

The Economics of Water in Paddy and Non-Paddy Crop Production around the Kilombero Valley Ramsar Site, Tanzania: Productivity, Costs, Returns and Implication to Poverty Reduction

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ABSTRACT Water scarcity is globally getting worse in the light of increase in demand for water use. Human and ecosystem health and economic development are affected by problems of water scarcity and water pollution. This paper assessed the net benefit of water resource in crop production around the Kilombero Valley Ramsar Site in Tanzania. Specifically, the study determines and estimates costs and benefits in crop production and quantify its monetary value using both market and non-market techniques. Household questionnaires, checklist for key informants, participant observation and participatory rural appraisal techniques were employed for data collection. Questionnaire survey was administered to 120 households to establish the major agricultural activities, crops, costs of production and income accrued from these activities. Data relating to household characteristics and water related economic activities were analysed using Statistical Package for Social Sciences whereby the cost for production, inputs and returns were analysed and compared using Microsoft Excel. The residual imputation approach was used to estimate the value of water in crop production. Findings revealed that, 88.3 percent of the respondents own land and 11.7 percent of them rent the land for crop production. The net values of water for irrigated paddy and non-paddy crops were estimated to Tsh. 273.6 (US\$ 0.23) and Tsh. 87.7 (US\$ 0.073) per m³ of consumed water respectively. The average productivity of water for paddy and non-paddy crop production is estimated at 0.85 kgm⁻³ and 0.69 kgm⁻³ of consumed water respectively. Furthermore, the returns from agriculture are less compared to returns from other water uses. Nevertheless, since majority of households are depending on agriculture this study recommends that emphasis should be put on effective and efficient use of water to improve its productivity.

1. INTRODUCTION

Water is a very essential natural resource for the world's economic growth. It can unite people that share a source of water such as rivers, lakes or provoke conflicts among them as they compete for it (URT 2002; World Bank 2002). However, freshwater is now scarce in many regions of the world. In many areas around the world, conflicts have risen due to increase in water demand among its competing uses (World Bank 2002; Young 2005, 1996). According to Malan (2010), choice in water resource allocation involves its availability, costs and economic benefits accruing from water, and environmental impacts. Thus, the increase in water demands in its competing uses and watershed degradation

are the driving forces for water scarcity which brought the critical need for the use of economics to assist in decision-making and water management.

Water is a basic natural resource for socio-economic development activities such as industrial production, irrigated agriculture, livestock keeping, hydropower production, navigation, recreation and tourism (URT 2002; Young 2005). Its benefits (values) are determined by the degree of use, the sustainability of that use and the non-use (Turpie et al. 2005). Kilombero Valley among other uses, serves as a source of water for domestic uses, farming, livestock and for fishing (Kato 2007; Masiyandima et al. 2004; McCartney et al. 2004). The potential of water in enhancing food security through irrigated

agriculture and alleviating poverty has led to many governments in developing countries to point out sustainable agricultural development through “wise use” of water resources as one of the prime goals in their national policies (URT 2002; Young 1996; FAO 2004).

Notwithstanding the benefits accrued and the enacting of legislation to prevent unsustainable use of water resource, water sources (wetlands) continue to be degraded at an alarming rate (Millennium Ecosystem Assessment 2005; Masiyandima et al. 2004; McCartney et al. 2004). Water scarcity is a function of supply and demand. Its demand for different Land Uses (LUs) such as industrial production, crop and livestock production, hydropower production, recreation and tourism is increasing in the light of population increase despite its degradation (Briscoe 1996; Gleick et al. 2001). The quantity and quality of water in different LUs around the Kilombero Valley Ramsar Site (KVRS) is reduced by degradation of water sources (Baum 1968; Kato 2007). Therefore, water productivity in different LUs around the KVRS continues to be reduced due to degradation of water resource (Kato 2007; Kangalawe and Liwenga 2005) hence, reducing the economic returns in different LUs (Aylward 2000). Hitherto, water management remains inefficient, resulting in shortages and conflicts over allocation regimes (Kangalawe and Liwenga 2005; Young 2005).

Competition among various sectors (agriculture, ecological functions, industry and cities) for limited water supplies is already constraining development efforts in many countries. As populations expand and economies grow, the competition for limited supplies will be intensified and create conflicts among water users (Turpie et al. 2005; Young 2005). This necessitates that policy and decision makers with regard to water policies and allocation to be well informed of the costs and benefits associated with water (that is, economic value of water in crop production) for appropriate interventions to be made. Such information is currently insufficient or not readily available especially in the study area. This paper, therefore, contributes to this knowledge gap. It uses the case of Kilombero Valley Ramsar Site in Tanzania to examine the value of water in paddy and non-paddy crop production, water productivity, costs, returns and implication towards food security and poverty alleviation of the local people and well-being of the national economy at large.

2. METHODOLOGY

2.1 Description of the Study Area

The Kilombero Valley is located in the Ulunga and Kilombero Districts, Morogoro Region and lies at the foot of the Great Escarpment of East Africa in the southern of Tanzania, about 300 km from the coast (Jatzold and Baum 1968). At the end of the Eastern Arc Mountain range, the Kilombero Valley forms a 6 650km² lowland oasis. The KVRS is situated in southern-central Tanzania (8°32' S 36°29' E). The Valley has potential areas for irrigation totalling to about 329 600 ha for surface water irrigation (Kato 2007). Currently, the valley is a major rice production area (McCartney and van Koppen 2004) supplying about 9% of all rice produced in Tanzania (Kangalawe and Liwenga 2005). The KVRS experiences dry seasons from July to August and hot dry seasons from September to November (Baum 1968).

