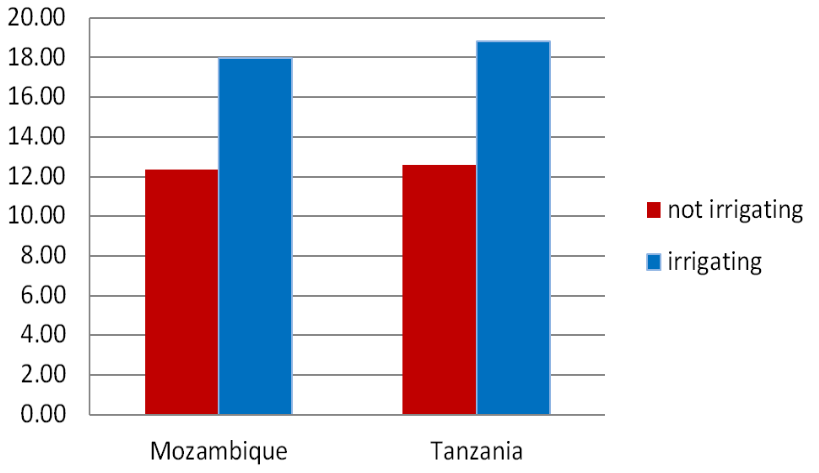
The following are indicators of household wealth that suggest higher wealth levels among irrigating households than non irrigating households.

Housing quality index



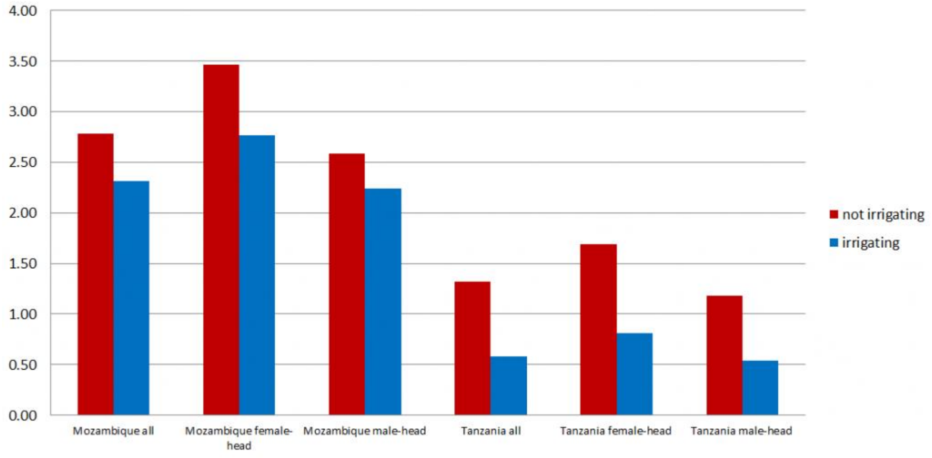
The graph above shows that households that irrigate have housing which ranks higher on the quality index.

Index of asset ownership



The graph above shows that households that irrigate accumulate more assets than those that do not.

Average number of months of food shortage



Households that irrigate also have greater food security. Although there are fewer female-headed households among irrigating than non-irrigating households, these female-headed households could benefit more from irrigation.

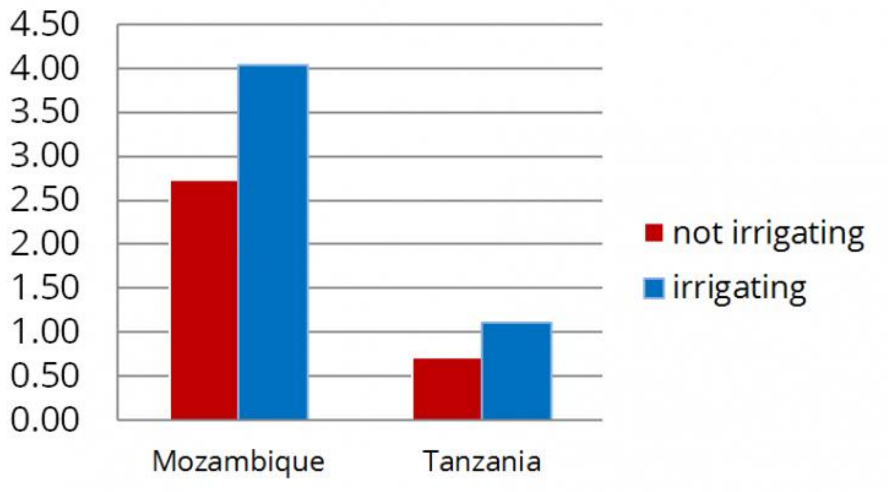
On average, households who irrigate in Mozambique said they endured food shortages annually during an average of 2.34 months compared to 2.87 months for households without irrigation. In Tanzania, these figures were 0.58 months compared with 1.35 months.

When female-headed and male-headed households are compared, the irrigating female-headed households appear to benefit more relative to their non-irrigating neighbours; reducing their annual period of food shortage by 0.67 months in Mozambique and 0.91 months in Tanzania.

The reduction in duration of food shortage for irrigating compared to non-irrigating households is smaller (0.42 months in Mozambique and 0.68 months in Tanzania) among male-headed households.

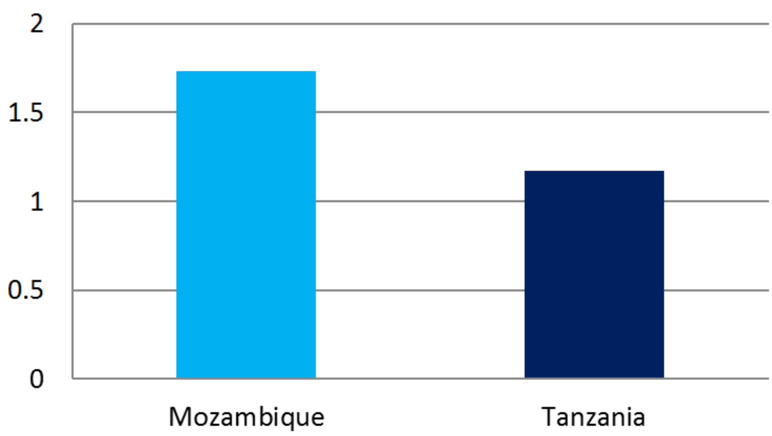
Irrigating households tended to have more land and invested more in inputs such as fertiliser and hired more labour.

Average area (ha) farmed per household



The graph above indicates that on average, farmers using irrigation farmed a larger area than those who relied on rainfall alone.

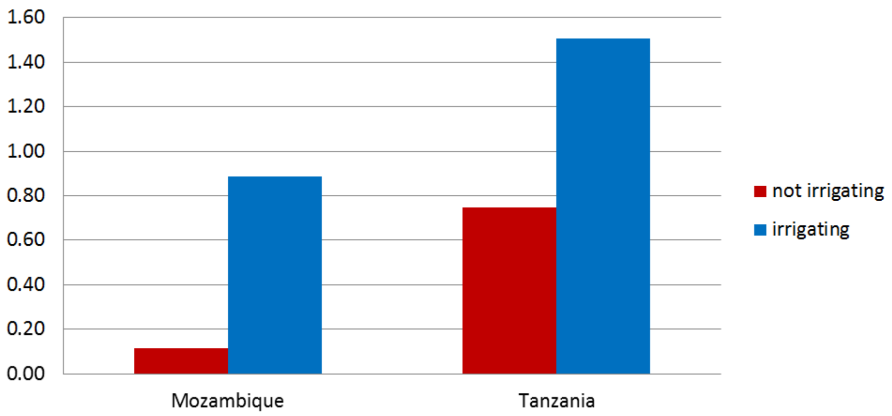
Average area of irrigated land (ha) per household using irrigation

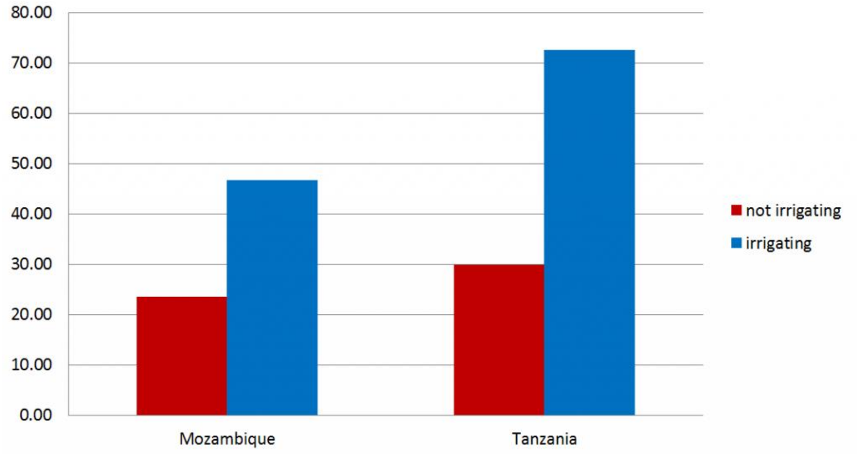


The area of crops irrigated averages 1.8 ha per household in Mozambique and 1.2 ha in Tanzania. Although this area is fairly small, production was strongly market-oriented.

