# Policy *Brief*

# EFFICIENT WATER USE TECHNOLOGIES: THEIR ADOPTION, UPSCALING AND POLICY IMPLICATIONS

Figure 1: Spate Irrigation Infrastructure and canal lining in Makanya catchment, Kilimanjaro Region, Tanzania. (Photo by Fredrick Kahimba, 28/04/2014)

## SUMMARY

Agriculture is an important sector for rural livelihood and key to the economy and employs majority of smallholders in Sub-Saharan Africa (SSA). Water shortage for agriculture is increasingly becoming a major constraint to improving the lives of the rural poor. The Tanzania agricultural sector, which is dominated by rainfed farming, is already much affected by inadequacy and unreliability of rainfall, with climate change likely to further exacerbate these risks and uncertainties (Mahoo et al., 2012).

The recent irrigation policy calls for the improvement of irrigation Water Use Efficiency (WUE) and effectiveness (URT 2013a). It has emphasized the promotion of Water Use Technologies (WUTs) of high efficiency such as drip irrigation and the System of Rice Intensification (SRI).

WUTs are regarded as the technologies commonly used by majority of the smallholder farmers and will make the most significant impact if improved and promoted. The WUTs did not differ much depending on the agro-climatic conditions (semi-arid vs. sub humid). However, within each district they differed mostly depending on district topo-sequence.

This policy brief thus presents key findings and policy recommendations for adoption and upscaling of WUTs in Semi-arid and sub-humid/SAGCOT areas of Tanzania for ensuring food security, and improving community livelihood and environmental sustainability.

## WATER USE TECHNOLOGIES AT A GLANCE

Investment in the promotion of WUTs and proper management of agricultural water can contribute to agricultural growth and reduce poverty mainly by: (a) permitting intensification and diversification for increased farm outputs and incomes; (b) increasing agricultural wage employment; (c) reducing local food prices thereby improving net incomes; and (d) reducing poverty through increased rural and urban employment (IFAD, 2007). To build climate resilience in the agriculture sector, the Agriculture Climate Resilient Plan ACRP has proposed adaptation strategies to use water more efficiently (URT, 2014). They include methods to harvest and store rainwater runoff, and better management of land and catchment areas (Table 1).

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Table 1: District priorities on WUTs that if promoted can make a difference in improving livelihood of smallholder farmers

| Topo-sequence | Semi-arid areas | Sub-humid/SAGCOT areas |
|---|---|---|
| Highland areas | Improvement of traditional micro-dams (*ndivas*); canal lining to minimize conveyance losses; Field management – terracing (stone, grass and earth); Traditional furrows | Terracing, traditional furrows; Field management – terracing (stone, grass and earth) |
| Midland areas | Canal lining; Improvement of storage structures (*ndivas*); field management – (terracing, *fanya juu, fanya chini*) | Ridge cultivation, terracing (*fanya juu fanya chini*, irrigation canals) |
| Lowland areas | Runoff RWH from gullies (spate irrigation); canal lining; field management – (tied ridges, boarder strips; water lifting devices) | Improvement of Irrigation canals for lowlands; water lifting devices; SRI; boarders and basin levelling |

## Objective

In order to recommend desirable and sustainable technologies as proposed in the ACRP and guide its investment and implementation, there was a need to carry out analysis of costs and benefits of different WUTs that can be applied by smallholder farmers, and the factors that influence adoption of these technologies, both for agriculture and domestic use in Tanzania.

## The Challenge

While majority of the smallholder farmers still depend on rainfed agriculture, the rainfed agricultural lands are low in productivity and at the same time prone to risks as compared to those in irrigated areas. Furthermore, climate change is likely to exacerbate the risks and uncertainties associated with rainfed agriculture (Kulkarni, 2011, Mahoo et al., 2012). This again calls for the need to improve the use of WUTs and intensify irrigated areas through improving water management practices. The success of WUTs, however, depends on the level of their integration within the community and socio-economic dimensions of a given locality.

