6 SMALL-SCALE IRRIGATION

SMALL-SCALE IRRIGATION INCLUDES A WIDE RANGE OF TECHNIQUES AND APPROACHES THAT SUPPLY WATER TO LAND WITH THE AIM OF IMPROVING SOIL-WATER MANAGEMENT.

Inexpensive small-scale irrigation (SSI) can effectively build the resilience of vulnerable farming households by reducing their reliance on erratic and unpredictable rainfall.

The introduction of appropriate, sustainable and successful SSI schemes requires attention to good practice at each stage of implementation, right from planning, to construction and through to community-level governance. Our work in Tigray demonstrates that participatory planning approaches are key to success and essential for continued service provision and sustainability.

"I am glad that Farm Africa has introduced us to this new technology and we are going to continue since they have shown us how important irrigation is and how to do it. We hope to get more produce and income as our experience grows over time to be cleverer in management of challenges such as pests and diseases. Even farmers in this area who were not among beneficiaries have started copying from us and have bought their own irrigation equipment."

– Haymanot Gebrekristos

SUSTAINABLE AGRICULTURE FOR IMPROVED FOOD SECURITY IN TIGRAY, ETHIOPIA

Land in Tigray's rugged mountains is scarce, and many farm sizes are very small. Many women, especially widows, and young people who have little access to land struggle to produce enough to feed their families. With funding from Irish Aid and the UK Department for International Development, Farm Africa worked directly with nearly 6,400 women and landless young people in Tigray's Ahferom woreda, providing them with the knowledge and skills to successfully bolster their food security and incomes through farming and rearing livestock.

This booklet is one of a series of six focusing on each of the project's key components:

1. Integrated watershed management
2. Fruit and vegetable production
3. Poultry production
4. Goat and sheep rearing
5. Honey production and marketing
6. Small-scale irrigation

Irish Aid
Government of Ireland
Rialtas na hÉireann

UKaid
from the British people

Farm Africa / Nichole Sobecki

PROJECT ACTIVITIES

In partnership with the bureau of agriculture and local extension officers, Farm Africa worked with over 700 farmers to explore the potential of SSI systems to intensify and diversify vegetable production in Tigray.

The initial feasibility discussions were embedded within parallel discussions and preparations for our integrated watershed management implementation work (see Paper 1 on integrated watershed management for more information), and held with a range of stakeholders including representatives from communities living upstream and downstream.

SSI beneficiaries were chosen in close conjunction with the local administration. A range of SSI technologies were implemented, ranging from mechanical pumps from nearby water sources to drip irrigation and canal construction.

SSI INVESTMENTS MADE OVER THE COURSE OF THE PROGRAMME

- **Pump distribution: 27 motorised pumps (serving 321 households), 200 treadle pumps, 200 pressurised and drip irrigation pumps were installed to 200 households**
- **Canal construction: A 500m canal was constructed to serve 32 members, irrigating a total of 13 hectares of land**
- **Training: Intensive support and training on community management, use and maintenance of irrigation equipment, irrigation scheduling and technical support on agricultural production was provided to the local community**
- **Key crops grown: onions, peppers, tomatoes, maize and 600 fruit and vegetable seedlings were distributed to 300 farmers**

Teklit from Maysure kebele benefited from a 500 metre irrigation canal. She received training on farming techniques, high-quality vegetable seeds, fruit seedlings and watering devices.

Since the irrigation, she says:

"Now I am very satisfied with what I have started to see in my farm. I am getting rewarding yields and income from my peppers, tomatoes and onions. My family and I have been depending on maize and teff for food and income, which meant it was difficult to feed and cover school fees for my siblings since the income was insufficient. From the current crop I expect to earn something in the range of ETB 40,000 to 50,000, which has never been generated there before."

Farm Africa / Nichole Sobecki

ACHIEVEMENTS AND LESSONS

During the first phase of the project, Farm Africa promoted drip irrigation. However, the technology was met with resistance from farmers who explained that its application was inappropriate for the following reasons:

- The local sandy soil type resulted in openings becoming clogged
- Drip irrigation isn't widely used in Tigray, resulting in a dearth of input suppliers and technical expertise locally
- In the absence of mechanised pumps, human-powered drip irrigation is too labour-intensive, proving especially challenging for female farmers

In contrast, where Farm Africa introduced motorised and treadle pumps to complement the drip technology, these were adopted quickly and enthusiastically by farmers, who chose to bypass the use of the drip technology and just pump water directly to the fields.