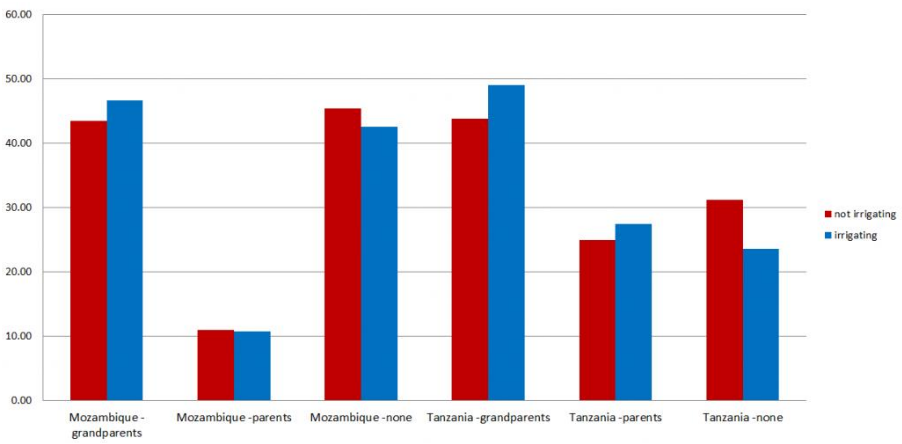
Input use (index of fertilizer, improved seed, pesticide) & % of households employing farm labour

The first graph below shows that irrigators tend to have a higher input use; whilst the second graph shows they employ more farm labour, when compared to non-irrigating households





Farmer’s prior links with the area (%)

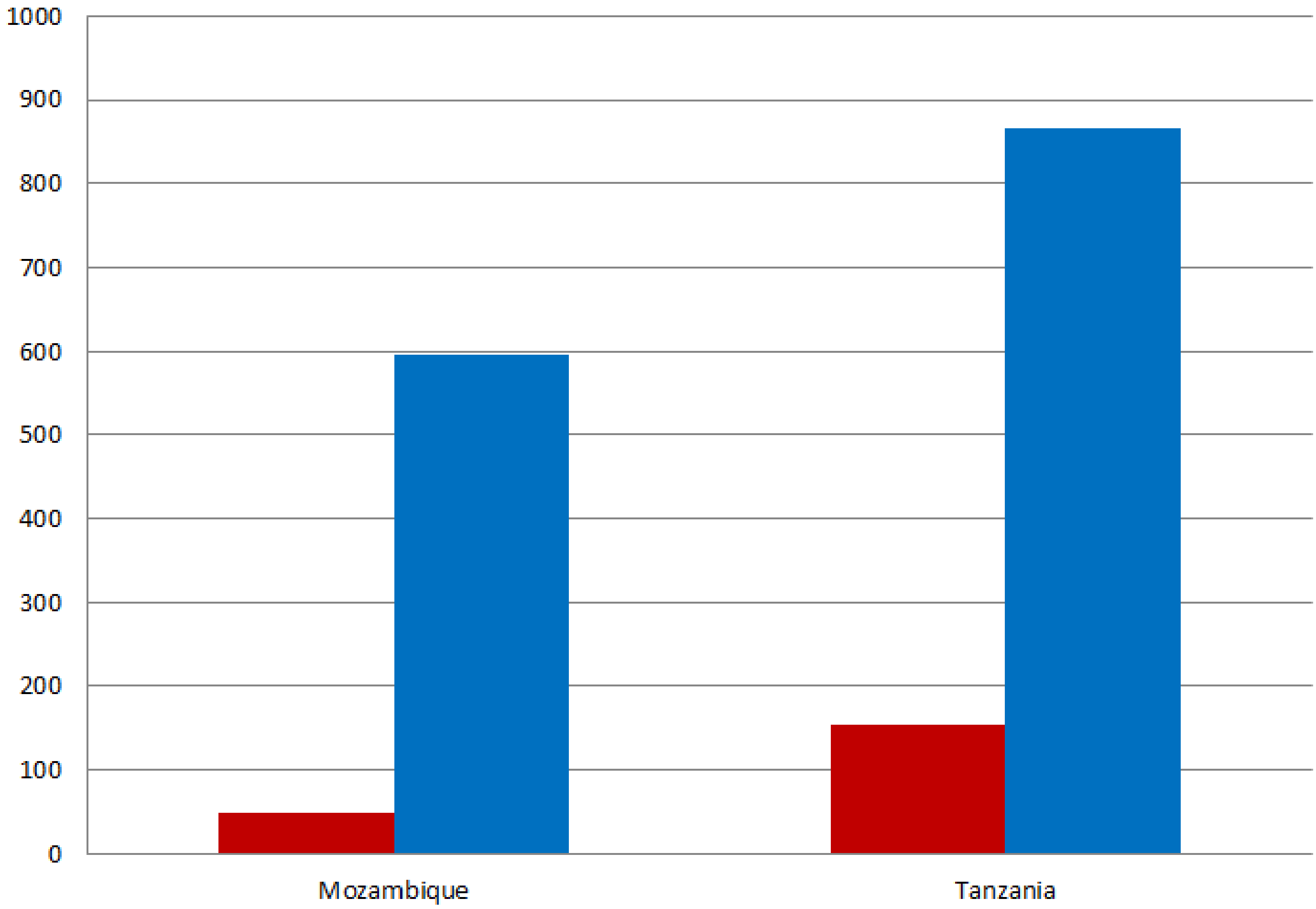


Data recorded on households’ prior links to the area in which they are farming shows relatively high percentages of households (25% in Tanzania and over 40% in Mozambique) with no prior family links to the area. Although these incoming settlers included both irrigating and non-irrigating households, the former tend to be less common than among households with previous family links in the area.

In conclusion, the SAFI data shows that irrigators cultivate larger plots, use more inputs and employ more farm labour. They also tend to be wealthier, obtain more than half of their income from farming, and experience fewer months of food shortage.

What difference did farmer-led irrigation make?

Average gross crop sales: USD/household per year



In Mozambique, farmers who irrigated received, on average, 12 times more in crop sales than farmers without irrigation. In Tanzania, farmers using irrigation saw an increase of five times.

Did irrigation make a difference to the wider economy?

The SAFI project demonstrated that irrigating households generated USD 35-69 million from additional crop sales relative to non-irrigating households in Rukwa region alone. Rukwa accounts for just 3.3% of the Tanzanian population and a tiny proportion of its irrigated land. This is many times more than the USD 2.2 million allocated annually to irrigation in the *national* budget.

The money irrigated farming in Rukwa generates is equivalent to 20 – 40% of the annual average of USD 188 million of donor funding proposed in Tanzania's 5-year budget for Sustainable Water and Land Management Fund (which allocates 85% for irrigation) in the government's Agricultural Sector Development Programme II.

Additional data sources

Official data are only collected through government surveys and these may be run at intervals of 3 to 5 years, which makes it difficult to accurately track the expansion and total area of irrigated land. The SAFI project undertook a pilot study to investigate if satellite data could be used to estimate the area of irrigated land.

Methodology

Radar signals transmitted from satellites onto the earth's surface give a reflected signal that is characteristic of particular types of vegetation and soil moisture. These reflected signals can be collected by the satellite irrespective of daylight or cloud cover. By collecting repeated signals over the growing season, a 'signature' of different types of vegetation growth can be identified.

Using the geographical coordinates of known irrigation sites, an algorithm can be constructed for the radar signal of irrigated fields. This can then be used to assess how widespread that signature is across a region and subsequently allows an assessment of the area of irrigated fields.

The SAFI pilot study was able to use this approach to analyse radar data collected at 12-day intervals by the European Space Agency's Sentinel-1 satellite to assess the extent of paddy rice across three regions in Tanzania.