The Kilombero district has a population of around 322 779 people (73 393 households), with growth rate of 2.5 percent per year and it is projected to have 516 447 people in year 2025 (URT 2003). Based on the documented information on the population and the growth rate of 2.5 percent (URT 2003) the population in the year 2010 was estimated to be 392 275 people. This indicates the increase in demand for water to sustain the increased population and for rice paddy and non-paddy crop production. The KVRS serves as a source of water to majority of the villagers who are subsistence farmers of rice paddy and non-paddy (vegetables, maize, sugarcanes, banana), livestock, fishing and domestic uses (Kato 2007) as well as for hydroelectric power production at national level.

2.2 Data Collection

Survey was conducted in three villages namely, Segamaganga, Lumemo and Njage where primary data were collected (Fig. 1). A combination of techniques such as Participatory Rural Appraisal (PRA) methods (focus group discussion and resource mapping), structured questionnaires (both closed and open-ended questions) and participant observation were used in data collection. This combination of methods was used to complement each other because of limitations by one technique and allows cross checking and verification of answers (Olsen 2004). A

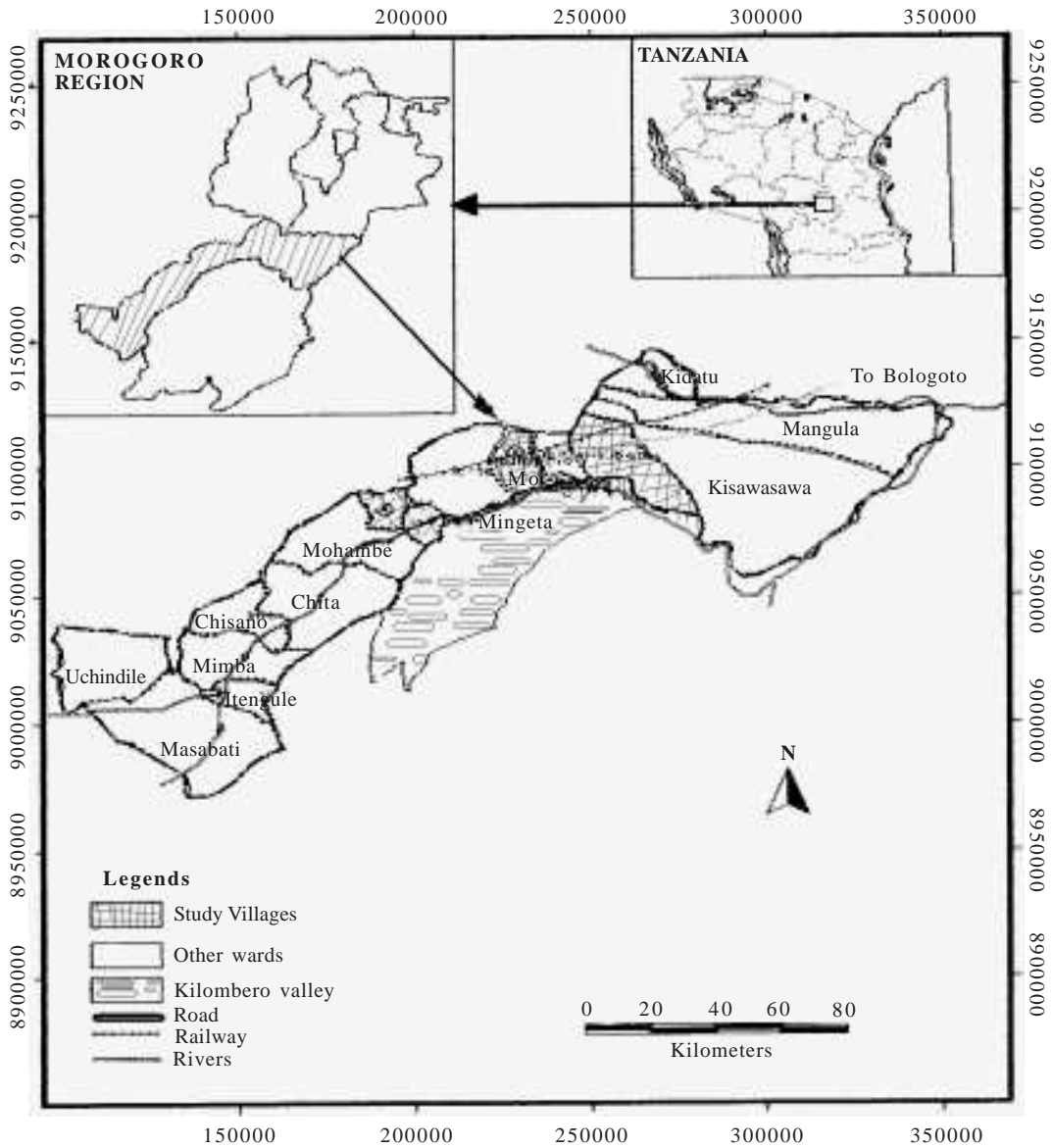


Fig. 1. Map showing Kilombero Valley Ramsar site and study villages

sampling unit for this study was a household which was randomly selected in all villages (Table 1) with 5 percent as the sampling intensity for households in each village. According to Bailey (1994), a random sample should at least constitute 5 percent of the total population to be a representative of that population. Questionnaires were administered to a sample of 120 households (both small scale farmers and irrigators)

for the purpose of collecting both quantitative and qualitative data (Table 1). Information collected focused mainly on socio-economic activities with respect to water consumption such as agricultural production (both paddy and non-paddy crop production), size of the crop land (acreage), inputs-cost element, outputs, prices, quantities produced, sold and amount consumed by household (domestically) (Turpie et al. 2003).

