Rainwater harvesting for improved smallholder crop yields in Tanzania

Policy Brief

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Plate 1: (a) Sole maize, flat cultivation with no fertilizer, (b) Sole maize, flat cultivation with fertilizer, (c) Intercropped maize pigeon pea, tied ridges with no fertilizer and (d) Intercropped maize pigeon pea, tied ridges with fertilizer

Pictures courtesy: Saidia, P.

Executive Summary

Rainfed agriculture is the mainstay of rural livelihoods in Tanzania. Irrigated agriculture accounts for only about 1% of cropland in Tanzania. Most of the farming and food production in Tanzania is done by smallholder farmers. However, the effects of climate change threaten these farmers' ability to maintain and accelerate agricultural growth. This policy brief recommends for the need to promote *in situ* rainwater harvesting in Tanzania using tied ridges, a proven water saving technology that significantly extends the available soil water for enhanced crop growth. The above is particularly important in water-scarce farming areas with low or erratic rainfall and on a sloping landscape.

Generally, rainwater harvesting coupled with use of chemical fertilizers and other recommended crop husbandry practices has been reported to lead to higher crop yields, food security and farmers' general well-being. For example, observations from the Trans-SEC project carried out in Chamwino and Kilosa districts showed that use of tied ridges and fertilizer micro-dosing (FMD) contributed to higher yields of maize, millet, pigeon peas and groundnuts compared to farmers' practice of flat cultivation without using fertilizer.

Based on the positive effects of rainwater harvesting, there is need for promoting and out-scaling rainwater harvesting in rainfed agriculture dependent areas. Doing so will mitigate the effects of low rainfall and intermittent dry spells that undermine crop yields. It is also recommended that institutions involved in mechanization of rural agriculture need to look into ways through which construction of tied ridges can be mechanized in an affordable manner.

Introduction

Smallholder farming is a major source of livelihoods and food security in Tanzania. However, the effects of climate change on top of other challenges threaten these farmers' ability to improve agricultural productivity so as to accelerate the growth of the sector (AGRA, 2017). According to AGRA, African agriculture will continue to be affected by climate change in ways that are uncertain but with profound negative effects on cereals. AGRA further points out the most likely to be affected are roots, tubers and particularly cereals whereby reductions in production of 2.9% in 2030 and 5.1% in 2050 are expected relative to the 2010 production levels.

Based on the above, farmers need to increase their livelihoods' resilience through income diversification, making risk-reducing investments in climate smart farming practices such as irrigation and rainwater harvesting (AGRA 2017, URT 2014). Biazin et al. (2012) have pointed out that appropriate application of *in situ* and micro-catchment rainwater harvesting (RWH) techniques could improve the soil water content of the rooting zone by up to 30%: combined with fertilizer use farmers could get up to six times increase in their crop yields compared to traditional practices. Increased crop yields due to improvement of soil moisture and use of fertilizers has also been reported by other studies (Makurira et al. 2011; Mahoo et al. 2012; Saidia et al., 2018)

In-situ RWH using tied ridges is a proven rainwater capturing and saving technology that significantly extends the available water content in the soil that can sustain the plant through shorter dry spells during the production season. This is particularly important in water-scarce areas with low and poorly distributed rainfall, and on sloping landscape. At the same time this technique prevents soil erosion caused by the short heavy rain falls.

Tied ridges compared to flat cultivation can double or triple crop yields where other productivity factors such as soil fertility are not a limiting factor. However, despite the potential of tied ridges, only a few farmers adopt them due to the higher labour requirements. In view of the highly degraded and (partly irreversibly) eroded soils of many Tanzanian regions, tied ridges are likely to be the solution on saving soil and land resources.

The policy brief advocates for the promotion and scaling-up of *in situ* rainwater harvesting and soil and water conservation technologies in the development of agricultural policies.

On-Farm Testing of Rain Water Harvesting (RWH) and Fertilizer Micro-Dosing (FMD)

The tied ridges, *in situ* RWH and FMD were the crop yields upgrading strategies (UPS) tested on-farm in four selected villages in both sub-humid Kilosa district and semi-arid Chamwino district. Farmers and local stakeholders selected the UPS to be tested and later adopted.

Participatory on-farm field experimentation was initiated in 2014/2015 and implemented for seasons (2014/15 and 2015/16) cropping seasons in all the case study sites (CSS) together with farmer groups involving 40-60 participants per group that tested the respective UPS.