It is too early to cite precise productivity increases, but anecdotal evidence tells us that improved water availability has allowed farmers to grow crops all year round and bolstered their resilience to an increasingly volatile climate, although challenges do remain during severe drought periods when the river can dry up. Furthermore, the technology has promoted crop diversification; many farmers are now producing vegetables, with households reporting a more diversified, nutritious diet, especially for children.

Tesfaye from Maysure kebele has been using SSI systems since 2015, using a motorised pump to grow peppers, tomatoes and onions.

"Farm Africa organised us into groups of 11 members to share one motorised pump across our individual farms. Initially there was no irrigation in this area and we did not have any knowledge on irrigated farming. There was a negative attitude towards irrigation, but after Farm Africa's training, I have benefited a lot. Initially my land was idle. I spent ETB 3,000 to buy inputs and I expect to earn ETB 10,000 this year. We are making plans to begin saving so that we can buy more pumps and maintain those we have received from Farm Africa"

CRITERIA FOR SSI FEASIBILITY

No one irrigation system is best for every application. When deciding on what system to use, a wide range of factors should be taken into consideration, including: systems for raising finance, crop mix, energy sources and cost, commodity prices, labour availability and potential savings in labour, economies of scale, the availability of water, levels of efficiency in drawing water and delivering it to the irrigation site, and the depth from which the water must be pumped.

The end goal of SSI initiatives is the improved management of water, to bring about improvements in nutrition, food security and household income. To ensure these improvements, good practice should be applied at each stage of implementation:

1. PRE-IMPLEMENTATION APPRAISAL

Based on our experience in Tigray, we have created a checklist for the minimum critical requirements that need to be in place for a SSI project to be successful:

- A continuous water supply. In practice, this means either the existence of a perennial stream or river close to the farm or adequate groundwater that can supply enough water to at least one harvest during the dry season.
- An appropriate legal framework to govern water use and resolve conflicts, as well as local government capacity to oversee and enforce laws.
- The availability of appropriate and cost-effective water lifting technology compatible with the smallholder farming system and soil type as well as the means to secure spare parts and other necessary supportive technology.
- Scope for community-level training, including awareness raising on the importance of irrigation, technical backstopping on application of the technology and support to crop production techniques.
- For maximum impact, SSI initiatives should be coupled with soil conservation and catchment management initiatives to prevent degradation and ensure continued supply of water.
- Potential for intensive mentoring on the profitability of the crops, structured support on how to manage the impact of price fluctuations and value chain development assistance to ensure farmers have the financial incentives and capacity to maintain adopted technology.
- The number of farmers being targeted for participation needs to be just right. Too few, less than five, will mean it's not profitable, too many, more than ten, and the equitable sharing of the technology becomes a challenge.
- As with integrated watershed management, the existence of a sound community level management structure, with clearly articulated and understood byelaws, and firm leadership is important for the long-term viability of the scheme.

2. GENDER ASSESSMENT

Gender dimensions must be taken into account if irrigation improvement are to benefit all the members of a community. Explore the following questions during the planning stage of the project.

- Are there barriers to women's adoption of the technology? How far is the plot from the homestead? How easy are the different technology options for farmers to use?
- Does the technology save labour or increase the labour burden of the household? Are there time savings in the collection of water?
- Are there any health risks associated with water use? Do the options for irrigation adversely affect sanitation?
- Who takes decisions over the technology and crop adoption?
- Does the technology improve incomes? If so, who benefits?
- Do communities support women's involvement in irrigation or managing of products related to the irrigation initiative? Are women likely to be given roles in irrigation management committees?
- Does the agricultural extension system have the capacity to take a gender-sensitive approach to training and ongoing support in the management of the scheme?