Secondary data on paddy production were obtained from Kilombero district Agricultural and Livestock Development office to supplement primary data.

2.3 Data Analysis

Statistical Package for Social Sciences was used to obtain descriptive statistics, charts, frequencies tables and graphs for presenting the results. Microsoft Excel was employed to analyse data and quantify benefits accrued from water (returns). However, different analytical tools were also used to analyse benefits of water in paddy and non-paddy crop production. The main approach used to capture the value of water was residual imputation approach (RIA). The Change in Net Income Approach (CINI) was used to calculate the net output values as shown in equation 1. This method has been proven to be a useful tool by providing desired results. It has been widely used by different authors (Stratos

of hired labour; and C_w is the irrigation fee (water use fee/cost). Moreover, the modelling of Crop Water Productivities (CWP) was imperative for prediction of *crop water* requirement prior to the use CINI Approach. This was done by using FAO's CROPWAT model which is a computer programme used to calculate crop water requirements (CWRs) and irrigation requirements (IRs) from climatic and crop data (FAO 2001). The climatic data were used in the model to calculate the reference crop evapotranspiration (ET_0). The ET_0 together with rainfall, crop parameters were used in the simulation of CWRs. The gross margins and returns to labour were calculated for paddy and non-paddy crop production.

However, in the residual imputation approach to capture the economic value of water the contribution of each input in the production process was determined. The suitable prices were assigned by market forces to all inputs but one (water), the remainder of all total value of products was imputed to the residual input. The approach approximates the marginal value product (MPV) of a productive input, such as water, by subtracting all costs of production but one from the total value of output. The remaining (residual) value is assigned (shadow pricing) to the non-priced input. For determining the residual value (economic water value) two principles were hypothesized. First, competitive equilibrium requires that the prices of all resources are equated to returns at the margin. Profit-maximizing producers were assumed to add productive inputs up until the point that value marginal products are equal to opportunity costs of the inputs. The second principle requires that the total value of product can be divided into shares, so that each resource is paid according to its marginal productivity and the total value of product is thereby completely exhausted. For an agricultural production process in which a single product denoted Y is produced by four factors of production namely; capital (K), labour (L), other natural resources such as land (R) and irrigation water (W). The production function will be:

$$Y=f(K,L,R,W) \quad [2]$$

If competitive factor and product markets can be assumed, prices may be treated as constants. Then considering the second postulates, it then follows that:

$$TVP_Y=[(VMP_K * Q_K)+(VMP_L * Q_L)+(VMP_R * Q_R)+$$

Tables 1: Socio-economic characteristics and household distribution in the study area

Village	Total number of households	Number of sampled households	Sample size (%)
Njage	725	37	5
Segamaganga	727	37	5
Lumemo	920	46	5
Total	2372	120	5*

*Indicates the average percentage as a minimum sample size (n) in the surveyed area

Economic Activities	Percentages
Agricultural Production	79
Non-agriculture	21
Total	100

and Basil 2005; Young 1996; Ward and Michelsen 2002) to calculate the net output values of crop production.

$$NOV=Y_c * P - C_{pr} - C_L - C_{FL} - C_{HL} - C_w \quad [1]$$

Where,

Y_c is the crop yield; P is the unit price of a product, for example, crop, C_{pr} entails all variable costs (in case of crop production, for example, seeds, fertilisers, pesticides, transport and packaging, financial costs associated with the purchase of variable inputs), C_L is the land rental price; C_{FL} is the cost of family labour, priced at the average hired labour wage, including field operation and management; C_{HL} is the cost

$$(VMP_W * Q_W) \tag{3}$$

Where TVP_Y is total value of product Y; VMP is value marginal product of resource i ; and Q is the quantity of resource i . Thus, on the assumption that price (value) for all variables are known except P_W (value of water); then;

$$P_W = \frac{[TVP_Y - \{(P_K * Q_K) + (P_L * Q_L) + (P_R * Q_R)\}]}{Q_W} \tag{4}$$

The “residual imputation approach” has been widely used to estimate economic values of water, particularly in crop production (Kadigi et al. 2004; Young 1996; Renwick 2001). The method entails identification of the incremental contribution of each input to the value of total output.

3. RESULTS AND DISCUSSION

3.1 Land Ownership for Households and Means of Acquisition

Findings show that about 37.5 percent of the surveyed respondents owned less than one hectare of land, 31.6 percent owned one to less than two hectare, 15.8 percent owned two to ten hectare of land while 15.1 percent of the respondents owned more than ten hectares of land (Table 2). Overall, about 88.3 percent of the respondents own land as an input of production and 11.7 percent of them rent the land for crop production (Table 2). These results imply that land is accessed by local people in the surveyed villages and they can use it as an input for crop production. It also indicates that land is in the hands of majority and some people in the surveyed villages can access land through renting. Kadigi et al. (2004) and Calder (2000) argued that land renting is common for people with small or no land and its cost varies with location and time. The results of this study can be compared

with the findings of Semra (2005) in Babati who reported that 98 percent of Tanzanian rural households own land with the average size of 2.4 ha per household. Furthermore, majority (41.7%) of the respondents had acquired land through purchasing. Some of them acquired it through inheritance (25%) and by government allocations (21.6%) while a few (11.7%) of them used to rent the land from land owners (Table 2). The implication of these results is that, probably people may be able to use their land for various socio-economic activities, thus, increase the ability to sustain their lives. It can also be established from the results that people can apply for land lease certificate and use land as an asset to borrow money from banks and other institutions.