Tanzania has substantial water resources and an irrigation potential yet to be exploited (Tumbo et al., 2012). Farming is generally on a small scale, with 85% of arable land used by small-holders, at an average plot size of 1.0 ha. Most agricultural systems are primarily rain-fed. With approximate 1% of potential irrigable land (29.4 million hectares) under irrigation (URT, 2013), the promotion of WUTs and proper management of agricultural water will ensure that the nation attains reliable and sustainable agricultural production and ensure food security and poverty reduction (URT, 2014).

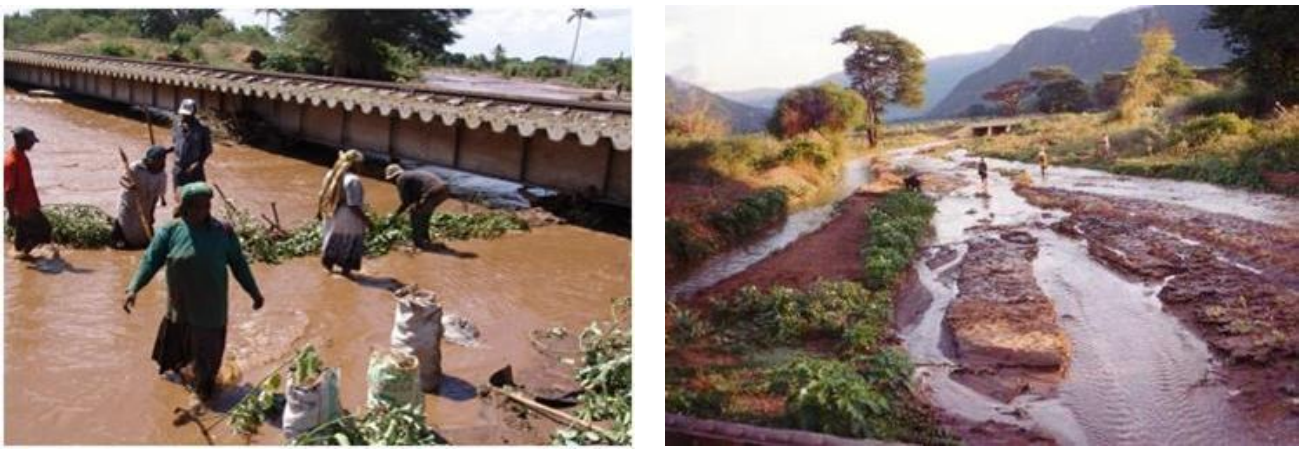

Figure 2: Community diverting water for spate irrigation in Makanya village, Kilimanjaro Region, Tanzania.

## MAIN FINDINGS

The key findings in this case study included the following:

(i) **Potential WUTs:** The WUTs that were most applicable in the semi-arid highland and midland locales included micro-dams, traditional canals/furrow systems and terraces. In the semi-arid lowland, key WUTs included runoff diversions for spate irrigation and other infield water management such as tied ridges and sunken borders/basins. In the sub-humid SAGCOT region the WUTs included traditional canal irrigation, terracing and water lifting devices in the highlands. In the sub-humid midlands and lowlands, the WUTs included ridges, improved irrigation canals, and System of Rice Intensification (SRI).

(ii) **Costs and benefits analysis of priority WUTS:**

*CBA of Microdam (ndiva):* The Costs and Benefits Analysis (CBA) is based on a community micro-dam serving 150 farmers each managing 0.5 acre. Green maize production was the enterprise considered. The green maize was sold at Tshs 200 per unit unshelled cob. The estimated plant population was 35,000/ha. The present value (PV) of total costs was estimated at Tshs 33.2 million per hectare. The PV of gross benefits was Tshs 40.1 million per hectare. Therefore, the PV of net benefits was Tshs 6.9 million per hectare. This is the stream of net benefits over the period of 10 years (between 2015 and 2025) at a discounting and inflation rates of 16% and 7.5%, respectively. The Benefit Cost Ratio (BCR) was 1.21 – meaning that every shilling invested will be recovered with an additional 21 cents. Based on the CBA, it is concluded that Microdam system is an economically viable project for smallholder farmers in semi-arid areas with payback period of less than a year.