3. PLANNING AND COMMUNITY ENGAGEMENT

At this stage, the critical factor is whether farmers are empowered to make their own decisions. This requires a participatory diagnosis of the problems to be solved, as well as an in-depth assessment of the interest, motivation and capacity of farmers to adopt irrigation techniques. On this basis, action plans can be meaningfully owned by farmers themselves, and subsequent choices are most likely to be appropriate to local context. Successful interventions need to include the following:

- Efforts must be taken to identify and engage with relevant actors, water users and stakeholders, including internal and external drivers of change. Channels should be set up to identify and respond to community members' concerns.
- Devise a clear action plan for installation and future operation of the SSI. This should consist of priority setting, a detailed calendar and defining community and local extension officer responsibilities from planning through to implementation and management.
- Work with the local community to establish clear procedures and processes of water user associations for all levels of water harvesting and irrigation activities.
- Draw up a plan for training and capacity building.
- Create a plan for knowledge dissemination and community engagement, including farmer-to-farmer exchanges, which encourage more technology uptake and wide-scale adoption.

Farm Africa / Mintesnot Kasa

4. RESOURCE MOBILISATION AND IMPLEMENTATION

From the outset, SSI schemes require investment. Investments can range from water lifting devices to new sources of water, which may need to be constructed, to water applications systems, such as canals. Furthermore, for farmers to reap the full benefits of an expanded SSI system they may need access to specific agricultural inputs for crops as well as tailored agronomic advice. Finally, farmers need some form of access to finance, ideally through a community-centred scheme. Taking these factors into account, the following "value-for-money" assessment should be considered:

- Cost-benefit analysis: The cost of sustainable farmer management of the SSI scheme (including infrastructure, technology and water user associations) must be an acceptable proportion of the income derived from irrigation. In other words, cost-benefit ratios must generate incentives that lead to rational production decisions.
- Finding synergies with other initiatives: SSI interventions can be combined with other initiatives to maximise impact. For example, combining SSI with efficient application technologies and soil conservation practices; as well as endeavours to integrate water and nutrient management.
- Integration with support services: It is important to ensure that critical support services are in place, such as access to inputs, support to farmer aggregation for market and access to finance.

5. REINFORCING COMMUNITY MANAGEMENT SYSTEMS

Water User Associations have existed for a long time. In general, they are well organised and effectively operated by farmers who know each other and are committed to cooperating closely to achieve common goals. Typical associations comprise up to 200 users who share a main canal or a branch canal. They may be grouped into teams of 20 to 30 farmers, with equal participation of women and men. These associations handle construction, water allocation, operation and maintenance functions to ensure efficiency and sustainability of the SSI scheme. Associations are typically governed by bye-laws, but work closely with local government.

Farm Africa / Nichole Sobecki

KEY TECHNOLOGIES AT A GLANCE

TREADLE PUMPS

The treadle pump is a human-powered pump that provides a simple solution to many water management obstacles faced by resource-poor farmers. Treadle pumps use body weight and leg and arm muscles to lift water from a depth of up to seven metres, meaning it can be used for extended periods of time without causing excessive fatigue to the user. Another advantage is the technology's simple design, meaning it can be manufactured locally using simple tools commonly found in rural areas.

Alongside the technology's ease of use, a key advantage of the treadle pump is its cost-effectiveness and relative simplicity; needing no fuel and limited maintenance. One pump can irrigate 0.25 hectares of land and costs around US$150, seasonal labour costs associated with operating the treadle set are estimated at US$600 per hectare.

Treadle pumps are suited to areas where there is a water source less than seven metres from the surface, and less than 200 metres away from the field to be irrigated. The treadle pump is not limited to irrigation, and is often used for other purposes such as extracting water for domestic use.

MOTORISED PUMPS

Motorised pumps require very specific conditions for successful implementation. Not only do they need a water source within reach of the pump capacity, but access to a power source, spare parts and qualified mechanics capable of making repairs. As the costs are higher, motorised pumps should, in general, only be deployed to farms producing high-value crops, otherwise they risk not providing sufficient financial incentives. There are some key advantages to motorised pumps: they are versatile, often portable (making them easier to share among larger numbers of farmers), labour-saving and irrigate large areas (between five and 200 hectares).