3.2 Crop Production

The interviewed households revealed that crop production accounted for 37.5 percent of land use systems in the surveyed villages. In general, majority (41.7%) of the households in Kilombero district depend on both rainfed and irrigation in crop production, 36 percent depends on rainfed agriculture only and few (22.3%) were practicing irrigation agriculture (Fig. 2). These findings show that there is a diversity of crop production system practiced in Kilombero district of which water from KVRS is a critical input. The results are in-line with previous studies (Baum 1968; Kangalawe and Liwenga 2005; Kato 2007; McCartney and van Koppen 2004; Ngaga et al. 2005; URT 2002) which revealed that wetlands have potential in crop production and for ameliorating the microclimate which provides conducive environment for crop production.

There is some variation in crop production within and between surveyed villages. About 40 percent; 36 percent and 24 percent households

Table 2: Land ownership for household and means of acquisition

Size of land for household	Acquisition of land				Total
	Bought	Rented in	Allocated by village government	Inherited	
Percentage (%)					
0.3 to <1 ha	13.3	7.5	4.2	12.5	37.5
1 to <2 ha	8.3	2.5	10.8	10.0	31.6
2 to 10 ha	10.8	0	3.3	1.7	15.8
Above 10 ha	9.2	1.7	3.3	0.8	15.1
Total	41.7	11.7	21.6	25.0	100.0

were practicing irrigation agriculture in Njage, Segamaganga and Lumemo respectively. Results also show that 45 percent of respondents from Segamaganga, 35 percent from Lumemo and 20 percent from Njage depend on rainfall for crop production. However, there is a group of households (45%, 35% and 20%) from Lumemo, Njage and Segamaganga respectively who practice both rainfed and irrigation agriculture. This trend can be attributed to various factors such as lack of enough capital for investing in irrigation-type of crop production. Majority (45%; 35%; 20%) of households were executing rainfed cropping system in Segamaganga, Lumemo and Njage

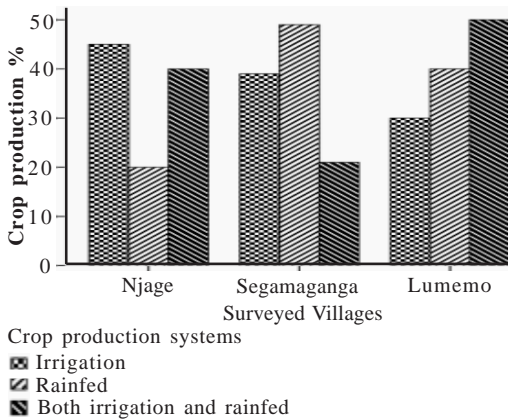


Fig. 2. Crop production in the study villages, Kilombero district

villages respectively (Fig. 2). This implies that people in some villages such as Segamaganga and Lumemo are not able to produce surplus yields (rainfed) for selling rather they can only produce little (subsistence farming) for home consumption. This can be attributed to absence of a national irrigation scheme in Segamaganga

and Lumemo villages as compared to Njage village where people are producing crops both for home consumption and for selling due to presence of irrigation project in their areas.

3.3 Value of Water in Crop Production

Tables 3 and 4 respectively summarize the costs and benefits for paddy and non-paddy crop production in the surveyed villages. The average productivity of water for paddy and non-paddy production included both main products as well as by-products of the crops. The production of each crop was derived by multiplying the area under each crop with respective average productivity value product per unit area. The average productivity from various crops was added to get total value production from crops. According to Palanisami et al. (2006) and Young (1996), the term water productivity refers to the degree of output or benefit resulting from the input quantum of water as applied on a unit base. In the domain of agriculture, it is expressed as the net consumptive use efficiency in terms of yield per unit depth of water consumed per unit area of cultivation. Crop production is the major water user in the world.

3.3.1 Costs, Returns and Value of Water for Paddy Production

Results show that, nearly 90 percent of crop producers use a number of inputs such as land, seeds, tools, labour, water and agro-chemicals such as fertilizer/manure and pesticides. Observations show that improved seed varieties are relatively expensive and they needed to be purchased at the beginning of each season, when farmers have little cash available. Nonetheless, some farmers use improved seed variet-

Table 3: Costs and benefits for paddy production in surveyed villages, Kilombero district

Costs for paddy production	(Tsh)	(US\$)
*Variable costs per ha per season	602 172	501.81
**Fixed costs per ha per season	122 640	102.20
Gross income per ha per season	1 272 252	1 060.21
Gross margin per ha per season	547 440	456.20
Productivity of consumed water (kgm^{-3})	0.85	0.85
Benefits to costs ratio	1.755	1.755
<i>Water</i>		
Average volume of water consumed (m^3/ha)	2 001	2001
<i>Returns</i>		
Average yield (Kg/ha)	1 704.92	-
Average value per m^3 of consumed water	273.588	0.22799

*Involves labour, agrochemicals, seeds. **Involves land, ox-plough, hand hoe

ies for paddy production. Most farmers keep a small portion of previous season’s harvest as next year’s seed so that new seeds do not need to be purchased at the beginning of the season.