The pilot study suggested that official statistics may seriously underestimate the expansion of irrigated areas. In the rice-producing region of Shinyanga, for example, the most recent agricultural census in 2007-08 recorded just under 30,000 hectares of irrigation. Nine years later in 2016-17, the reflected radar images, suggested paddy rice fields created by farmers cover approximately 250,000 hectares, or between 8 and 10 times more. Similarly, in the Rukwa region, radar image analysis suggested irrigated areas are between 3 to 6 times larger than recorded in the 2007-08 census.

The pilot study showed that 'training' the algorithm to identify a reflected radar signature for paddy rice meant it was less successful at identifying other kinds of irrigation (e.g. for tree crops) and new algorithms would have to be developed for these.

The large areas of irrigation identified in the pilot study indicate that the value of agricultural output from farmer-led irrigation development is significant. For example, the value of paddy rice produced in Shinyanga Region can be estimated at about USD 155 million, of which at least USD 80 million is likely to be sold (assuming the official average yield of 2.5 tons per hectare and a price of USD 250/ton). The significance of this cash flow in the agricultural economy can be assessed relative to investments made informal irrigation.

Watch a lecture by Professor Phil Woodhouse outlining the SAFI project:
https://youtu.be/ynGPiB6yfhc

Key Messages

- Farmers' initiatives are playing a key role in the rapid expansion of irrigation, even though much of this activity may lack official recognition or support.
- Households that irrigate land fare better in terms of household assets, months without food, quality of housing, size of farm and inputs to raise farming productivity.
- Irrigated production is strongly commercially-oriented and the value of crop sales was significant for both the overall income of households using irrigation and in terms of contribution to the national economy.

- Expansion of irrigated production sets in train important social and economic change and poses new challenges in terms of market access, water management and land tenure.

Suggested further reading:

Find out more about the SAFI project: http://www.safi-research.org/

Messica case study: http://www.safi-research.org/wp-content/uploads/2019/08/Messica-case-study-for-SAFI-online-course.pdf

Acknowledgements:

- Chris de Bont, Stockholm University, Sweden
- Hans Komakech, Nelson Mandela Institution of Science and Technology, Tanzania
- Angela Manjichi, Instituto Superior Politécnico de Manica (ISPM), Mozambique
- Phil Woodhouse, Global Development Institute, The University of Manchester

Section 5 – Farmer-led irrigation in action

We will now visit a farm in Tanzania to hear about how they have been lobbying the government for additional support for the irrigation scheme they initiated.

The Location

The Mawala irrigation scheme lies in Kahe ward, 12km southeast of Moshi town, in the Kilimanjaro region of northern Tanzania. The area is part of the Pangani River Basin, and falls within the Northern Irrigation Zone. Mawala is one of three villages that up the Mawala irrigation scheme.

Harding, Rowena. "Farming in Kahe Ward". Global Development Institute

The Context

The mean annual precipitation is 365mm, with most rain occurring between March and May. Agriculture is the main source of income for most villagers.

The ward has a long history of irrigation development by farmers, companies and the government. The Mawala irrigation scheme has its origins in 1968, when the government (supported by the Food and Agricultural Organisation) started constructing a canal from the Miwaleni spring to irrigate land. Originally, the Kahe scheme was meant to be a village scheme, operated by smallholder farmers who grew both food and cash crops. However, in an attempt to save money, the government handed the project over to a private company and later the estate moved into the National Agriculture and Food Corporation's (NAFCO) hands. Under NAFCO about half the former estate was given to the village authorities to distribute amongst the farmers. In 1999, the NAFCO estate was privatised. This has resulted in the current situation, whereby water from Milaweni spring flows through the NAFCO canal to the pumping station of a private sugar estate. What remains flows downstream to the Mawala irrigation scheme.

Recent Developments

Most infrastructure in the Mawala irrigation scheme is made and maintained by farmers themselves. The canals are dug by hand and, as they are cleaned, become deeper over time, with many canals now below field level, making irrigation difficult. Farmers use temporary structures (such as bags, grass and mud) in an attempt to raise the water level. Some canals (including Raymond's canal at Bomba Tatu – see below) do not have a way of closing or opening their intake, making water division more difficult.

Farmer-led Irrigation Development

The initial water group has been transformed into an irrigation cooperative, called the *Ongama,* which collects water fees to pay for the water-use permit. Water division is organised at canal level, and the system varies from canal to canal. *Ongama* organised the cleaning of the canal.

In some canals, farmers have collected money and built structures to improve their canals but they cannot upgrade the whole system because of insufficient funds.

After initially obtaining their water rights in 1997, farmers from Mawala asked for support to survey the scheme and estimate the costs for division boxes. Letters with requests for support have been sent to different government offices with varying levels of success.

Raymond is a farmer from Mawala village in Tanzania. He is part of a large group of farmers who have worked together to dig irrigation canals, maintain them and manage water allocation.

Watch the video here: https://youtu.be/-7Ozdho35Uw
Before this construction was started, the prime minister visited this place. This was the time of Prime Minister Mizengo Pinda. During his visit he came to the place called Bomba Tatu. At that time there were only three culverts. When he saw how the place was, and we further explained to him about the challenges we were facing, he told us to wait and he would take the matter to the government and request a construction project. After he left, a water trench started to be built.

The construction was done in phases whenever the government got money. It would be channelled to build the irrigation system from one phase to another. We are still hopeful of more money and we shall continue to build more canals channelling water onto the farms.

Risks of government intervention in farmer-led irrigation development

Although Mawala farmers say they are happy with the support they have received, there are some general challenges with government interventions in farmer-led irrigation development areas:

Farmers might stop investing, as they now consider themselves a government scheme or because they do not want to do anything that does not match the government's vision for the area.

Public or donor funding is often already earmarked for specific interventions (such as infrastructural upgrades) and can therefore not necessarily address the most pressing needs of farmers (for instance better market access or better extension services), resulting in sub-optimal results.

Infrastructural projects often come with the requirement to make a formal organisation for its management (such as an irrigators association or a water users association). This can undermine existing organisation set up by the farmers themselves.

The influx of money for infrastructural projects can lead to division with a community as some benefit whilst others do not.

Kahe Ward, Tanzania

If you would like to read more on farmer-led irrigation in Tanzania, and Kahe ward in particular, then research led and conducted by Chris de Bont, Stockholm University provides more detail.

Case study of Kahe Ward: http://su.diva-portal.org/smash/get/diva2:1179965/FULLTEXT01.pdf

Short introduction to the fieldwork: http://www.safi-research.org/wp-content/uploads/2019/08/Kahe-case-study_section-4.pdf

Key messages:

- Benefits to farmer-led irrigation development include: raised productivity, incomes and employment; cheaper for governments than large-scale irrigation schemes; makes greater use of farmer’s local knowledge
- Challenges that arise from widespread irrigation expansion include: increased water use, and issues of competition with other water sources; may accentuate existing social and economic inequality; could lead to unregulated pesticide use with an associated pollution risk; a challenge for regulatory authorities.
- Active lobbying by farmers for support from the government can be part of farmer-led irrigation development, but flexible funding, community-ownership of the intervention process and an eye for existing institutional arrangements are key to maximise the benefits of any intervention.
- By creating a policy and regulatory framework which values farmer-led irrigation development in all its diversity and by removing constraints such as poor infrastructure, governments can support farmer-led irrigation development whilst mitigating possible risks.

Acknowledgements:

- Chris de Bont, Stockholm University, Sweden
- Phil Woodhouse, Phil Woodhouse, Global Development Institute, The University of Manchester
- Raymond, Farmer, Kahe, Tanzania

Section 6 – History of irrigation design

In this section you'll learn about:

- participatory design and its implications for farmer-led irrigation development.
- the importance of real participation.

Irrigation systems for smallholders designed by experts often fail to deliver the expected results.

As we have seen in section two, participatory design methodologies have previously been promoted as an approach towards sustainable irrigation development. However, from the early 1990's until around the late 2000's, there was a standstill in the development and improvement of approaches to designing smallholder irrigation systems, coupled with a period of very low international investment in such systems.

Interest and investment in irrigation has now picked up again – but technocratic design and implementation practices still seem to have the upper hand. Why?

Definitions

To understand how we can best work with farmers in a genuinely participatory manner, we need to define key terms.

- A design is the end product of the design **process**.
- Design **approaches** are methods for shaping the design process.
- An irrigation **system** is the infrastructure needed to take, transport and deliver water to crops.
- An irrigation design is **not** simply a technical plan. It also encapsulates an implicit social, organisational and economic rationale for the overall design.
- Once construction starts, how a design approach is **operationalised** (either by the engineer as part of the process or by the farmers after the fact through appropriation) is a critical factor in the success of the scheme. However, it is regularly ignored as the official design process often ends when the technical plans are approved.