Farmers were practically trained to design the tied ridges and on different levels of fertilizer micro-doses. The technical specifications of the ridges were the height of the ridge should be at least 20 cm for better root penetration and crop anchorage: the cross furrows, known as ties, should be 15 cm high and between 1.5 and 2 m apart. Fertilizer micro-doses rates included 12.5, 25, 50 and 75% of recommended rates of about 60 and 40 kg/ha of N and P fertilizers respectively. However, the majority of farmers chose 25% which seemed to give optimal results but still in the affordable cost range.

In each CSS a central learning plot called "Mother Plot" – as a farmer field school (FFS) – where treatments of different crop-innovation combinations with control farmers' practices were considered in the design of the FFS. This enabled farmers to make their preferential choice decisions of the UPS-crop mixes to try on their small farm plots "Baby Plots" before expanding the scale. Across the CSS villages, 221 farmers established between 600-800 'Baby plots' where they tried the UPS for production of different food crops.

Plate 2: Tied ridges for *in situ* rainwater harvesting

Picture courtesy: Saidia, P

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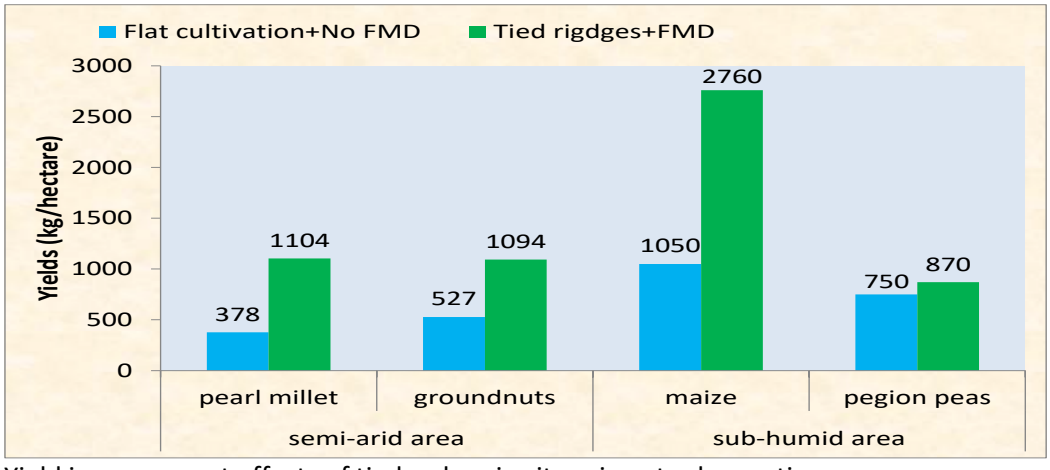
Yield improvement effects of RWH and FMD

- Generally, findings from the Tran-SEC Project show both the 'Mother' and 'Baby' plots out-performed the traditional flat cultivation practiced by farmers both for pigeon peas and maize. However, 'Baby' plots' yields varied very much among farmers based on soil type, landscapes and other husbandry practices. Nonetheless, findings from the two seasons of testing show the 'Baby' and 'Mother' plots yields for different crops had a comparable pattern.
- The figure below presents average yields from the on-farm "mother plot" for the two CSS areas of semi-arid (Chamwino district) and sub-humid (Kilosa district).
- In the semi-arid area, the yield increment for pearl millet with RWH and FMD over farmers' practice under flat cultivation without chemical fertilizer at all was 192%; and for groundnuts it was about 108%.
- In the sub-humid area, the increment in yield of maize with RWH and FMD over farmers' practice was 162%; and for pigeon peas it was 16%.



Yield improvement effects of tied redges in situ rainwater harvesting

Conclusion

The empirical evidence indicates that RWH in combination with FMD can significantly contribute to upgrading crop productivity in rain-fed agriculture in both the semi-arid and sub-humid farming environments. Such yield increments could contribute to closing the yield gap hence, increased food security and farm incomes at the same time conserving the environment against erosion.

Policy recommendations

- The government through the Ministry of agriculture needs to promote RWH for upgrading productivity of rain-fed agriculture in areas of Tanzania where investments in traditional irrigation schemes is not possible and/or viable.
- The President's Office Regional Authority and Local Government (PO-RALG) through the local government authorities (LGA's) needs to effectively use the extension officers available to promote the uptake of RWH and FMD technologies for increased crop yields, food security and improved general well-being of the smallholder farmers.
- The initial construction of tied ridges is tedious to implement as it takes four times more labour, compared to flat cultivation. Therefore, there is need for institutions such as the Centre for Agricultural Mechanization and Rural Technology (CARMATEC) and the Department of Engineering Sciences and Technology of Sokoine University of Agriculture, to look into ways of mechanizing the process. However, affordability by smallholder farmers in terms of initial and maintenance costs should be considered.

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