Table 4: Costs and benefits of non paddy production in surveyed villages, Kilombero district

<i>Costs of non-paddy production</i>	<i>(Tsh)</i>	<i>(US\$)</i>
*Variable costs per ha per season	353 832	294.86
**Fixed costs per ha per season	116 640	97.20
Gross income per ha per season	765 607.2	638.006
Gross margin per ha per season	295 135.2	245.946
Productivity of consumed water (kgm ⁻³)	0.6896	0.6896
Benefits to costs ratio	1.63	1.63
<i>Water</i> Average volume of water consumed (m ³ /ha)	3 363	3 363
<i>Returns</i>		
Average yield (Kg/ha)	2 319.018	2 319.018
Average value per m ³ of consumed water	87.72	0.0731

*Includes costs of labour, agrochemicals and seeds.

**Includes costs of land, ox-plough and hand hoe

The economic value of water for crop production therefore fluctuates based on timing of planting and marketing the crops, owing to the impact of price volatility. For example, the price for rice fluctuates considerably during the year in direct relation to the quantity of produce offered on the market (Fig. 3). Rice marketed early in the

season (April-May) fetches a price that can be up to two times higher than the average price later in the season (July-August). This might be due to the reason that early in the growing season there is no enough stock to meet market demand, thus, the market price for crop products at this time is high. This results in fierce competition for water early in the growing season. Conversely, similar results were observed by the URT (2004) in most areas of the country such as Usangu Basin and Iringa Region.

The results in Figure 4 show slight linear relationship between the production and price of rice in January-March and later there are variations whereby the graph shows ups and downs which specify that, the increase in crop production influences the prices. This implies that, as the production (supply) goes up the crop prices falls and vice versa. Although yields are lower, a farmer who harvests in April-May may be able to obtain up to about Tsh. 28 500 (US\$ 23.75) per bag of paddy compared to Tsh. 8 500 (US\$ 7.1) to Tsh. 14 000 (11.7) later in the season (July and August) (Figs. 3 and 4). However, by the end of the harvesting season, the sale price can fall up to Tsh. 7 200 (US\$ 6). The results of this study are in line with findings from previous studies (Sokile and Mwaluvanda 2005; Palanisami et al. 2006) which reported that farmers who harvests in April-May may earn Tsh. 22 000 (US\$ 18.33) to Tsh. 32 000 (US\$ 26.7) in most of Sub-Saharan countries. Hiring of oxen for ploughing and labour for nursery preparation, transplanting and harvesting was common to farmers with insuffi-

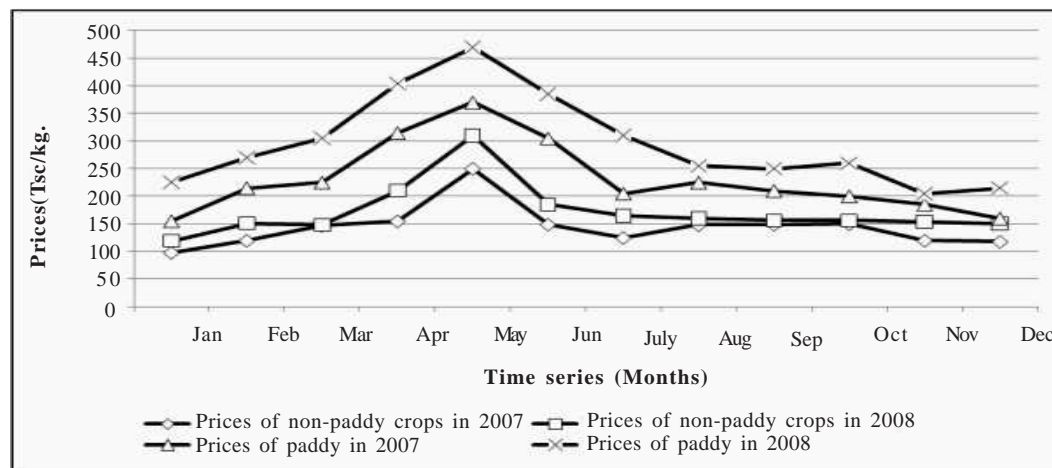


Fig. 3. Price fluctuation for crops in the surveyed villages, Kilombero district

cient cash in KQRS. Majority of the interviewed households, who do not have enough money, tend to use their own labour in ploughing their fields by hand hoe. Findings show that both hired and family labour costs approximately Tsh. 103 572 (US\$ 86.31) per ha in a respective season for ploughing or transplanting work.