*CBA of SRI*: The CBA was based on 1 ha of paddy grown under SRI. The yield was estimated at 8 tons/ha – each a selling price of Tshs 850,000 / ton. The PV of total cost for SRI was estimated at Tshs 30.1 million per hectare. The PV of gross benefits was Tshs 41.8 million per hectare. Therefore, the PV of net benefits was Tshs 11.7 million per hectare. The BCR for the SRI investment is 1.39. The investment period, discounting rate and inflation rate used are the same as that used for the micro-dam. Therefore, based on the CBA, SRI system is a promising WUT for smallholder farmers in SAGCOT with paying back all investment costs in the first year.

*CBA of Drip irrigation scheme:* Based on the analysis for 1 ha of vegetables production. The enterprise considered in the analysis was cabbages at a plant population of 33,000/ha. Each cabbaged was sold at Tshs 500. The PV of total costs was estimated at Tshs 52.4 million /ha. The PV of gross benefits was Tshs 93.2 million /ha. Therefore, the PV of net benefits was Tshs 40.8 million /ha, with a BCR of 1.78. Based on the CBA, drip irrigation has the highest BCR compared to other WUTs such as Microdam and SRI.

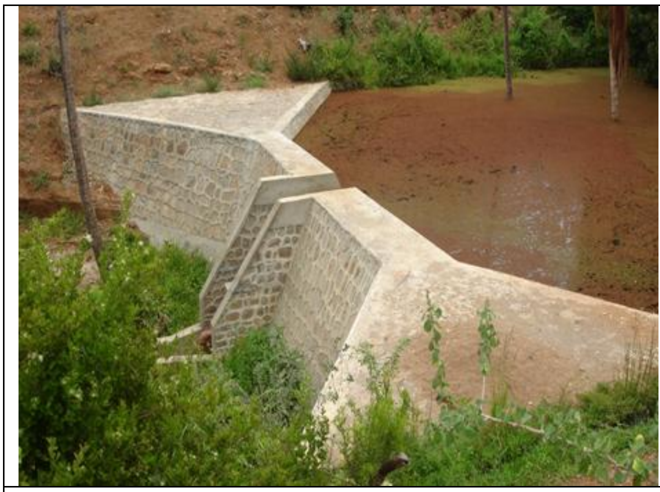

Figure 3a: Improved Microdam WUT in Same district,

Figure 3b: Comparison of rice growth performance

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| Kilimanjaro Region | between SRI and non-SRI rice plant. |

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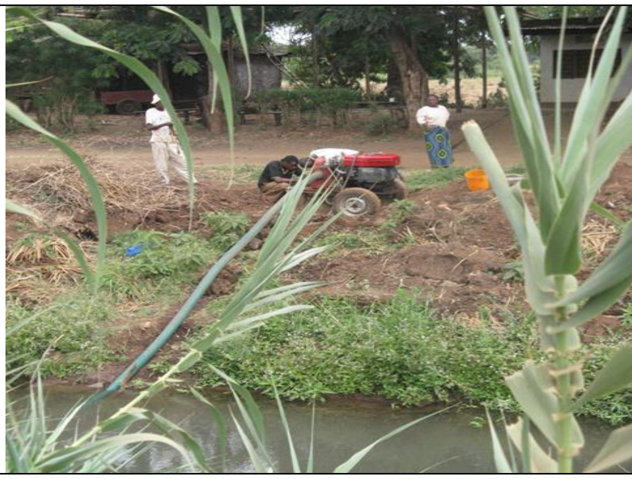
|  |  |
| Figure 4a: Stone terraces, typical infield WUTs in semi-arid and sub-humid highland areas (Tumbo et al., 2012). | Figure 4b: Petrol powered motorized pump for water abstraction from irrigation canals, typical WUTs in semi-arid and sub-humid lowland areas (Photo by FC Kahimba, 2013). |