Motorised pumps are normally quite expensive: in Ethiopia they range from ETB 13,000 to ETB 90,000 (£444 to £3,000). The practical challenges of using motorised pumps account for their lack of availability, which in turn increases the cost of spare parts and technical expertise. Farmers' lack of basic familiarisation with the technology and the relatively high price of fuel present further obstacles to motorised pump uptake. The complexity and cost of the technology makes its management by Water User Associations more challenging, it requires a solid institutional basis and clear leadership to make it successful.

A recent technological breakthrough has seen the introduction of the small low lift motorised pump, able to discharge 2 – 15 litres per second. The pumps are more competitively priced, ranging from £160 to £400, and can irrigate an area between one and five hectares. The innovation's operational costs are mostly limited to fuel, which is estimated at US $500 per hectare per season.

DIRECT APPLICATION FLEXIBLE HOSE PIPES

Hoses can be attached to a treadle or motorised pump, or a gravity system with sufficient pressure, and used to direct water onto plants. It is a relatively low cost and easy-to-use method for applying water, generally in conjunction with a pump.


Farm Africa / Mintesnot Kasa

DRIP IRRIGATION

Drip irrigation delivers precise application of irrigation water to plant roots. Under the right circumstances, the technology has the potential to benefit poor farmers, but there is little evidence of this potential translating into real-world benefits in the field. For success, it is vital that the community is committed to water conservation, has a reliable source of clean water nearby and access to spare parts and technical support.

The key benefits are that it maximises productivity of water, has low labour requirements and is available in different sizes, from $10m^2$ up. The main obstacles are that the communities often lack reliable access to inputs and the technical capacity to filter dirty water, set up the technology properly and make repairs.

SOLAR-POWERED SMALL-SCALE IRRIGATION

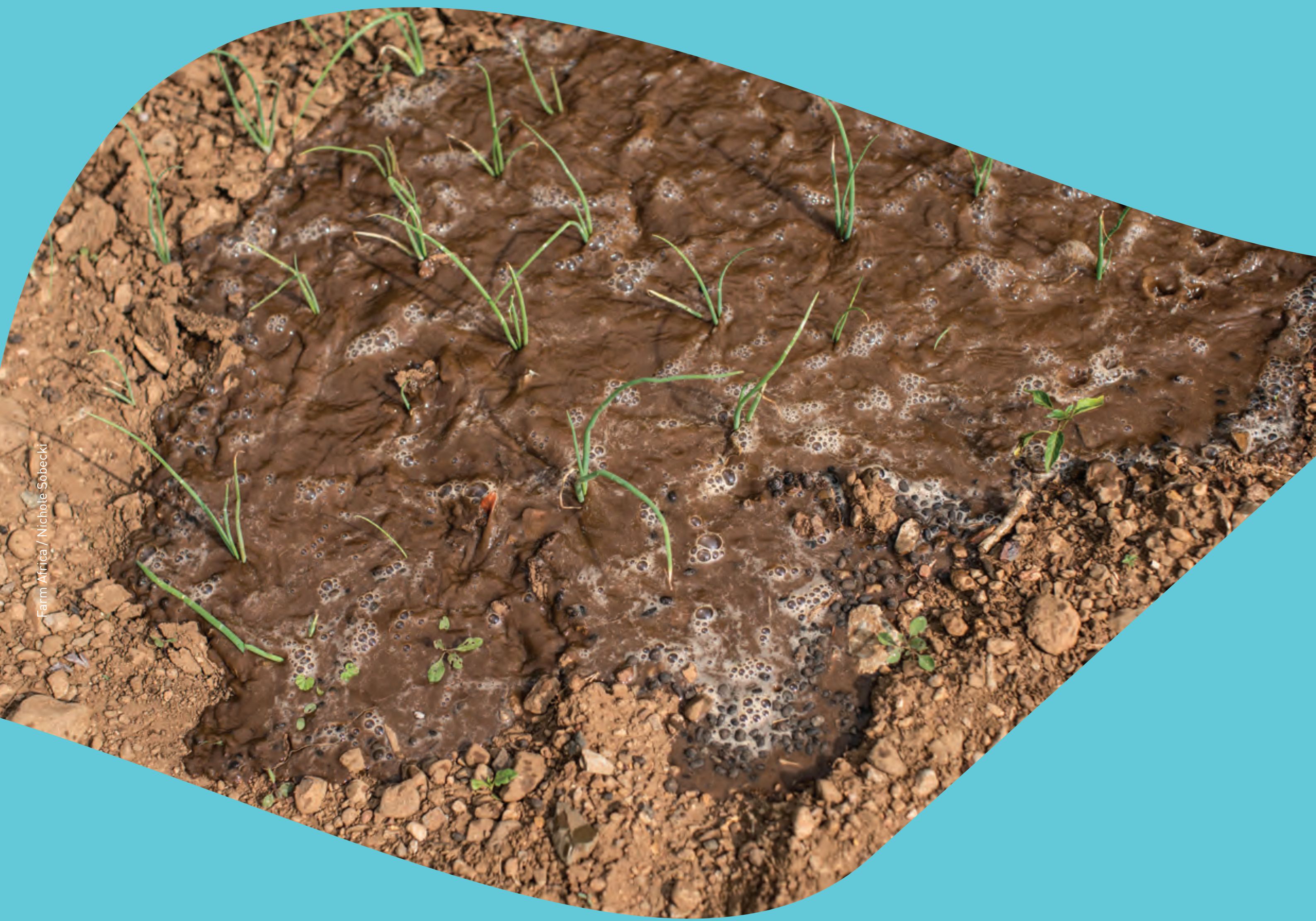
Solar pumps bypass typical fuel cost issues, have low maintenance costs and have proved reliable in the field. However, a key limitation is capacity; typically a solar-driven electric pump can only irrigate a plot 0.3 to one hectare in size. Key requirements are a water source less than 10 metres in depth, adequate sunshine (8 to 12 KW per day), the availability of panels and pumps locally and maintenance technical expertise.

