Improving Irrigation Water Use Efficiency and Functionality of Irrigation Schemes for Food Security in Water Deficit Counties Project in Kenya

Summary

Application of ICT in supporting irrigation water use efficiency has not been adopted in Kenya despite its potential in addressing water scarcity. Sensor-based technologies have been applied in other parts of the world including Tanzania, Malawi, Australia and South Africa with impressive returns to investment in irrigation sub-sector. In addition, integrated research on soil parameters and water balance in drier parts of Kenya has the potential of increasing food security and nutrition and the share of irrigation value in the market. This collaborative research is therefore aimed at validating sensor-based irrigation TIMPS (Developed in Meru University of Science and Technology), soil and water productivity TIMPS (developed in KALRO) in three ASAL counties; Tharaka-Nithi, Kajiando and Machakos. Improved food productivity and farmers livelihoods will be major expected outcomes of successful project implementation.

Background

Increasing climate-induced stress and risks among several communities across landscapes in Kenya calls for innovative adaptation and mitigation strategies. Varying and changing climatic conditions in Kenya have one common characteristic marked with either too much or too little water. Incidences and severity of droughts and floods are on the increase in the country. Inadequate deployment of ICT-mediated interventions, inadequate adaptive capacity, lack of learning platforms, inadequate policy support and soil deterioration in irrigation schemes are some of the outstanding constraints facing irrigation development in Kenya particularly in water scarce counties.

Agriculture, which is a key pillar of the country's economy, contributing to about 24% to the Gross Domestic Product (GDP), is one of the most sensitive sectors to seasonal variability, climate change and soil nutrient deprivation. This is exacerbated by the country's dependence on rain-fed agriculture particularly in ASALs. Kenya is considered to have an economic water scarcity and hence one of the water stressed countries in the world. Projections indicate that in the next 20-30 years, neither water stress nor economic water scarcity situation will improve and soil degradation may be on the increase. These scenarios have implications on farm-based incomes for already resource constraint farming and pastoral communities, food security and nutrition.

Sustainable and improved agricultural productivity have been the focus of previous and current governments with food security being one of the flagship initiatives currently as one of the Big 4 Agenda. Vision 2030 and ASTGS are explicit on the need to promote technologies and innovations that support agricultural sustainability, food security, value addition and hence agricultural transformation (Government of Kenya 2018). Attainment of these goals is feasible through intensified improvement of irrigation water management and governance and thus a gradual shift from rain-fed to irrigation-supported agriculture.

Recent studies in Kenya have indicated that approximately 193,600 ha of land is currently under irrigation but agricultural production from most

irrigation schemes is below the expected production potential due to degradation of soil and water quality arising from inefficient irrigation practices (Muchangi, 2005). For instance, approximately 400,000 ha of the targeted 1,300,000 Ha is chemically degraded and structural deformed (Wanjogu, *et al*., 2014). Studies in Machakos and Kajiado Counties, Muya et al. (2014) showed that over 75% of the irrigated area have saline-sodic problems and heavy metal toxicity resulting from use of polluted irrigation water. Moreover, the inefficient irrigation water application methods currently practiced in these areas exacerbates these problems by excess losses of nutrient bases and increased acidity. These are the key gaps that the proposed adaptive collaborative research will provide long-term solutions for resource constraint farmers using Machakos, Tharaka-Nithi and Kajiado Counties as case studies.

A number of climate smart agriculture TIMPS have been developed and if validated would contribute significantly to the solution of these problems. These include sensor-based ICT irrigation systems, Saltrad, Vermitech, biochar, and rain water harvesting for supplementary irrigation.

Meru University of Science and Technology (MUST) has developed a sensor based irrigation technology that enables small-scale farmers in ASAL areas practice irrigation farming using rain-harvested water. This ICT technology can also be used to address the problem of water logging arising from over irrigation. The Saltrad consists of elements that remove sodium from the soil and reduce the pH thus creating an enabling environment for removal and leaching of sodium (Wikiiru, 2012). This technology is more cost-effective as compared to conventional method where large amount of gypsum is used to reduce sodium. Vermitech is a TIMP that uses vermicompost in combination with appropriate tillage that improve soil structure for enhanced leaching of excess salts thereby reducing salinity as reported by Ansari (2008). The deep tillage and ripping included in vermitech is intended to break hardpan layer in cultivated soils and improve infiltration and holding capacity (FAO, 2018). In cleaning the polluted irrigation water, Phytoremedial plants (*Polygonum senegalensis* and *Amaranthus hibiridus*) will be tested and validated in Kabaa irrigation scheme which is currently using the polluted Athi River water. It is a biological method which is cost-effective and environmentally friendly method for purifying water (Orwa *et al.,* 2014). Biochar is a TIMP developed through biomass carbonization and is effective in improving the quality of degraded soils by changing their physical and chemical properties for enhanced crop production. It has shown the ability to improve soil fertility, protect water quality, and generate carbon neutral energy as demonstrated by (Muya *et al*, 2012).