The costs of land was estimated at Tsh. 122 640 (US\$ 102.20) per ha in a respective season whereby other variable costs for crop production were approximately Tsh. 387 960 (US\$ 323.30) per ha in a respective season. Thus, the total cost (variable costs plus fixed costs) for paddy production in study villages was Tsh. 724 812 (US\$ 604.01) per ha in a respective season. Findings revealed that the average income of the interviewed respondents in the surveyed villages was Tsh. 1 272 252 (US\$ 1 060.2) per ha per season for paddy production (Table 3). The gross margin for paddy production was deduced from gross income, and it was found to be Tsh. 547 440 (US\$ 456.20) per ha in one season (Table 3). The average productivity of water for paddy production was estimated at 0.85 kgm⁻³ of consumed water (Table 3). In this study, the average yield was found to be 1 704.92 kg/ha. The results also revealed that the value of consumed water in paddy production is Tsh. 273.6 (US\$ 0.23) per m³ of consumed water. The results of this study can be compared with those of previous studies (Palanisami et al. 2006; FAO 2005; Sharma et al. 2005) which report that water productivity in developing countries ranges from 0.18 kgm⁻³ to 1.01 kgm⁻³ of consumed water. How-

ever, the volume of water consumed in paddy production was estimated to 2001 m³ per ha per season by the use of CROPWAT and was given in Table 3. Together with the average yield of paddy produced per ha per season (1 704.92 Kg/ha), the volume of consumed water enabled the calculation for its average productivity (0.85 Kg/m³). Therefore, from these results, the value of water for paddy production was established to be Tsh. 273.6 per m³ of consumed water (Table 3).

3.3.2 Costs, Returns and Value of Water for Non-Paddy Crop Production

Table 4 provides a summary of the costs, returns and value of water per m³ of consumed water for non-paddy crop production. Major non-paddy crops which are produced in the surveyed villages were maize, banana, tomatoes, sweet potatoes, vegetables and cassava. The average area for non-paddy (mixed cropping) fields per household is approximately 0.7 ha. Most respondents (36.7%) reported that they were using some agrochemicals such as fertilizers and pesticides in non-paddy crop production. Most of the farmers who were producing non-paddy crops reported more or less similar inputs for their produce. Some of these inputs apart from land, water, fertilizers and pesticides are labour, seeds and equipments to mention few.

It was revealed that both hired and family labour costs approximately Tsh. 181 410 (US\$ 151.2) per ha in a respective season for ploughing, weeding or harvesting work. Additionally,

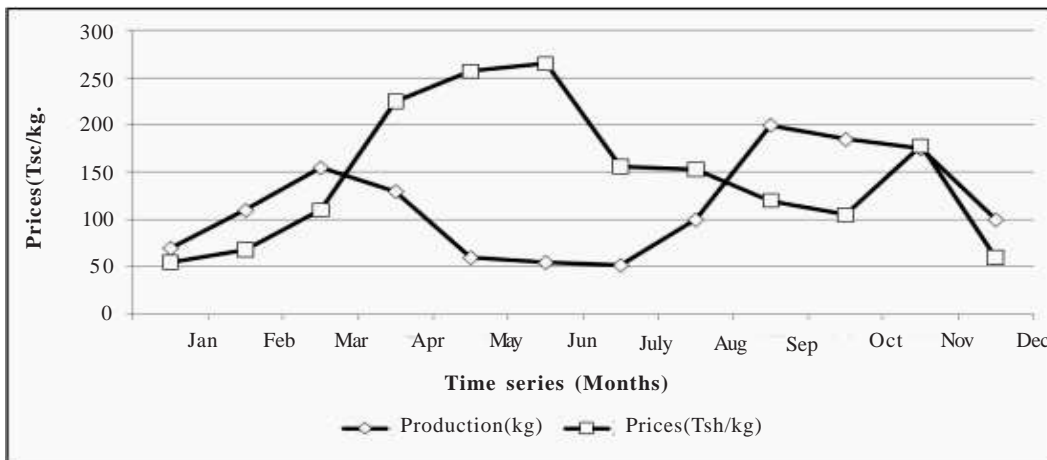


Fig. 4. Rice production and prices in the study villages, Kilombero district

the costs of land was estimated at Tsh. 91 080 (US\$ 75.9) per ha in a respective season whereby other variable costs for crop production were approximately Tsh. 197 880 (US\$ 164.9) per ha in a respective season. The total cost (variable costs plus fixed costs) for non-paddy production in study villages was Tsh. 470 472 (US\$ 392.06) per ha in a respective season. The average income for non paddy crop production in the surveyed villages was estimated at Tsh. 765 607.2 (US\$ 638) per season (Table 4). Conversely, the gross margin for non-paddy production (US\$ 245.95 per ha in one season) was observed to be less than gross margin for paddy production. The average productivity of water for non-paddy production was estimated at 0.69 kg per m³ of consumed water and the average yield was found to be 2 319 kg/ha. The average value of consumed water in non-paddy production is Tsh. 87.7 (US\$ 0.07) per m³ of consumed water (Table 4).

These results on estimated values of water in this study can be compared with those reported in other studies in developing countries like Tanzania and elsewhere around the World. For instance, Turpie et al. (2003) estimated the average gross income per unit water used in irrigation at the range of US\$ 0.1 to 1.4 per m³ of consumed water depending on area of the basin and type of irrigation. In the study conducted by Kadigi et al. (2004) in Usangu basin, the estimated value of water in crop production ranging between US\$ 0.04 to 0.17 per m³ of consumed water. This study shows that, the gross income per m³ of water consumed in paddy production in Kilombero Valley is Tsh. 273.6 (US\$ 0.23) and Tsh. 87.72 (US\$ 0.07) for non-paddy production. The difference may be attributed to higher water consumption (6 319 m³/ha per season) and low yields (842 kg/ha per season) for crop production in Usangu compared to Kilombero Valley. This study also revealed that 2 001 m³/ha and 3 363 m³/ha of water per season was consumed to produce 1 704.92 kg/ha per season and 2 319 kg/ha per season with 0.85 kgm⁻³ and 0.69 kgm⁻³ (Tables 3 and 4) respectively as the productivity of consumed water for paddy and non-paddy production in the surveyed villages. The difference also might be due to loss of water quality by pollutants from industries and the agricultural industry itself.