Colonial irrigation design

The way engineers are taught about irrigation is based on historic principles. Europeans with colonies in Africa and Asia implemented certain ways of doing irrigation for very specific reasons, and these principles are still being taught today.

In colonial times irrigation was used as a way to exert power because the control of land use was influenced by the provision of water. Different colonial powers had different guiding principles. The Dutch maximised the value of crops produced on a given area of land, while the English system maximised value of crops produced for a given amount of water.

This resulted in different technologies because the Dutch system required quick adjustment and measurement, with daily control by an official; whereas the English prioritised variety in the canal flow and a more distributed system.

In the mid-20th century problems arising from blueprint approaches to irrigation design included low performance, accumulation of silt in canals, salinisation, and negative gender effects.

The main responses to this included:

- giving management control to a group of farmers (in jargon referred to as the tertiary level) so they could use the system and resolve problems as they manifested themselves;
- the introduction of water rotation schedules at the tertiary level based on crop water requirements;
- paying attention to organisational structures, for example establishing a Water Users Association to improve farmer organisation at various levels;
- training farmers to use the technology as envisaged by the design engineers.

At that time, the prevalent idea was that farmers could be trained how to use pre-designed irrigation systems and that organising farmers in groups would support these efforts. This implied that a farmer's use of irrigation could be shaped to the system; rather than the system being responsive to the needs and desires of the farmer.

Towards participation

By the 1990s, the importance of participation began to be recognised, as a response to the failures of the more technocratic approaches to design. However, this coincided with reduced investment in irrigation development programs, so opportunities to test it were limited. When participatory approaches were adopted, it was largely a rhetorical claim, rather than a decisive shift in design approach.

Over time, engineers have become more aware that the design of an irrigation system imposes a hierarchy that distributes water in a particular way. How an engineer perceives fairness is reflected in the structures they put in place and farmers shouldn't be expected to 'naturally' understand and agree with the assumptions underpinning this design. As a result, farmers often modify a structure that engineers have put in place, for example by adapting an overflow system.

Below are two images taken from the Mawala irrigation scheme in Tanzania. They show two ways in which farmers have modified existing structures, such as blocking a gate to influence water division and adding pipes to increase water flow into their canal.

de Bont, Chris. Farmers block gate to influence water division. Mawala Irrigation Scheme, Tanzania. 2018.

de Bont, Chris. Farmers has additional pipes to allow more water to flow into their canal. Mawala Irrigation Scheme, Tanzania. 2018.

Practitioners should observe these adaptations, learn from them and understand what kind of structure has been imposed on farmers and what kind of structure farmers propose as an alternative, and why.

Genuine participation remains a complex, demanding process. Particular assumptions that are made in the project formulation can make it difficult later on to change the outcomes in spite of participatory processes. Examples include:

- Assumptions about what a (smallholder) farmer is and can do. The dominant perception is that an African smallholder farmer can work on a 0.5ha piece of land (no more or less). Rather than recognising that there is a multitude of types of farmers, this results in rigid target sets on beneficiaries (for example, a 100ha irrigation system must benefit 200 farmers).
- Democracies have been imposed on local communities, but they are not always fair or representative. There are many examples of traditional African management structures that cannot be translated into voting democracies. Project imposed democratic structures can be a means for power capture by new elite farmers.
- The idea that new 'modern' production methods can simply be transferred through training farmers remains dominant – as is the expectation of a workforce of trained extension workers to translate these concepts into African practices. Consequently, projects are still framed as 'introducing new technologies' instead of identifying the local dynamics through which farmers have developed improved (farmer-led) production practices and disseminating that experience among neighbouring farmers.

Sustainable Irrigation Development Project (PROIRRI) in Mozambique

The PROIRRI project, funded by the World Bank in Mozambique, is a case study of a recent effort to incorporate a social-economic irrigation design approach.

The PROIRRI approach identified key elements:

- infrastructure development
- water management
- production support
- value chain development and
- financial services

PROIRRI was based on the assumption that for a sustainable irrigation development project to succeed, all these elements had to work together.

The project envisaged that many of the social and organisation aspects would be addressed before the technical design of the irrigation was finalised, enabling the operational implications of different designs to be discussed and evaluated as part of the design process. At the end of that process a final design would be made and agreed on by farmers already organised as an irrigation association and/or production groups.

But what happened in reality was different. The social elements of the PROIRRI model became separated from the infrastructure elements and the two progressed independently, with infrastructure choices not taking social structures into account.

The result is that the PROIRRI has repeated the mistakes of post-colonial irrigation development by pushing for infrastructural development without taking the social-economic aspect into consideration within the physical design.

Continuation of the PROIRRI project under the name of IRRIGA sought not to develop more new irrigation infrastructure, but to ‘explain to farmers how to use the irrigation systems’ constructed during the earlier PROIRRI phase.

The concern is that this project could become another example of the assumption that farmers should be taught and shown how to farm, according to the perception of ’modern’ agriculture and technocratic irrigation engineers’ views. It also assumes that farmers will take on the responsibility of operating and managing imposed irrigation systems.

The current situation

Since the late 2000’s, interest and investment in irrigation has picked-up again, but technocratic design and implementation practices still dominate.

There are disincentives for moving from blueprint approaches to interactive and participatory approaches, such as:

- Accountability problems: who are irrigation projects accountable to? Projects are generally led by government and donors, and although the design approach attempts to be participatory and create ownership amongst those farmers involved, accountability remains subject to donors’ political agendas and criteria on technological progress.
- The blueprint approach results in quicker, more efficient construction and higher profits for the contractor. This provides an economic incentive to minimise engagement with local social processes and to pursue a standardised model of ‘modern agriculture’.

A vicious cycle exists. When farmers are not involved in the design, they don’t appreciate the system. Consequently, farmers as ‘owners’ of the irrigation system are blamed for low performance explained through a lack of knowledge of operating procedures.

As farmers are seen as having limited knowledge, they are not involved in irrigation design. And as they are not involved, history repeats itself.

What seems disappointing about examples of irrigation projects such as PROIRRI is that existing knowledge on how to implement an interactive participatory design process is ignored or weakly institutionalised during the project.

For irrigation design to work it needs to reflect the local socioeconomic context. Irrigation practitioners must change from trying to ‘adapt the user to the system’ to ‘adapting the system to the user’.

Irrigation design approach for farmer-led irrigation development

A farmer-led irrigation development approach allows for users and engineers to co-design and create sustainable irrigation solutions that can be achieved by farmers themselves. This approach uses two circular learning processes that form the basis for the (farmer-led) 'Participatory Irrigated Agricultural Development' (PIAD) approach developed by Wouter Beekman and Gert Jan Veldwisch.

An iterative learning process

For participatory irrigation planning with farmers, it is critical that the impetus for the project must come from farmers themselves.

Central to farmer-led irrigation development "must be their own rationality, their own 'wheel', in combination with critical, consensus-based self-analysis by the users, amidst both diverging and shared interests" (Boelens and Dávila 1998, p. 427).

Designing an irrigation development should be an *iterative process* of information exchange, discussion, negotiation and collective decision-making about the future use and related technical features of an irrigation system between the farmer and the actors engaging with that farmer. This ensures that social elements are taken into consideration.

A suggested approach is that the communication between engineers and farmers can be formalised in *learning cycles with planned engagements* between the groups around decision points (Scheer, 1996).

Learning cycles will differ between the engineers and farmers. They may revolve around the same topic and formalised communication is necessary to foster mutual understanding.

A learning cycle is an iterative process that advances in spirals while a constant renegotiation, redefinition of the problem and redesign takes place until the intervention is finished, and often even beyond.

