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Report#

Study on Effective Agricultural Water Management of Rice Field in Africa (Supplementary Irrigation)

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STUDY ON EFFECTIVE AGRICULTURAL WATER MANAGEMENT OF RICE FIELD IN AFRICA
(SUPPLEMENTARY IRRIGATION)

INTRODUCTION

Water scarcity in Africa is primarily due to insufficient storage capacity, signifying that Africa faces crisis of water management and governance rather than water scarcity. With water as a key input for agricultural production, improving water productivity is an obvious entry point to safeguard both people's livelihoods and the environment (Awulachew et al., 2005; Faurès and Santini, 2008).

The major limiting factor for irrigated rice cultivation is water. As the demand for effective management of water increase due to climate change, future rice production will depend heavily on developing and adopting strategies and practices that use efficient water application.

The recent increased attention and promotion of Agriculture Water Management (AWM) technologies such as small reservoirs reveals that, improvements in water storage and use are necessary to meet increased demands for crop production due to increasing population (Descheemaeker et al., 2010).

STATEMENT OF THE PROBLEM

Problems of water management in agriculture are gaining increased importance in the dry and humid areas. The implications of a rapidly increasing population on food demand, the environment and water availability are becoming severe. It is estimated that food output has to increase over the next years in order to satisfy household food demand and this may come by increasing the productivity of cultivated land by irrigation and increasing output with application of new technology.

Climate change will increase rainfall variability. Although the consequences widely vary with the local parameters and are still hard to predict, there is an undeniable trend towards increased variability of rainfall events in much of Sub-Saharan Africa. Adaptation will thus require additional resilience to dry spells, much of it through increased (and better distributed) water storage. It will also require adapting to more frequent floods and intensive rainfall.

Problems in large-scale irrigation systems. Pre-investment studies show the numerous benefits from the operation of large irrigation projects. These are often highlighted by the expected increase in farmland productivity within the service area. The assured water supply during the dry season (DS) enables most farmers to grow crops year-round and, consequently, increase farm employment.

In spite of these advantages, large projects are usually subjected to limitations and drawbacks. These include:

1) need for large investment in construction of facilities, which also imposes additional burdens on the government because direct financial benefits take a long time to materialize;
2) high operation and maintenance costs that usually render these projects less economically viable ;
3) lack of trained personnel who can efficiently operate and maintain these systems;
4) inability to irrigate hilly agricultural areas; and
5) in some instances, institutional and social problems hamper the completion of these projects as per design and also the smooth operation of those completed.

In today's prevailing conditions, small-scale infrastructure offers significant performance advantages over large-scale systems within AWM investment projects.

AIMS AND OBJECTIVES

Aim. The major aim of the study is to assess the implications of irrigation water management on productivity in the dry period of the growing season in Tamale area, Ghana. It will be through developing low-cost, easy and quick construction techniques of micro reservoir to promote rice production in sub-Saharan Africa.

Specific objectives. The following objective guide the discussion in this study: assessing the current condition and future direction of agricultural water management for rice production in North Ghana (Tamale area) including water saving technologies; studying what and how much fees will the farmers pay in the rice production process toward using the irrigation facilities; how can farmers manage the facilities by themselves after the project; and generating recommendations which will assist in improving the irrigation system.

Research Questions

1. How can output of rice be increased without necessarily increasing the land size?
2. Is rice production worthwhile in the study area?
3. What are the resources available for rice production in the study area?
4. What quantities of these resources are currently being used for rice production in the study area?
5. What costs are the farmers incurring in the rice production process currently in the study area?

BACKGROUND

In Ghana, agriculture accounts for about 37.4% of the gross domestic product (GDP) and employs 56% of the total economically active population. It is predominantly practiced in smallholder "with an average area of less than 1.2 ha (Aquastat Survey, 2005)" which produce about 80% of Ghana's total agricultural output. Only about 39% of the total agricultural land area is currently cultivated. Production levels of the major staple food crops in a normal rainfall year are adequate, particularly for non-grain crops. However, seasonal food insecurity is widespread, mainly due to excessive dependence on rain-fed agriculture. Generally, productivity is low and variable because of the prevailing traditional low external input, shifting cultivation farming systems and reliance on rain-fed agriculture. With the population growth rate estimated at 1.7% and the growing demand for industrial crops for local industries and for export, irrigated agriculture is an important factor in promoting agricultural growth.