The results of this study show that water productivity for paddy and non-paddy crop pro-

duction are 0.85 kgm⁻³ and 0.69 kgm⁻³ of consumed water respectively (Tables 3 and 4). The differences may be attributed by varying cropping and land-use patterns, low growth in yield levels and agro-climatic factors for the former as compared to Kilombero district. Additionally, the latter may have relatively high availability and accessibility of water. However, the key element for the higher water value of the latter is the low non-water inputs used by the farmers which lead to relatively low variable costs of crop production in Kilombero district. Kumar et al. (2008) suggested improvements of non-water inputs with better water management as an effective strategy for increasing yield and water productivity in India.

3.4 Implication of Crop Production towards Poverty Reduction in KVRS

Poverty is increasingly acknowledged as a dynamic, multi-faceted and multi-scale problem. The courses in which people get into and out of poverty are non-linear, path-dependent and scale-dependent. However, crop production can significantly contribute to poverty reduction through increased water productivity for increased yields, cropping areas and higher value crops. This study shows that water productivity in crop production is very low (0.6896 and 0.85 kgm⁻³ for non-paddy and paddy crops respectively) (Tables 3 and 4) which may be attributed to water use inefficiency especially when we consider crop yield per drop of water. It also shows that, 79 percent of households around KVRS are farmers (Table 1) involving in both paddy and non-paddy crop production. Thus, increasing water productivity in the agriculture sector in this area is of necessity as the efforts towards poverty reduction. This will therefore favour both subsistence farmers and surplus farmers. The increased water productivity will raise employment directly (farm workers), indirectly (by increasing household income and for instance crop product processing sectors) and may lower prices in open economy or if there is high transport costs. Poverty is more than a descriptive idea and basically it is prescriptive. Consequently seeking an approach for combating poverty becomes a political decision. It is of interest that, there should be reliable and valid information to enable policy and decision maker to decide on water allocation not only based on economic

perspective but also considering the social aspects in water allocation.

Increased water productivity will reduce water poverty in agriculture sector and it will increase the mean yields which in turn lead to increased food supplies (food availability, affordability by increased household purchasing power and lowered price), higher nutritive value and better nutrition levels. This implies that by increasing water productivity, crop production will have direct and indirect positive impacts towards poverty reduction to poor majority, be it an absolute or relative poverty regardless of a wide range of indicators of poverty, and different lines of thinking in defining what is the real meaning of poverty. However, returns from crop production (rainfed and irrigation) must be counterbalanced against costs. These includes both the direct costs of irrigation projects themselves, costs of some negative impacts and the opportunity costs of irrigation investments.

4. CONCLUSION

Cultivation of paddy and non- paddy crops (such as maize, banana, tomatoes and vegetables) requires a land with suitable soils and easy access to water of which is the function of the ability of the household to own or rent such a land. Despite its potentials, crop production has relatively small returns to cost ratio as compared to other land uses and yet it is the main water consumer in the study area. For irrigated crops such as paddy and non- paddy crops, the net values were estimated to Tsh. 273.6 (US\$ 0.23) and Tsh. 87.7 (US\$ 0.073) per m³ of consumed water respectively. The small return to cost ratio in agriculture might be due to high input costs in the sector. Nevertheless, the opportunity cost of water transfer from irrigated paddy to other alternative uses downstream is considerable both at local and national levels. Rice from Kilombero constitutes 9% of the total national supply in Tanzania. If farmers in this area stop producing irrigated paddy, there will be shrinkage in the national annual rice production with possible increase on paddy and rice prices, unless this gap is covered by increase in rice production from other regions. Although, return to cost ratio from agriculture is small, yet it is a very important land use especially by considering that about 80% of respondents are depending on agriculture for their livelihood.

5. RECOMMENDATIONS

As per above conclusion, therefore, this paper recommends that emphasis should be put on effective and efficient use of water by applying drip irrigation in order to improve its productivity in agriculture sector. For example water requirement for tomatoes is different from that of maize, therefore applying water (irrigating) at the right time based on different plant water requirement may improve water use by avoiding water loss.

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REFERENCES

- Aylward B 2000. Economic analysis of land-use change in a watershed context. *Journal of Agricultural Economics*, 19: 2 - 4.
- Bailey BK 1994. *Methods of Social Research*. New York: Cllier-MacMillan Publishers.
- Baum E 1968. Land use in the Kilombero valley from shifting cultivation towards permanent farming. In: H Retherberg (Ed.): *Smallholder Farming and Smallholder Development in Tanzania*. Dillingen: Weltforum Verlag Munchen, pp. 21 - 50.
- Briscoe J 1996. Water as an economic good: The idea and what it means in practice. *Journal of Environmental Economics*, 30: 2 - 11.
- Calder IR 2000. *Land Use Impacts on Water Resources*. New York: The Free Press Cllier-MacMillan Publishers.
- FAO 2005. FAOSATAT Data Base. From <<http://apps.fao.org/default.htm>> (Retrieved on December 29, 2011).
- FAO 2004. Economic Valuation of Water Resources in Agriculture: From the Sectoral to a Functional Perspective of Natural Resource Management. From <<http://apps.fao.org/default.htm>> (Site visited on January 2, 2011).
- FAO 2001. U.N. Food and Agriculture Organization Statistical Databases (FAOSTAT): Agriculture. From <<http://apps.fao.org/default.htm>> (Retrieved on December 4, 2010).