In addition the hardware TIMPS, the project will deliberately enhanced the adaptive of the stakeholders, develop a knowledge sharing platform and influence policy through round table dialogue.

The proposed adaptive research, through increased irrigation efficiency will contribute to the following; local and national food security and nutrition, increased levels and diversity

of income for irrigators and adjacent communities, as well as increase the contribution of the irrigation sub-sector to the national economy.

Problem statement and justification

According to Global hunger index 2018, Kenya is ranked as food insecure in addition to rising cases of malnutrition and unsafe food production due to irrigation with polluted water (Daily Nation, August 16, 2019). The declining trends in food production under many irrigation systems in Kenya due to soil structural deformation, waterlogging and increased chemical degradation is attributed to low irrigation efficiency of the current irrigation practices (Muya et al., 2019). Therefore, enhancing irrigation water productivity, through improved efficiency, as well as putting more arable land under irrigation will reverse the declining trends in the quality and quantity of agricultural production. Muya et al. (2016) showed that, by increasing irrigation efficiency from 55 to over 90%, more than 450,000 m^3 of water was saved, which would irrigate an additional area of 150 ha, hence increased production.

Technologies, innovation and management practices (TIMPs) required to improve water productivity in the project area (Machakos, Kajiado and Tharaka-Nithi Counties) should address the critical problems currently constraining agricultural production. In these areas, the current decline in agricultural production is associated chemical and physical land degradation arising from the negative impacts of climate and inefficient irrigation practices (Muya et al., 2014). Chemical degradation includes increased rate of heavy-metal toxicity in areas irrigated by polluted water which is currently a serious health issue, particularly in the selected project sites in Kabaa Irrigation Scheme in Machakos County. In addition, inappropriate tillage results into soil structural degradation, thereby, developing into a hardpan that impends water storage and uptake. The problem of hardpan and surface sealing in Tharaka-Nithi has been also reported by Kamoni *et al.* (2018) as the main cause of increased volume of run-off that needs to be harvested and efficiently used for irrigation instead of flowing on the surface to cause further erosion.

Project objectives

Overall objective

Poverty levels and food insecurity in target counties reduced through sustainable improvement of returns to irrigation investments

Specific objectives

(i) To validate sensor-based and market-driven irrigation technologies in Tharaka-Nithi, Machakos and Kajiado Counties

(ii) To improve soil and irrigation water productivity among smallholders in project counties and beyond

(iii) To facilitate establishment of ICT-based information sharing, and learning platforms to support the promotion of/and uptake of validated TIMPS (VIA)

(iv) To build the adaptive capacity of the irrigators and supporting agencies in sustainable management of validated TIMPS

(v) To promote evidence-based county level policy, planning and budgeting processes in the irrigation sub-sector particularly in respect supporting the validated TIMPS at scale

Expected results

Expected outputs

(i) Sensor-based and market-driven irrigation technologies in Tharaka-Nithi, Machakos and Kajiado Counties validated
(ii) Soil and irrigation water productivity among smallholders in, Tharaka-Nithi, Machakos and Kajiado improved
(iii) Establishment of ICT-based information sharing, and social learning platforms facilitated and promoted in Tharaka-Nithi, Kajiando and Machakos counties.
(iv) Adaptive capacity of the irrigators and supporting agencies developed through short-term training sessions and exchange programs in Tharaka-Nithi, Kajiado and Machakos counties.
(v) Evidence-based county level policy, planning and budgeting processes in the irrigation sub-sector promoted Tharaka-Nithi, Kajiando and Machakos counties

Expected outcomes:

(i) Sustainable economic returns and profitability from irrigation investments increased

(ii) Resilience of land systems under irrigation improved

Collaborations and partnerships

(a) University of Embu leads the process and address issues related to governance issues, instillation of monitoring tools, capacity building, and development of robust monitoring and evaluation framework.
(b) KALRO-Kabate particularly the Irrigation Department is in charge of delivering objective 2 on improving soil and water productivity
(c) Meru University of Science and Technology focuses on delivery objective one on the validation of sensor-based technologies to aid in improving irrigation water use efficiency.
(d) The Agricultural Mechanization Research Institute (AMRI) participates as a key partner in delivering objective 2 on soil fertility issues and irrigation mechanization and
(e) The Communities in the project sites in the 3 counties are participating in all the objectives.

Project team

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Project duration

January 2020 – December 2021.