## Factors Influencing Adoption of Water Use Technologies

Key factors underlying adoption of WUTs technologies were identified. These factors can be grouped on three categories – farm/farmer based, technology and institutional related. Farm/farmer related include positive perception of farmers regarding the potential of technology in increasing crop yield, farmer's choice of crop with high water productivity and returns per drop, gender of a decision maker in the household, education, and secured land tenure. Technology-related include low initial capital investment, less labour requirement; locational suitability (e.g. topography, soil type); and simplicity of technical and design requirement. Institutional factors include availability of credit to farmers, extension services and technical support.

## Approaches for Scaling Up of WUTs

Potential approaches for up-scaling WUTs were identified. These can be grouped with respect to planning scale where they are carried out – i.e. local, sub-national (e.g. district) and national scales.

*Local planning scale:* improving community awareness and build the capacities of farmers on WUTs (e.g. in terms of capital, knowledge) through training approaches such as Farmers Field Schools (FFS) and exchange visits; and secured access to land by farmers.
*Sub-national planning scale:* increase public investment in WUTs through different agricultural funding mechanisms e.g. the District Agricultural Development Plans (DADPs), District Irrigation Development Fund (DIDF) and development partner funding; strengthening local water resource governance institutions such as Water User Associations (WUAs); and staff capacity building and strategic planning in the local governments and Water Basin Offices (WBOs) to enhance up-scaling of WUTs.

*National planning scale:* formulate, harmonize and implement policies to promote potential WUTs in different agro-ecological zones and mobilize strategic public investments in this regard.

## Policy Recommendations

- Policies address the issue of water management in a holistic manner. There is a need to review the policies to have coherent focus on promoting efficient WUTs.

- The need for harmonization of policies that interlink natural resources to avoid conflicts over water uses. Whereas for example the customary land law recognizes the right to land entailing some resources therewith, the water law does not recognized such customary right by granting the ownership right to water by the owner of land on which the water resource is found
- The irrigation policy needs to be revised to put additional emphasis on markets and minimizing post-harvest losses and focusing on value chains upgrading. At the moment it has more emphasis on increased crop production and productivity.
- There is a need for putting in place adequate mechanism for enforcing policies, regulations and by-laws. At the moment still there is unsustainable cultivation in catchments and destruction of water sources thereby limiting the flow of water on which some of WUTs directly depend. In some areas where farmers and pastoralists co-exist, conflicts always arise from grazing on farmland which demolishes water infrastructure.
- Crop enterprise choice is critical to ensure returns on investment from different WUTs are optimized. Farmers might need to be capacitated to be able to undertake such choices from a range of crops that can be grown on their lands given WUTs.
- For proper adoption, WUTs should be promoted as a package with other technologies such as improved seeds, fertilizer use, and appropriate crop choice to ensure that farmers realize higher productivity and profitability.
- Promotion of WUTs should not be gender-blind but rather limit spaces for gender exclusion such as ensure participation of women and youth in the extension trainings and implementation of WUTs. Insecure land tenure especially among women should be dealt with in accordance to the land legislation that curtails gender discrimination on this aspect.
- Farmers have to receive adequate training on the technical know-how of the WUTs – including how to operate, repair and maintain the technologies. Farmers must have access to credit tailored to their conditions – low incomes, seasonality of production and lack of collateral.
- The local government must devise strategic means of availing financial resources to in invest in WUTs e.g. through DADPs and DIDF. Strengthening the local water governance institutions such as WUAs is important for sustainable up-scaling of WUTs.

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