- Gleick PH, Singh A, Shi H 2001. *Emerging Threats to the World's Freshwater Resources Report*. California: Oakland Ltd.
- Jatzold R, Baum E 1968. *The Kilombero Valley: Characteristic Features of Economic Geography of a Semi-humid East African Floodplain and Its Margins*. Dillingen: Weltforum Verlag Munchen.
- Kadigi RMJ, Kashaigili JJ, Mdoe NS 2004. The economics of irrigated paddy in Usangu Basin in Tanzania: Water utilization, productivity, income and livelihood implications. *Physics and Chemistry of Earth*, 29: 1091 - 1100.
- Kangalawe RYM, Liwenga ET 2005. Livelihoods in the wetlands of Kilombero Valley in Tanzania: Opportunities and challenges to integrated water resource management. *Physics and Chemistry of the Earth*, 30: 968 - 975.
- Kato F 2007. Development of a major rice cultivation area in the Kilombero valley, Tanzania: Graduate school of Asian and African area studies. *Journal of African Studies*, 3: 6 - 18.
- Kumar MD, Ajay M, Sushanta T 2008. Economic value of water in agriculture: Comparative analysis of a water-scarce and a water-rich region in India. *Journal of Ecology*, 33 (2): 214 - 230.
- Malan H 2010. Wetland ecosystem service and their valuation: A review of current understanding and practice, wetland valuation. *Journal of Ecological Economics*, 440 (9): 95 - 110.
- Masiyandima, M, McCartney MP, van Koppen B 2004. *Sustainable Development and Management of Wetlands. Wetlands Contributions to Livelihoods in Zambia*. Rome: IUCN.
- McCartney M, Masiyandima M, Houghton-Carr H 2004. Working wetlands: Classifying wetland potential for agriculture. *Journal of Ecology*, 35: 223 - 241.
- McCartney MP, van Koppen B 2004. *Sustainable Development and Management of Wetlands: Wetlands Contributions to Livelihoods in United Republic of Tanzania*. Rome: IUCN.
- Millennium Ecosystem Assessment 2005. *Ecosystems and Human Well-being*. Washington, D.C: Island Press.
- Ngaga YM, Turpie JK, Karanja FK 2005. *Catchment Ecosystems and Downstream Water: The Value of Water Resources in the Pangani Basin, Tanzania*. Dar es Salaam: IWM.
- Olsen W 2004. *Triangulation in Social Research: Qualitative and Quantitative Methods can Really be Mixed*. Oxford: Causeway Press.
- Palanisami K, Senthilvel S, Ranganathan CR, Ramesh T 2006. Water productivity at different scales under canals, tank and well irrigation systems. *Journal of Agricultural and Rural Development Studies*, 641(3): 62 - 70.
- Semra E 2005. Perspective on Poverty and Agriculture in Tanzania: Case of Babati district. From <<http://www.eldis.org/fulltext/esrfpolicy0.2.htm>> (Retrieved on November 3, 2010)
- Sharma BR, Samra JS, Scott CA, Wani SP 2005. *Watershed Management Challenges: Improving Productivity, Resources and Livelihoods*. Colombo, Sri Lanka: IWMI.
- Sokile CS, Mwaluvanda W 2005. Integrated Water Resource Management in Tanzania: Interface Between Formal and Informal Institutions at Ghauteng 2004-2005. In: *Proceedings of International Workshop on African Water Laws; Plural Legislative Framework for Rural Water Management in Africa*. 26 - 28 January 2005, Ghauteng, South Africa, pp. 9 -20.
- Stratos A, Basil M, 2005. An integrated system for water resources monitoring: Economic evaluation and management. *International Journal of Ecology*, 1: 193 - 208.
- Turpie JK, Ngaga YM, Karanja F 2005. *Maximising the Economic Value of Water Resources*. Dar es Salaam: Ungano Development Communication Press.
- Turpie JK, Ngaga YM, Karanja F 2003. *A Preliminary Economic Assessment of Water Resources of the Pangani River Basin, Tanzania: Economic Values, Incentives for Sustainable Use and Mechanism for Financing Management*. Dar es Salaam: IUCN.
- United Republic of Tanzania (URT) 2004. *Basic Data, Agriculture Sector 2003/2004*. Dar es Salaam: Government Printer.
- United Republic of Tanzania (URT) 2003. *National Bureau of Statistics: National Population Census 2002*. Dar es Salaam: Government Printer.
- United Republic of Tanzania (URT) 2002. *National Water Policy*. Dar es Salaam: Government Printer.
- Ward FA, Michelsen A 2002. The economic value of water in agriculture: Concepts and policy applications. *Journal of Water Policy*, 4: 423 - 446.
- World Bank 2002. *Water Priority for Responsible Growth and Poverty Reduction: An Agenda for Investment and Policy Change*. Washington, D.C: World Bank.
- Young RA 1996. *Measuring Economic Benefits for Water and Investment Policies*. Washington, D.C: World Bank.
- Young RA 2005. *Determining the Economic Value of Water: Concepts and Methods*. Washing D.C: RFF Press.