Research Application Summary

# Design parameters, criteria and operation guidelines of controlled drainage and sub-irrigation for *dambo* smallholder farmers' water user groups

Mwenechanya, F.[1], Kahimba, F.C.[1], Tarimo A.K.P.R.[1], Wiyo K.A.[1] & Salim, A.B.[1]
[1]Sokoine University of Agriculture, P. O. Box 3000, Morogoro, Tanzania
**Corresponding author:** mwenechanyafrank@yahoo.com

## Abstract

This study is establishing recommendations for spacing, depth and layout of controlled drainage and sub-irrigation that could be practiced in *dambos* of Central Malawi by smallholder famers' water user groups. To achieve this, soil physical and chemical properties and field investigations on hydraulic conductivity and topography have been accomplished for four *dambos* within central region. This will be used as input parameters for deriving the design and operation guidelines.

Key words: *Dambo*, design parameters, smallholder farmer, sub-irrigation

## Résumé

Cette étude établit les recommandations pour l'espacement, la profondeur et la disposition du drainage contrôlé et de l'irrigation souterraine qui peuvent être pratiqués dans les *dambos* du centre du Malawi par des groupes des usagers de l'eau, formés de petits agriculteurs. Pour atteindre cet objectif, les propriétés physiques et chimiques du sol et des enquêtes de terrain sur la conductivité hydraulique et la topographie ont été accomplies pour quatre *dambos* dans la région centrale. Ceci sera utilisé comme paramètres d'entrée pour tirer les lignes directrices de conception et d'exploitation.

Mots clés: *Dambo*, paramètres de conception, petits agriculteurs, irrigation souterraine

## Background

*Dambos* with their dominant characteristic of seasonal perched water table from January to May offer an opportunity to intensify crop production and alleviate constraints resulting from erratic rainfall pattern. Apart from water availability, *Dambo* soils, compared to the surrounding interfluve soils, are usually fertile. They also possess high organic matter and high cation exchange capacities (Boast, 1990). These characteristics make *dambos* more viable for intensified crop production. This is well recognised by smallholder farmers and as a result *dambos* have been used to grow crops in Malawi using indigenous knowledge. The use of *dambos* however, is done during dry

season only. During rainy season, the *dambos* are flooded with water and are put out of production. Increasing population growth and the constraint of limited arable land in Central Malawi poses a strong need of putting this land into production during the wet season and an effective way of practicing sub-irrigation during the dry season. At the moment the peasant farmers use residual moisture to grow crops during dry seasons, and by intuition when they feel the retained moisture is insufficient they supplement it with watering canes and treadle pump irrigation using water from dug wells. This study is developing a technically viable method of reclaiming the *dambos* during the rainy season so that it can be put into production by introducing simple, flexible and affordable drainage system. The modification should also enable use of the same system to raise the water table and by capillary action grow crops during the dry seasons

**Literature Summary**

Despite controversies surrounding using wetlands for agriculture, it is beyond doubt that wetlands like *dambos* will still be exploited for agriculture in developing countries. Lankford and Franks (2000) argue that coexistence of wetlands and irrigation for rice is possible in at least some parts of Tanzania, provided that the spatial and temporal variability in the water needs of the wetland are understood and accommodated into the agricultural planning. Faulkner and Lambert (1991) suggested that up to 30 percent of *dambos* may be irrigated without obvious adverse ecological impacts with appropriate planning and management. Musara *et al*. (2010) however observes that one of the major constraints to sustainable management of wetlands is the absence of appropriate decisions on the use of wetland resources. Where drainage is practiced, it is likely to result into over exploitation of *dambo* water resources if not controlled (Matiza, 1992). However, controlled drainage and sub-irrigation, though advocated for many years, associated design criteria and guidelines ignore the needs of smallholder farmers in developing countries and associated potential role of water user associations in the planning, design and management (Vlotman and Jansen, 2003). This study is trying to fill this void.