The irrigation design process consists of three phases:

1. Problem identification.
2. Conceptual design.
3. Construction and re-design.

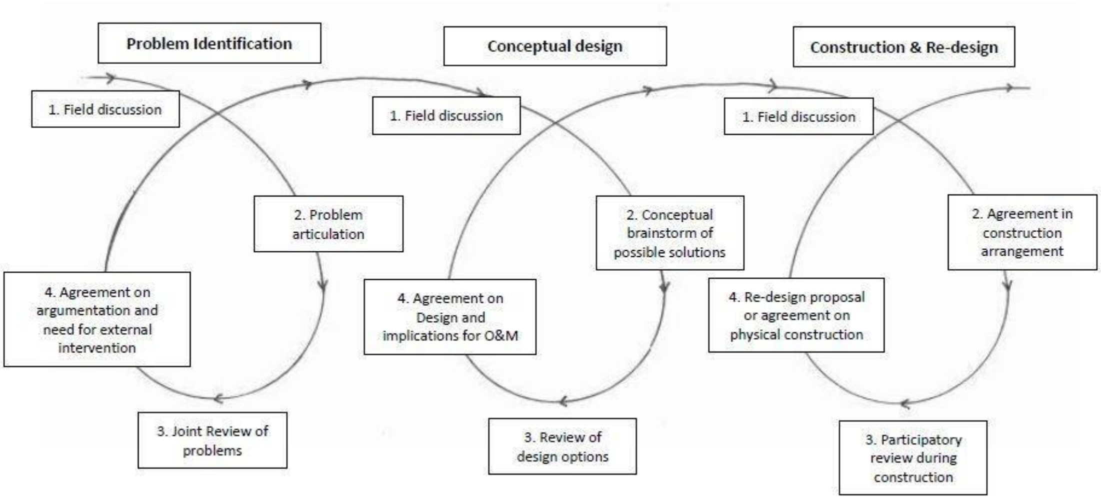


Figure 1. Schematic representation of an irrigation development process focusing on the participatory construction as used in the PIAD approach.

Problem identification phase

The activities in this phase aim to reach a shared analysis of current irrigation practices, potential improvements and solutions.

Irrigation practices are seen as combinations of infrastructure, management processes and institutional arrangements around water management, but also include agricultural production processes and market relations.

It is important to repeatedly question why users perceive a proposed intervention to be necessary, because it helps clarify their analysis of the problem. This results in a process of pushing back and forth between the farmers, trying to externalise their management problems through infrastructural interventions by the project, and the engineer internalising issues as essentially rooted in the management or regulatory domains, until a consensus is reached of what can only be solved technically and what can be solved organisationally. The aim of this process is to formulate the design criteria.

Conceptual design phase

This phase is a continuation of the discussions undertaken in the problem identification phase, in which initial ideas for possible solutions have been raised. However, it is also a distinct phase, as the focus changes from analysing existing problems, to thinking about solutions. It involves comparing and analysing different solutions with varying combinations of institutional and physical change.

An important discussion during this phase concerns the roles and responsibilities during construction and use of the systems by different actors. This discussion clarifies what types of structures are to be constructed, what materials are needed and who does what during the construction.

This feeds into discussions on how the project's operation and maintenance (O&M) is to be organised after construction, and to what extent it requires a change (or re-design) of organisational structures to facilitate it.

This discussion is critical because many rules and regulations in a farmer-led irrigation system are determined by the initial investors or owners, and additional investments by projects are liable to cause organisational change through shifts in "ownership".

The result of this phase is an agreement on what to construct, who takes particular actions and who contributes in the construction phase.

Construction and re-design phase

The start of this phase is marked by the signing of a three-party contract between the engineer/project, the constructor and the farmers. While actual construction activities start soon after the signing, the design activities continue.

The construction phase is an integral part of the iterative process of designing, where new insights acquired during construction lead to further re-design. Even after extensive discussions and visualisation, designs remain very abstract and difficult to understand for many farmers. This can be particularly acute if the proposed solution is one that users are not familiar with. For example, explaining hydraulic principles is difficult to convey without a constructed example.

The process of re-designing during construction is an important element in the appropriation by the farmers of the improvements. It allows for learning cycles through practice and the close interaction with the contractor and engineer, deliberately attempting to put farmers in the driver's seat.

Conclusion

The learning cycles inherent in this iterative approach not only function as a form of project management, but are also supportive of efforts to strengthen local conflict management techniques as translated into operations and maintenance regulations.

These processes are relatively time-consuming (and expensive) when implemented at a small scale, but have good prospects for scaling-up when actively building on the learning processes.

This is backed up by research showing that large-scale projects focusing on small-scale interventions might lead to better results, allowing for active involvement of the farmers in all the design and construction phases. This approach allows for active investments by the users, both in design and in project costs and labour, which subsequently results in the maintenance and replication of the improvements.

Key messages:

- Participatory design approaches are a feasible alternative to technocratic approaches and design.
- Historically, participatory approaches remained outside of the mainstream, due to a drop in investment in irrigation. Although today this is changing, participatory approaches remain largely dominated by technocratic implementation and design practices.
- Making assumptions in the project formulation can make it difficult to change outcomes, in spite of participatory processes.
- Participatory irrigation planning is an iterative learning process which must be led by the farmers.
- Although time consuming (and expensive) at small-scale, the processes have good prospects for scaling-up when building on the learning processes.

Suggested further reading:

Costs and Performance of Irrigation Projects: A Comparison of sub-Saharan Africa and Other Development Regions: http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB109/RR109.pdf

Mozambique – Sustainable Irrigation Development Project (PROIRRI): environmental and social management framework: http://documents.worldbank.org/curated/en/650321468062682355/Mozambique-Sustainable-Irrigation-Development-Project-PROIRRI-environmental-and-social-management-framework

Supporting Farmer-Led Irrigation in Mozambique: Reflections on Field-Testing a New Design Approach: https://www.researchgate.net/publication/304186956_Supporting_Farmer-Led_Irrigation_in_Mozambique_Reflections_on_Field-Testing_a_New_Design_Approach

Acknowledgements

- Wouter Beekman, Resiliência Moçambique

Section 7 – Practical interactions between engineers and farmers

Our job is to learn from each other and find more innovative irrigation system – Mohammed Nouri, Assistant Professor, Water Resource Management

In this section you'll learn about:

- how you communicate your role to farmers;
- how you can learn from farmers;

The Farmer versus the Irrigation Engineer

Consider these attributes often assigned to farmers and engineers. Do you agree with these labels?

Farmer	**Irrigation Engineer**
Informal	Formal
Inefficient	Efficient
Traditional	Modern

Do we as practitioners feel that to move to the more professional model farmers must learn from us? Or is the learning mutual?

Scholars in the 1970s promoted linear models of thinking and often said that public irrigation schemes failed because of the farmers' lack of knowledge, or because farmers don't follow instructions. In these instances, the farmer is to blame when something goes wrong.

However, we should ask ourselves how the farmers see the technologies promoted to them. How do they imagine the reaction between water and soil or different technologies?

If we think like an engineer, we have technical descriptions for describing the various aspects of our work. People working on farms have the same experience as us of irrigation and agricultural concepts but will use a different terminology.

We may assume a farmer's lack of knowledge, but it's our own specific jargon that limits understanding. We must learn to listen and communicate with farmers to benefit from their empirical knowledge.

Working between farmers & engineers with Louise Sibusiso Nkomo

Hear Louise Sibusiso Nkomo, a project leader in water management in Zimbabwe, describe the challenges she sees in her role working between farmers and engineers.

Watch the video: https://www.youtube.com/watch?v=CP1TkxLVnkE

Video transcript:

Successful irrigation has always been an interaction between the engineers and the farmers. Now the common, most visible problem is that the engineering side of the technology side has always advanced way faster than what the communities themselves can adapt to or can use. So this is where the challenge lies: what is required or what is wanted is for us to eliminate the myth that traditional or former irrigation practices are inevitably not efficient or effective. Instead, farmers working together with engineers can always come up with ideas or systems that are and can be used by the farmers themselves.

Mohamed Naouri on being an expert in the field

Mohamed Naouri, Assistant Professor at the Department of Agronomy at Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj, Algeria, gives an example of when he went into the field as an 'expert' and attempted to impose his understanding on smallholder farmers.

As an irrigation engineer in the field, and with experience of working for a public Algerian company, I was used to a linear model of innovation and of thinking how best to bring new technologies to farmers.

At the time I was studying towards my PhD and on my first day in the field I entered a greenhouse and saw a young man using technology like in the image below:

Naouri, Mohamed. Greenhouse. Arusha, 2019

When I saw this I thought, "I'm an engineer, they are already using this technology, it will be an easy thesis. I will only need one and a half years instead of three."

I asked the farmer "What kind of irrigation system are you using and how do you manage it?" He replied, "As you can see, we are using drip irrigation.". As an irrigation engineer, I imagined a drip irrigation system and had a picture of the basin or container, a pumping station, filters, the central fertigation unit and a distribution network. So I asked him to show me the water basin or the container. I also expected to see fertigation units and filters.