Low output results in water being delivered relatively slowly; this means it is important to combine solar powered pumps with other irrigation and pipe systems, and construct a reservoir for two to three days of storage to increase discharge and account for periods of low sunshine. Taking into account the pump's low capacity, the costs of the solar technology are high. The initial investment costs for setting up a solar-powered SSI system are often prohibitive, typically between £7,900 and £12,000 per hectare. However, the operational and maintenance costs are relatively low at £40-80 per hectare. With the right selection of high-value crops and the right management mechanisms, solar irrigation could represent a good long-term investment.

OPEN GRAVITY WATER CANAL AND PIPE CONVEYANCE SYSTEMS

This irrigation system consists of an intake structure, a conveyance system, a distribution system, a field application system and a drainage system. The intake structure (such as a pump, dam and source diversion) directs water from the source of supply, such as a reservoir or a river, into the irrigation system. The conveyance system transports water from the main intake structure up to the field ditches. The distribution system transports water through field ditches to the irrigated fields. The field application system then circulates water within the fields. Finally, the drainage system removes the excess water (caused by rainfall and/or irrigation) from the fields.

Typically water conveyance is done via a simple earthen gravity canal. A key disadvantage of this system is high levels of water losses due to evaporation and seepage through the canal bottom, particularly in sandy soils. If water regulating structures are absent or inadequate, water distribution will be uncontrolled, leading to possible canal breakages and water losses. This system also requires careful technical oversight, with regular maintenance by the community or local stone masons. Managing the relationships between upstream and downstream water users as well as the sheer complexity of water distribution can also be extremely taxing. Costs are also potentially high; to construct a simple canal can amount to £470 – £630 per hectare including partial lining (10 percent) and small regulation structures.



Farm Africa / Nichole Sobecki

SPRINKLER IRRIGATION SYSTEMS

This technique includes a complete irrigation system with pump, distribution pipes and mobile laterals on which the sprinklers are placed. The pressurised water is led to the field through a pipe system and water spraying is accomplished by using several rotating sprinkler heads or spray nozzles. The system has high water efficiency, is easy to install and the equipment is readily available on the market. However, it requires an adequate water supply, low wind conditions and specialist technical advice. Furthermore, initial investment costs are high (£2,400 – £4,000 per hectare) as are fuel costs (about £630 – £790 per hectare per season). That said, there are some key advantages; water losses are low and the system is easily moved, especially convenient for supplemental irrigation in locations where rainfall has been inadequate. Also it has low labour requirements and it can be applied at a number of different sizes and designs.