According to FAO (2006), Ghana has a renewable water resource of 53.2 km^3 out of which 0.25 km^3 is used for crop production. Though the potential cultivable land is about 42% of the total area of the country, only 4.25% is actively under cultivation.

Indicating that, water and land resources in the country are woefully under-utilized for irrigation as well as rain fed agriculture (Venot et al., 2012).

Irrigation in Ghana has been contributing significantly to the lives of many people especially in the areas of poverty alleviation, food security and general improvement in the quality of lives of those who are engaged in it and still has some huge potentials that could be exploited (MoFA, 2011; Namara et al., 2010). However, the sustainability of irrigated projects worldwide is being questioned environmentally and economically (Gleick, 1992), the need therefore to sustainably managed the current irrigation projects and schemes in Ghana. The outputs of the irrigation schemes and projects in Ghana have been considered not to be very encouraging and that some of these projects have been rendered unproductive due to the lack of maintenance (MoFA, 2013).

The use of irrigation technology in Ghana is not widespread, but it is considered of great importance in view of the seasonal and intermittent occurrence of drought in the country.

From hear, JIRCAS "Japan International Research Center for Agricultural Sciences" planned a project "Study on Improvement of Micro Reservoir Technologies for Enhancement of Rice Production in Africa (IMRT for Rice)". The constructed micro reservoir (small farm reservoir) will be used as supplemental irrigation technique. Supplemental irrigation will be done from "panicle formation stage" to "boot stage"; when productivity is severely affected by water shortage (rain not enough).

Water storage is like an insurance mechanism for the smallholder. It acts as a buffer against the variability of the rainfall regimes and therefore increases the resilience of the farmers against: (i) dry spells during the rainy season, as well as (ii) rainfed-crop failure, in as much as it allows farmers to secure at least one dry season crop that can either be consumed or sold.

Why Micro Reservoir?

A micro reservoir "Small Farm Reservoir (SFR)" is a water impounding structure with a maximum depth of 4m and pond area of 1000 to 3000 square meters. It serves limited areas no more than 2 hectares and is designed to become an integral part of individual rain-fed

What are the advantages and benefits of SFRs?

- Ensure crop intensification and diversification
- Ensure improved farm income
- Less capital intensive
- Easy to construct and maintain
- Empower farmer cooperation and production capability

Micro reservoir "Small Farm Reservoir (SFR)"

Uses of OFRs

In the rain-fed areas, OFRs are used to provide supplemental irrigation to rice fields during wet season (WS), especially during prolonged periods with no rainfall. Water stored in the OFR allows farmers to grow a dry season (DS) crop. The water is also used to grow fish, which is an additional source of income for farmers.

Optimal supplemental irrigation (SI) in rainfed areas is based on the following three criteria: (1) water is applied to a rain-fed crop that would normally produce some yield without irrigation; (2) because rainfall is the principal source of water for rain-fed crops, SI is applied only when rainfall fails to provide essential moisture for improved and stable production; and (3) the amount and timing of SI are scheduled not to provide moisture stress–free conditions throughout the growing season, but to ensure a minimum amount of water available during the critical stages of crop growth that would permit optimal instead of maximum yield (Oweis, 1997).

EXPERIMENTS ON SMALL FARM RESERVOIRS

In Indonesia, the stored water in cooperative OFRs, which were built by the farmer groups in 1990-92, is used to irrigate the farm of each member of the group. Farmer groups identified the land to be used for cooperative OFRs in village-level meetings that were attended by the village head, extension people, and other farmers. The land used is usually owned by the village (bengkok land). The size of cooperative OFRs ranges from 200 to 2,000 m^3. The budget allocated by the local government is used for the purchase of materials and food for farmers who help in the construction. Farmers contributed their own labor without compensation for OFR construction.

In Philippine, an OFR provides supplemental irrigation to the entire rice farm (average farm size of 3.3 ha) in the wet season and meets the water requirements of about 40% of the farm for growing rice in the dry season. In addition, farmers grow fish in the reservoir. Benefits from the use of OFR water for rice and fish productions in the two seasons are higher than the investment needed for OFR construction. The economic analysis, assuming a 15-yr life span of the reservoirs with a 3-yr cyclic maintenance schedule, shows a high internal rate of return of 177% (Bhuiyan, 1994).