In reality, what I saw was this…

Naouri, Mohamed. Irrigation System. Arusha, 2019

I asked again "What system are you using. Is it really drip irrigation you are using?" He replied "Yes.". So I asked to see the water basin or the container for the water. And he said "We don't have a container or basin, we don't really need it.". So I asked, "When you take the water from the tube well, where do you put it? Where does it go?" He took me outside and showed me this,

Naouri, Mohamed. Water column/tower. Arusha, 2019

"The water goes in this water column," he said. I replied "What's a water column and how do you use it?" And he said, "Are you sure you're an irrigation engineer?".
I then asked to see the filters. He said "We don't use those, we threw them away. The irrigation engineers at the time brought them to us but they are not useful in our area." Since this time I have seen numerous irrigation systems like the one I saw that day.
Then I said, "Okay. You don't have basins and you don't have filters but you really need a fertigation unit.". He said "Yes, but this is what we use…" and he held up two jerry (watering) cans.
I thought it would be an easy thesis but it took me more than 3 years to understand all of this. I told the farmer "I am going to stop thinking like an irrigation engineer" and I asked him to draw me his irrigation system.
Farmer-led irrigation systems may look very different from text book examples, but engineers and researchers should respect this and try to understand the ingenuity of local farmers. Unorthodox irrigation systems that have been adapted to suit local contexts can be extremely effective.

Ensuring farmers are engaged in irrigation developments with Miguel Tafula

Miguel Tafula is an irrigation engineer in Mozambique. He talks about a project he is working on and how he ensures farmers are actively engaged in irrigation developments.

Watch the video: https://youtu.be/YTSEKWOWK2c

Video transcript

It's very important to identify farmer champions because they are the ones who have the ability to influence other farmers and can also help in terms of integrating the farmers into our activities.

We don't elect a champion farmer – we consider a farmer who is knowledgeable but is self-motivated and emerges naturally. We identify the champion by seeing the motivated farmer who also has the ability to influence other farmers and also to explain what we are doing in the local perspective.

So a champion leader is a very important factor during the implementation of new technologies, new innovation platforms. Also they are the one who influence the other farmers and motivate them to participate in each activity we are developing.

They're the ones who are responsible for demonstrating the new techniques that we want to implement and also they are the ones who coordinate all fields of activities. We don't do it by ourselves – we make them understand that they are leading the different activities that we want to promote in the field. We are just facilitators to introduce the new technologies. But it is the farmers who lead and who coordinate the introduction of new technologies and it is the champion who is responsible for demonstrating the new technologies to them.

Translation tips

Mohammed Nouri explains the importance of ensuring farmers understand the new technology.

How? You demonstrate.

Photo by Steve Johnson on Flikr

"When I was in the field the first thing i did is explained to farmers how groundwater works, using a container with water in it and a sponge. When I put the sponge into the water it was demonstrating this (container) is the reservoir, this is what is happening under the ground, and the sponge is the soil.

This is the water we can use. But we can't use all the water we have here, because when you take the sponge out of it, only the water that drops can you take from the groundwater. The water that stays in the sponge we can't really use it."

A tip for better communicating with farmers is to provide short information for them to consider.

For example, telling farmers that only 1% of water stays in the plants, and that most of the water goes into the air and the soil is shocking information that helps them think about how and when they bring water to plants.

Key messages:

- Failure of irrigation schemes should not be assumed to be due to a lack of farmers' knowledge. Such an assumption would overlook farmers' experience and engineers' inability to communicate due to their frequent use of inaccessible, technical terminology.
- Successful irrigation depends on interaction between engineers and farmers. Engineers and farmers need to learn from one another and collaborate to find more innovation irrigation systems.
- Effective communication with farmers should provide concise information for them to consider, with visual props and examples.

Suggested further reading:

Small-scale farmer innovation systems:
https://quno.org/sites/default/files/resources/SSF%20Innovation%20Systems%20-%20Literature%20Review.pdf

Acknowledgements:

- Mohamed Nouri, Assistant Professor, Water Resource Management
- Louise Sibusiso Nkomo, Project Leader in Water Management, Zimbabwe
- Miguel Tafula, Irrigation Engineer, Mozambique

Section 8 – Making small-scale irrigation technology work for women

Sophie Theis, a former Senior Research Analyst at the International Food Policy Research Institute talks about gender issues in small-scale irrigation technology. Sophie is talking about gender challenges for small holder farmers in general but these points are equally valid for farmer-led development of irrigation.

Watch the PowerPoint from Sophie's presentation (https://youtu.be/Hi5dghn3G7s).

Presentation Transcript

In this presentation, I'm going to discuss how irrigation engineers and policy makers can develop and promote small-scale irrigation technology that works for women. I'll discuss why women currently do not have equal ability to adopt irrigation technology, why this is a problem and how we can change this. I'll be focusing on small-scale water lifting and application technologies such as motor solar tidal pumps and drip kits.

I'm drawing on experience gained in the 'Feed the Future' Innovation Laboratory for small-scale irrigation supported by the US Agency for International Development (USAID) as well as through the REACH program supported by Department for International Development (DFID). Links to papers that describe gender and irrigation in more detail are provided on the final slide of this presentation.

To begin with, why is small scale irrigation not working for women?

All available studies have found a gender gap in the adoption and use of irrigation technologies in developing countries. This means two things: first, men are more likely than women to practice irrigation; and, second, among those who do irrigate, men are more likely to use mechanised technologies to lift and apply water, technologies such as the diesel pump (shown in the presentation), while women are more likely to use labour-intensive manual methods such as buckets, shown in the picture on the right. This gender gap in the use of irrigation reflects the reality that women do not have the same opportunity to adopt and benefit from irrigation technology as men do.

Let's look now at why this gender gap in irrigation matters. Why do women need irrigation technologies? We'll think about all the benefits of irrigation. Women are also farmers and, in fact, make up about 43% of the on-farm labour force in developing countries – they may need irrigation for the same reasons men do. In addition, they shoulder a larger overall labour burden than men do because of their many unpaid household responsibilities – cooking, cleaning, caring for children, collecting fuel and water.

Thus women need irrigation technologies to improve their own agricultural production, reduce their drudgery, save time and produce nutritious food in the dry season. More specifically, irrigation technologies can support women farmers in the following ways. Such technologies can help them generate income through higher value produce, higher yields and an extended growing season. They can help women grow more nutritious crops that withstand weather variability and climate stresses. They can give them access to a water supply for multiple purposes in addition to crop growing, eg for drinking and cleaning, for livestock, and so on. They can improve family health and reduce the burden that falls on women of caring for the sick, as well as reducing women's own time and energy burden of collecting and using water.

Which kinds of women are we talking about here? Women farmers have different needs that vary by context and by other aspects of identity, such as education, wealth, class, ethnicity, land ownership status, and so on. In addition to these important categories, we need to distinguish between women in female-headed households and women in male-headed households. These two groups face different challenges and opportunities. As a result, different strategies for reaching them with irrigation technologies are required.

Female heads of household have no spouse or adult male living with them. They might be widows, divorcees or unmarried women. This group is often marginalised and has less access to resources and to labour. However, compared with women in male-headed households, they may have more decision-making power and mobility. So it might be less difficult for them to decide to adopt irrigation technology but more difficult to afford the technology or find the labour to apply it.

In contrast, women in male-headed households may have more access to resources and to labour but less decision-making power and autonomy than female heads of household. Often we think in terms of the household unit but decades of research have demonstrated that household members do not share all resources and income equally. This means that, if a male-headed household adopts irrigation, the wife in the household does not necessarily see the same benefits as her husband. For example, she may provide labour for irrigation but have no say over how the income generated is spent. Women's control over income matters for gender equity and also because research shows that, when women have control over income, they spend more on children's health and education.

So when we talk about reaching and benefiting women with irrigation technologies, we should be aware that strategies may need to be tailored to different kinds of women in the specific context where we are working. It is also important to note that comparing female with male heads of household is not adequate, because this leaves out the majority of women, who live in male-headed households. So we also need to look at dynamics within male-headed households. Given what we've discussed thus far about why women need irrigation technologies and how they have different needs depending on their identity and the household in which they live. What can we say about why there is a gender gap in the adoption of irrigation technologies?

The next part of this presentation will discuss how women face specific barriers to adopting irrigation technology. Of course, men also face barriers but women often face more and different kinds of barriers than men do simply by virtue of being born female. Men and women are treated differently, have different opportunities and face different social expectations about what they can and cannot do. The reason we do this research and give presentations like this one is to advance our understanding of what such gender-based barriers are, so that we can remove them and give women an equal chance to adopt these important technologies. And there are specific actions which irrigation engineers and policy makers can take to contribute to this goal.