**Study Description**

The study is being conducted in Central Region of Malawi in Mchinji and Lilongwe districts covering four *dambos*. To establish recommended spacing between laterals soil characteristics, drain depths, and crop rooting depths have been collected. Insitu hydraulic conductivity has been conducted using Auger hole method. The *Dambo* soil physical properties like,

soil colour, soil texture, soil consistence, soil structure, soil porosity, plant roots, rock and mineral fragments, water holding capacity, infiltration rate and bulk density. The chemical properties of the soil which have been determined for the four *dambos* is soil pH, organic matter, soil nitrogen, available phosphorus, exchangeable potassium, other cations- Ca, Mg, cation exchange capacity, electro conductivity and micro nutrients. The collected data have been used to determine the soil type and these will assist to derive appropriate input parameters needed for drainage spacing. Secondary data have been collected on associated rooting depths of the crops commonly grown and this will be used to decide the drainage depth.

## Research Application

Findings reported here are preliminary. *Dambos* have an impermeable layer within a depth of 1m to 1.5m. The soil profile within the layer was found to be homogeneous for specific locations at the interfluves and *dambo* centre. Soil texture varied in all *dambos* under study from Sandy Clay to Clay from the interfluves to centre. Saturated Hydraulic conductivity at the *dambo* interfluves (peripherals) is around 4.2mm/ hour and as low as 0.6mm/hour at the centre. Soil structure varies from being granular at the interfluves to slightly blocky at the mid way and very block at the *dambo* centre (Table 1). The study will be continued for additional two years.

**Table 1. Soil physical and chemical characteristics in dambos and interfluves inMalawi.**

| *Dambo* Position | Sand (%) | Silt ( %) | Clay (%) | OM (%) | K sat mm/hr | Matric bulk density g/cm$^3$ | Wilting point % volume |
|---|---|---|---|---|---|---|---|
| Interfluve (*Dambo* periferal) | 51 | 14 | 35 | 0.90 | 4.2 | 1.4775 | 23.075 |
| *Dambo* centre | 29 | 15 | 56 | 1.18 | 0.6 | 1.34 | 32.58 |
| *Dambo* position | Field capacity | Saturation | Available water | Texture | Soil color | Consistence | Structure |
| Interfluve (*Dambo* periferal) | % volume | % volume | cm/cm | class | | | |
| | 33.3 | 44.275 | 0.1125 | Sandy clay | Dark gray | slightly firm | Granular |
| *Dambo* Centre | 43.98 | 49.42 | 0.112 | Clay | Black | Very firm | Extremely blocky |

**Acknowledgement**

Special thanks are extended to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), International Development Research Centre (IDRC) and Foundation for Irrigation and Sustainable Development (FISD), for financial and material assistance towards this study and all staff members of FISD for their support.

**References**

Boast, R. 1990. *Dambos*: A review. *Progress in Physical Geography* 14: 153–77.

Faulkner, R.D. and Lambert, R.A. 1991. The effect of irrigation on *Dambo* hydrology: A case study. *Journal of Hydrology* 123:147-161.

Lankford, B. and Franks, T. 2000. The sustainable coexistence of wetlands and rice irrigation: A case study from Tanzania. *Journal of Environment and Development* 9:119-137.

Matiza, T. 1992. Wetland ecology and priorities for conservation in Zimbabwe. Proceedings of a workshop on Wetlands in Zimbabwe. IUCN, Harare, Zimbabwe.

Musara, J.P., Chimvuramahwe, J., Mukuwiri, P. and Tsaurai, D. 2010. Re-Embracing Indigenous Technical Knowledge Systems (ITKS): The potential of wetland maize production in household food security. Case of Murinye Communal Area, Zimbabwe. *Journal of Sustainable Development in Africa* 12:96-105.

Vlotman, W.F. and Jansen, H.C. 2003. Controlled drainage for integrated water management. In: Drainage for a secure environment and food supply; *9th international drainage workshop*. Wageningen, Alterra-ILRI.