Panigrahi et al. (2007) carried out experimental studies on a rain-fed rice-mustard cropping system consisting of a small on-farm reservoir with a capacity of 61 m^3 and a farm area of 800 m^2. It was revealed that such a system is an economically feasible option for small-scale supplemental irrigation. Smallholder irrigation schemes are also being developed in semi-arid regions of Sub-Saharan Africa (SSA), where erratic rainfall and high evaporation are serious constraints on agricultural production. Microdams, dugouts, sub-surface runoff harvesting tanks, and rooftop rainwater harvesting systems are all different rainwater harvesting practices found in the Makanya catchment of rural Tanzania (Pachpute et al. 2009)

In Madhya Pradesh, India, incomes of farmers who constructed on-farm ponds to irrigate pulses and wheat have risen by more than 70%; as a result, they have also been able to improve and expand their livestock herds. In Tanzania, half of the dry-season cash incomes of smallholders come from growing irrigated vegetables. In Zambia, the 20% of smallholders who cultivate vegetables in the dry season earn 35% more than those who do not (Namara et al., 2010; Jean et al., 2012).

MAIN FINDINGS

- **Smallholder irrigation could change the lives of millions of people**

Smallholder farmers in sub-Saharan Africa can increasingly use small-scale irrigation to cultivate their land. Individually/group owned and operated irrigation technologies improve yields, reduce risks associated with climate variability and increase incomes, allowing farmers to purchase food, health care and education.

- **Small-scale AWM is outpacing the use of large-scale irrigation**

The proliferation of small-scale private irrigation is an established trend in South Asia that is now gaining ground in sub-Saharan Africa. In many African countries, water management by smallholders is already more important for irrigation than the public irrigation sector, in terms of the number of farmers involved, the area covered and the value of production. For example, in Ghana, private irrigation by smallholders employs 45 times more individuals and covers 25 times more land than public irrigation schemes (Giordano et al., 2012).

- **Water at the right time can make a big difference to farmers' incomes and nutrition**

Small-scale private irrigation provides millions of poor farmers with additional income during the dry periods. Having access to water at this time means they can cultivate crops and earn much money.

- **Smart investments in AWM could benefit farmers across sub-Saharan Africa**

As small-scale water management technologies become more accessible, the potential to expand private irrigation is enormous. This is especially so in sub-Saharan Africa, where there is significant scope to extend the area of land that is irrigated or under improved agricultural water management. Investment costs of small-scale irrigation technologies are affordable, and implementation is relatively straightforward when compared to large-scale irrigation, so the potential for up-scaling and reducing poverty is high.

For example, In Tanzania, investments to improve community-managed irrigation schemes are resulting in income and yield improvements on a par with government-managed irrigation schemes, but at a lower cost. Similarly, on-farm rainwater management and conservation agriculture could yield significant returns.

- **New investments would be supporting an existing, farmer-driven trend**

Small-scale AWM could expand significantly if farmers were able to overcome key constraints, such as high upfront investment costs; poorly developed supply chains; high taxes and transaction costs; difficulty accessing information and knowledge on irrigation, seeds, marketing, and equipment and other inputs.

- **Smallholder AWM lacks supportive institutional structures**

The adoption of small-scale irrigation technologies by many individual farmers is a new dynamic, which presents opportunities and challenges that differ from conventional irrigation development. Smallholder AWM requires new organizational models because existing governing bodies concerned with water management are often not adapted to handle the challenges posed by this alternative, dispersed mode of supplying water.

Irrigation departments tend to oversee large-scale canal irrigation, while agricultural departments are concerned with rain-fed farming. Small-scale private irrigation falls between the two and, therefore, lacks an institutional 'home'. As a result, opportunities for improving small-scale private irrigation are often lost.

- **Unregulated and expanding small-scale irrigation poses new challenges**

Small-scale private irrigation poses several challenges related to social equity and environmental sustainability. Poor farmers cannot always afford the upfront investment costs for AWM technologies and the associated agricultural investments needed to generate higher profits. While all farmers face agricultural risks, poorer farmers are often less able to access resources and assume proportionally larger financial risks.

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