One common mistake is to focus only on the act of technology adoption, say buying irrigation equipment. That single moment of purchasing or acquiring a technology, however, exists within a whole process of technology development, dissemination and use. When women are left behind, it might be at any point along this whole process, not just at the point of purchasing a technology.

In addition, we want to know what happens after new technology is adopted and how doing so affects men’s and women's well-being.

If we imagine a situation one year after the purchase of a new technology, we can consider a process that includes technology design, dissemination, adoption and use; this will help us see more clearly where women might be left out and where there are opportunities to include women. So for each stage we can ask the following questions. Starting with the design phase we can ask: do existing technologies meet women's needs and what are women's needs and preferences around the design of an irrigation technology? In the phase of disseminating or marketing it: what barriers do women face in learning about the technology and how do these differ from those facing men when adopting the technology? What other barriers do women face compared to men? And what barriers do they face after the technology has been adopted and is being used? How does this affect men and women differently? Who benefits and who bears the costs?

Let's look at how each phase here can better serve women, starting with the design phase. We're motivated to understand women’s specific preferences as users of irrigation equipment so that they actually become customers and want to adopt the technology.

Design Phase

What are some of women's unique needs and preferences regarding the design of the technology? Well, these are going to be context-specific but technology designers and policy makers can ask where, when and for what purposes women want irrigation and water technologies. Some issues to investigate include whether they want the technology for multiple uses, like irrigating crops, domestic use and livestock watering; for this, the location or portability of the technology may matter. In addition, what is women's willingness to pay for the technology, to acquire it and to operate it? How much of the operational costs and what type of costs are women willing to take on? These would include the cost of fuel and maintenance and the human energy required to operate the technology. Policy makers should also consider women's preferences around financing options, including whether they prefer to purchase or rent technology individually or jointly with a husband or with a group. They can assist in making financing options available through subsidies or special credit lines for women. Finally, design should also consider whether women feel comfortable, given their social context and norms, operating certain technologies.

As an example, in the innovation lab for small-scale irrigation (ILSSI) research in Ethiopia, women expressed a preference for technologies that were labour saving, allowing them to use water for multiple purposes during multiple seasons and which were installed near the home so that they are suitable for home gardens. These are all considerations to explore in the specific setting where you are working to design appropriate technologies with and for women. Therefore once technology is designed that meets women's needs, we need to make sure information about the technology reaches women. So let's look at the phase of dissemination.

Dissemination

Note that traditional ways of reaching farmers with extension don't necessarily include women. For example, women may not have permission to attend or may not feel comfortable participating in farm or field schools trainings and demonstrations with producer groups, especially if it's mostly men that are attending and facilitating.

If producer groups, cell phones or extension agents are used to disseminate information about a new technology, women may very likely not receive the information, as they're often not members of male-dominated producer groups, are less likely to own cell phones and are less likely to interact with extension officers or irrigation equipment dealers. However, we can meet women where they are and, if we recognise that these channels are not reaching women, we can either adjust the channels or use new channels that tap into women's specific networks, such as women’s savings groups, frontline health workers or recruiting lead farmers from among a group of women.

For any channel of disseminating information, we do need to make sure the women trust the information provider and feel comfortable asking questions, so that they can make an informed decision about adopting the technology. Next let's look at gender considerations in the moment of adopting technology. We'll look at what barriers women face compared to men in adopting the technology and what resources they need in order to purchase it.

Adoption

Most of the time when we're talking about technology adoption, this is through the purchase of irrigation equipment, although sometimes people will receive equipment through a project or will rent it. But let's say someone wants to buy irrigation technology and can afford it. What other resources does this person need? Research in Kenya found that men are more likely to buy irrigation pumps with loans and that women who bought pumps did so with cash. In many contexts this reflects the fact that access to credit is much more challenging for women than men. Women often need the consent of their husband to take out credit and can struggle with 'know your customer' requirements such as providing ID, a credit history or collateral in order to receive it. In addition, adopters of irrigation need to have access to complementary resources such as local land, water and labour to practise irrigation. Yet women are often strongly disadvantaged on these factors. Land ownership or drilling wells can be prohibitively expensive and other options like joining a water-user association and negotiating for water rights might not be open to women because of the social norms in these organisations. Furthermore, as we discussed earlier, women in male-headed households need to have the power within their family to make the purchase, and may need the consent and support of their husband.

Finally, irrigated agricultural production needs to be sufficiently profitable to pay back any credit that is taken out. Keeping in mind that, for more expensive equipment like motor pumps or solar pumps the payback period is often greater than a single season and repayment terms need to allow for this time, let's look at what happens after technology adoption, when a technology is being used. How are men and women affected differently, and do women actually benefit from the technology they adopt?

Use

First, men and women, even within the same household, may experience different costs and benefits associated with a new technology. For example, we can study how the workload changes around irrigation, considering all the tasks of irrigating and cultivating produce during the year. We can examine who within the household has the power to decide how the technology is used, on whose plots of land and who controls the income generated.

At the community level some instances of technology adoption may cause wage labourers to lose employment. In other cases, women and other less powerful actors may lose their rights to water and to land. So we also need to look at how different groups of people within a community are affected differently by technology adoption.

Further, if we want to support women in truly benefiting from technology, we need to help make it a profitable venture. The irrigator needs market access to buy inputs and sell the product, business skills, and access to agricultural information and financial services. However, we also need to ask: profitable for whom – do women have any control over the income that is generated by irrigation?

From the research conducted by ILSSI in Tanzania, two women described how they laboured with their husband cultivating irrigated produce over the year. But in the end their husbands ended up selling the rice they produced at a local warehouse. The women say that, “where ownership is concerned, it's a father or husband who claims it, because he signs for the sacks at the warehouse and even sells the produce. You won't even know of the amounts, whether he gives you a fake calculation. You just have to accept”. Another woman says. “You can't go daily to check them [the sacks] since you aren't the one who signed for it inside there. Because his fellow men will think of me oppositely, so I just remain at home.” This raises the point that if we want irrigation technology to benefit women, we need to be aware of risks, such as loss of control over income.

Some of the risks to keep in mind are thus that women do not necessarily have access to, and control over, the profits of irrigated production. Although there are things, that can be done to increase their chance of sharing in the control of irrigation profits with their husband.

Transferring technologies to women may not guarantee their control either. If men in the household are not supportive, they will take control instead. For instance, in a case study in Ghana pumps were distributed to women. But most respondents, both men and women, answered the question of ownership by saying that men were the owners of the pump, despite the project having specifically given the pumps to women.

We also need to be careful that any irrigation technology introduced does not increase women's time burden excessively. Finally, more powerful actors within the family or outside it may appropriate land, income streams or water sources from women after they make investments in irrigation that make their land or produce more valuable. Thus efforts to help women secure their land and water tenure and defend their rights to these resources are needed to ensure that the benefits of technology adoption accrue to women.

What can irrigation engineers and policy makers do to ensure that women have an equal chance of benefiting from irrigation? Here are several ideas. They can design technology with women to ensure it meets their needs, studying women's priorities and preferences. They can ensure marketing, dissemination and extension approaches actually reach women so that they learn about the irrigation technology and how it is used. They can support women's ability to purchase technology by providing access to finance, appropriate subsidies and groups. They can help secure women's access to and control over irrigable land and to water for irrigation and, importantly, they can monitor and evaluate gender-related outcomes after technology adoption, both within the household and within the community. In this way they will be able to see whether women are reached, helped and empowered by the technology.

Suggested further reading:

Introduction to the Gender in Irrigation Learning and Improvement Tool

Acknowledgements

Sophie Theis, former Senior Research Analyst at the International Food Policy Research Institute

Berta Zakayo Kimati, Farmer, Mandaka Mnono

Section 9 – Policy implications

In this final section you'll learn:

The benefits and challenges associated with farmer-led irrigation development

Policy recommendations moving forward

Benefits of farmer-led irrigation development

The SAFI project showed that households using irrigation suffer fewer months of food insecurity and have better housing and higher indices of asset ownership than non-irrigators. Additionally, an overwhelming majority (84%) of irrigators consider that irrigated crops deliver at least half of their income. Farmer-led irrigation development thus offers benefits in terms of increased income and economic growth.

Where governments and donors have supported farmer-led irrigation development, the benefits are typically achieved at much lower public investment costs (USD2-4000/ha) than those associated with large-scale irrigation (USD10-20,000/ha). In part, this is because irrigation development that is farmer-led is associated with partial water control and smaller-scale infrastructure development than state and donor-supported investments.