Farm Africa / Nichole Sobecki

SURFACE IRRIGATION

This entails the application of water to fields at ground level. Typically, the entire field is flooded or the water is directed into furrows or borders. The estimated cost of setting up a surface irrigation is US $160 per acre.

The simplicity of this approach is appealing. However, if not done properly it can lead to wastage of water, soil erosion, loss of crop nutrients and salinisation of the soil. Furthermore, terrain variations can cause the water to be distributed unevenly, leading to non-uniformity in maturation and reduced crop growth and yield.

Furrow irrigation involves digging narrow ditches in the field between the rows of crops. The water runs along them as it moves down the slope of the field. The water flows from the field ditch into the furrows by opening up the bank of the ditch or by means of syphons (small curved pipes that deliver water over the ditch bank).This technique is especially suitable for crops sensitive to mechanical stem damage such as maize, sunflower, leafy vegetables, potatoes and tomatoes. Water is more uniformly applied, allowing uniform maturation. However, furrow irrigation is relatively expensive.

Basin irrigation involves the use of basins, which are horizontal, flat plots of land, surrounded by small dykes or bunds. The banks prevent the water from flowing to the surrounding fields. This is commonly used for rice grown on flat lands or in terraces on hillsides. Necessary conditions to be considered include soil types, slope of land, available water flow, depth of fertile soil and type of crop to be grown.

TECHNICAL TIPS IN SELECTING THE RIGHT SCHEME

- Ascertain the water holding capacity of the soil in each field and the water requirements and response of each potential crop.
- Use an effective soil moisture monitoring system, particularly to schedule irrigation accurately.
- Choose the right application equipment for each situation; according to agroecology, soil type, gradient, availability of water, cost-benefit, cultural issues, availability of land, planning and management capacity and suitability for high-value crops.
- Select suitable crops for irrigation, taking into consideration cropping calendar, improved varieties with potential under irrigation, crops for self-consumption and food security and those destined for the market.
- Audit performance afterwards to seek ways of improving the efficiency of water use and application.

Farm Africa / Nichole Sobecki

COMMON PITFALLS OF SSI PROJECTS

- Lack of community engagement in the selection of irrigation technologies.
- Lack of understanding of processes required to involve communities.
- Lack of fit between the technologies on offer and the capacities and needs of households.
- Poor promotion and ongoing technical support.
- Ineffective targeting.
- Lack of capacity to manage complex schemes.
- Availability of water (water shortage).
- Availability of appropriate technology, inputs and technical maintenance support.
- Agronomy support and market for high-value crops.

CHARACTERISTICS OF A SUCCESSFUL SSI INITIATIVE

A successful SSI intervention should effectively address the full range of activities that make up the irrigation enterprise. This includes markets, access to sustainable finance, inputs, infrastructure, institution-building and crop production technical support. It is vital for success that an SSI initiative pays equal attention to the infrastructure (hard components) as well as the social and institutional systems (soft components) of water user organisation and agricultural production. Any initiative must have a clear focus on market development, and a clear flow of information to farmers. A successful initiative must have taken into account livelihood strategies outside the irrigated context, as well as multiple demands on irrigated water.

Ultimately, however, an initiative that has a full sense of ownership by farmers (men and women alike), built through involving them in all aspects of decision-making, will be a success.

Farm Africa / Mintesnot Kasa

FARM AFRICA

Investing in smallholder farming is the number one way to combat poverty in rural Africa. Farm Africa is a leading NGO specialising in growing agriculture, protecting the environment and developing businesses in rural Africa.

AGRICULTURE
Developing agricultural expertise for long-term change.

ENVIRONMENT
Safeguarding the environment for years to come.

BUSINESS
Boosting business to drive prosperity.

Ethiopia Kenya Tanzania Uganda United Kingdom

www.farmafrica.org

FarmAfrica

FarmAfrica

FarmAfrica

Farm_Africa

Info@farmafrica.org

Registered charity no 326901 (England & Wales)

This material has been funded by Irish Aid and UK aid from the UK government; however the views expressed do not necessarily reflect the Irish and UK governments' official policies.

Irish Aid
Government of Ireland
Rialtas na hÉireann

UKaid
from the British people