Where farmers themselves are investing labour, capital and land in irrigation, the cost to African government budgets is further reduced. In this way, farmer-led irrigation development may offer a strategy through which governments can invest less to achieve their agricultural productivity and food security goals.

Farmer-led irrigation development builds on farmers' own knowledge of the local variability of land and water resources, potentially making it more responsive and adaptable to environmental change.

Risks of farmer-led irrigation development

Increasing irrigation may raise competition for water, not just among irrigators but between irrigation and other sectors, such as hydropower and municipal water supplies. Farmer-led irrigation development thus poses challenges of both monitoring and regulation to government agencies responsible for planning land and water resource management.

Rural economies in sub-Saharan Africa need to create employment and diversify agriculture. Irrigators tend to have more land and are more likely to hire labour than non-irrigators. Thus, while the agricultural intensification that farmer-led irrigation development promotes will raise irrigators' incomes and generate new employment, it may also accelerate social inequality, across generations and gender. In terms of gender, only 16% of irrigating households examined in the SAFI project were female-headed compared to 26% of non-irrigating households. Further questions arise over gender differences in household labour in irrigated fields and ownership of irrigated crops.

Increased fertiliser and pesticide use among irrigators raises downstream pollution risks, particularly where technical advice on input use may be lacking. Additional health risks may arise from the use of non-treated wastewater to irrigate vegetables in urban and peri-urban areas.

Finally there is a risk that centralised irrigation planning authorities may respond to farmer-led irrigation development in ways that over-regulate farmers' irrigation activities and reduce their dynamic and entrepreneurial character. In this regard, farmer-led irrigation development poses particular challenges to legislative and regulatory bodies which need to create regulatory frameworks that are enabling of small-scale irrigation initiatives while mitigating the risks.

Attention must also be paid to the politics of water resource allocation. Once small-scale farmers are no longer recognised as “non-commercial subsistence cultivators of rain fed crops” but rather as “entrepreneurial users of (in aggregate) major quantities of water“, they would move into a highly politicised policy arena in which the politics of water allocation is dominated by highly organised and influential lobby groups such as:

- hydropower;
- urban water supply;
- wildlife tourism;
- international investors.

All these groups have experience of gaining preferential access to water at the expense of agriculture.

We know from talking to policy makers that farmers are seen as wasteful users of water. This may be further accentuated by a policy environment shaped by international development agencies’ pre-occupations with water conservation.

A key policy question for small-scale farmers is whether they have water rights when they develop irrigation. If farmers pay water charges they acquire water rights; conversely, if they do not pay charges, their rights to water may be ignored by authorities responsible for water resource management. In African contexts the question of how to facilitate and regulate water-use by small-scale farmers remains a policy challenge.

A particular problem is that many trained engineers expect irrigation to look like this:

Yet in reality, African landscapes in which farmers have developed irrigation more closely resemble this:

The challenges of adapting policy to engage with farmer-led irrigation development

Below, an irrigation engineer discusses the challenges of adapting policy to engage with the phenomenon of widespread farmer-led irrigation development.

Mohamed Naouri, Assistant Professor at the Department of Agronomy at Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj, Algeria, advises on what he thinks is key for policy makers to consider when working with farmer-led irrigation development.

Watch the video (https://youtu.be/Ge57xyRd7AM)

Video Transcription

I think that developing irrigation technologies for a diversity of farmers and also for the diversity of situations can be a really hard question to solve for irrigation engineers. This is especially true when we are talking about or when it concerns farmers and smallholders from developing countries. The linear model of transferring technology shows its limits so I think that policy makers have to pay more attention to the translation processes. This means not only building on adaptation of technologies to local needs but also building a network of actors who can handle this and who can support such irrigation technologies or such innovations.

Aloysius Mubangizi is a Water and Resources Consultant and advises governments and institutes like the World Bank. He explains some of the tensions between the different actors in farmer-led irrigation development.

Watch the video (https://youtu.be/ycc-CVIoOwQ)

Video Transcription

Governments are trying to create a scheme that is very expensive and that becomes an issue with budgeting because governments don't have enough resources. Then they think maybe we could do more if we got farmers involved and developed what they are using and we create a big thing out of *it and spend a lot less money as there is less maintenance, less installation. Governments and development partners are now interested in this and want to support the farmer-led line of technology. Because the farmers are already adopters and adapters there is no hardship for them in trying the technology and maintaining it. They already know how to use it and can be helped to do it better.*

We need the governments to recognise informal irrigation schemes and be identified. If you see a farmer struggling you can line a canal and then leave it to them and then go – they already know what they're doing. Translating the technology helps the farmer feel in control and he doesn't oppose it.

Policy recommendations

The SAFI project developed the following recommendations with policy makers to help them work with farmers implementing their own irrigation initiatives.

Make farmer-led irrigation development part of economic and social security strategies

- Seek ways to reduce vulnerability and spread benefits of irrigation among different social groups;
- Facilitate access to reliable markets for inputs and produce;
- Identify and remove constraints such as transport infrastructure, taxation of key inputs and electricity supply.

Learn from existing practice and the diversity of irrigation that farmers operate, design and influence

- Analyse the dynamics and constraints of farmer led irrigation development in specific contexts;
- Manage expectations for replicability of experience from one site to another;
- Encourage opportunities for farmer-to-farmer learning.

Get more accurate data

- Evaluate alternative, and possibly complementary, methods of mapping and measuring irrigation beyond formal 'schemes';
- Revise irrigation statistics to enable recognition of location and extent of farmer led irrigation development;
- Identify the status and support the needs of farmer-led irrigation development.

Develop a supportive and accessible regulatory framework

- Recognise small scale irrigators as productive water users;
- Avoid onerous or costly registration procedures that stifle initiatives and dynamism;
- Review legislative and regulatory frameworks for water and agriculture to ensure they take account of farmer-led initiatives;

- Explore investment and technical strategies for intensification instead of expansion of irrigation;
- Identify how state agencies' technical and organisational capacity needs to be improved to enable more effective engagement with farmer-led irrigation development.

Key messages:

- Benefits of farmer-led irrigation development include: raised productivity, incomes and employment; cheaper for governments than large-scale irrigation schemes; makes greater use of farmers' local knowledge.
- Challenges that arise from widespread irrigation expansion (not only as the result of farmer-led irrigation development) include: increased water use; issues of competition with other water users; may accentuate existing social and economic inequality; increased pesticide use may be associated with pollution risk.
- Active lobbying by farmers for government support can be part of farmer-led irrigation development, but flexible funding, community-ownership of the intervention process and an eye for existing local institutional arrangements are key to maximise the benefits of any intervention
- By creating a policy and regulatory framework which values farmer-led irrigation development in all its diversity, and by removing constraints such as poor infrastructure, governments can support farmer-led irrigation development while mitigating possible risks.
- The rapid expansion of farmer-led irrigation initiatives offers great benefits to farmers and the rural economy, but its rapid spread and dynamic nature also comes with its own challenges for policy makers and irrigation practitioners.

Suggested further reading:

Modernisation and African Farmer-led Irrigation Development: http://www.water-alternatives.org/index.php/alldoc/articles/vol12/v12issue1/481-a12-1-7/file

Re-introducing Politics in African Farmer-Led Irrigation Development: http://www.water-alternatives.org/index.php/alldoc/articles/475-a12-1-1/file

Water laws and farmer led irrigation development: http://www.water-alternatives.org/index.php/alldoc/articles/vol12/v12issue1/483-a12-1-9/file

Acknowledgements

- Phil Woodhouse, Global Development Institute, The University of Manchester

Section 10 – Conclusions and further information

Congratulations on completing the introduction to farmer-led irrigation course!

Feedback

We hope you enjoyed the course. We are always keen to hear about what you thought of the course and how you think we can improve it.

If there is something you would like to comment, then please email us at gdi@manchester.ac.uk.

Join the network

The Farmer-Led Irrigation Network provides a platform for public officials, technicians, private sector actors, donors, NGO representatives and researchers to study and discuss the current dynamics and options in irrigation development in Africa, ranging from agribusinesses, public irrigation schemes and farmers' irrigation initiatives.

If you're interested in keeping up to date with the latest debates, please email: safi.network@nm-aist.ac.tz

Further training

This online course is based largely on a short face-to-face training course run by WISE Futures, Tanzania. View their upcoming courses, or contact them for bespoke training enquiries.