The Economics of Irrigated Paddy in Usangu Basin in Tanzania: Water Utilization, Productivity, Income and Livelihood Implications

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Abstract

Globally, there is a general lack of consensus on how the available water resources can be allocated efficiently and equitably among its competing uses. In irrigated agriculture, this decodes to the central question of how this sector can be balanced in the manner that it produces more 'crops per drop' using less water and releasing adequate water for use by other sectors while concurrently enhancing rural income and livelihoods. This requires that the values and costs of irrigated agriculture, at all levels, are well understood and appropriate interventions made. Based on this ground, this paper presents an economic analysis of the value of irrigated paddy in Usangu basin. In attempts to answer the question of what will be the effects if farmers in Usangu stop producing irrigated paddy, the analysis shows the following consequences: a) about 576 Mm^3 of water — currently consumed in paddy irrigation, or 345.6 Mm^3 — traded inter-regionally as "virtual water" would be utilized in alternative ways, either as evaporation from seasonal swamps within the basin or made available for other intersectoral uses, b) there will be a shrinkage in the annual paddy supply (both at the local and national levels) of about 105,000 tonnes of paddy (66,000 tonnes of rice) - equivalent to 14.4% of the total annual paddy production in Tanzania, c) an opportunity cost of about Tsh 16.4 billion (US$ 15.9 million) will be incurred annually (equivalent to Tsh 546,875 or US$ 530.95 per annum per household practicing irrigated paddy in Usangu), and d) the country's current account of the balance of payments will be affected by an average of US$ 15.9 million per annum. The effect will either be in form of annual decline in rice exports or increase in imports depending on the country's supply and demand for rice.

Introduction

Of all sectors, irrigated agriculture is generally perceived as the largest consumer of water virtually everywhere it is practiced. According to the World Meteorological Organization (1997), the sector withdraws about 70% of all the global water. But, the same sector also plays a vital role in enhancing food security, improving rural income and livelihoods, especially in developing countries where agriculture remains the mainstay of the national economies. Currently, the sector accounts for about 40% of the global food production even though it represents only 17% of global cropland (*ibid*). In developing countries, irrigated land accounts for about one fifth of the total arable area with some 15% of agricultural water used in irrigated agriculture totaling to about 2,000 – 2,500 Km^3 per year (UNESCO-WWAP, 2003).

The potential of irrigated agriculture in enhancing food security 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 fundamental goals in their national policies. In Tanzania, the *Tanzania's Development Vision 2025* provides the guiding framework for the agricultural and other sectoral policies. The vision is for the country to move from a less developed country to a middle-income country by 2025, with a high level of human development. Specific targets include: a high quality livelihood, which is characterized by sustainable and shared growth (equality), and freedom from abject poverty; good governance and the rule of law; and a strong and competitive economy capable of producing sustainable growth and shared benefits. Along with this vision is the *Tanzania's Poverty Reduction Strategy Paper (PRSP)*, which was launched in October 2000. The PRSP sets out the country's medium term strategy for poverty reduction and the indicators it will use for measuring progress. It views irrigated agriculture as an important strategy for increasing food security. The PRSP is further supported by the *National Poverty Eradication Strategy (NPES)*, which sets out Tanzania's strategy and objectives for poverty eradication through to 2010. The key priority areas for achieving poverty reduction include: reducing income poverty through equitable economic growth; improving human capabilities, survival and social well being; and containing extreme vulnerability among the poor.

Achieving the above targets can be very tricky to say the least because it requires that the available resources are allocated and used in a balanced manner with social equity, economic efficiency and environmental integrity used as the major "yardsticks." In irrigated agriculture, the most challenging issue is how this sector can be balanced in a manner that it produces more 'crops per drop', utilizes less water and releases adequate water for use by other sectors while concurrently enhancing incomes and livelihoods of the rural poor. This requires that the costs and benefits associated with irrigated agriculture are well-understood and appropriate interventions made in a well-informed manner. Recognizing this pre-requisite, this paper uses the case of Usangu basin to examine the value of water in irrigated paddy, the amount consumed and the role of irrigated paddy in shaping livelihoods and income of the local people and welfare of the national economy at large.

Methodology

The Study Area

The study was carried out in Usangu basin between September 2002 and March 2003 as part of the RIPARWIN research work.[1] The Usangu basin is located in the southwest of Tanzania between approximately latitudes 7^{0}41' and 9^{0}25' South, and longitudes 33^{0}40' and 35^{0}40' East. It lies within the eastern arm of the Rift Valley, marked by distinct escarpments in the southern and eastern parts, and forms the upper catchment of the Great Ruaha River (GRR) (Figure 1). This river is a main tributary to the Rufiji river, which forms the largest drainage basin in Tanzania, covering some 174 800 km^2 or about 18% of Tanzania Mainland. The total area of the Usangu basin is 20,811 km^2 - about 12% of the total Rufiji basin. From Usangu basin, the GRR flows through the Ruaha National Park serving as the main source of water for the park.

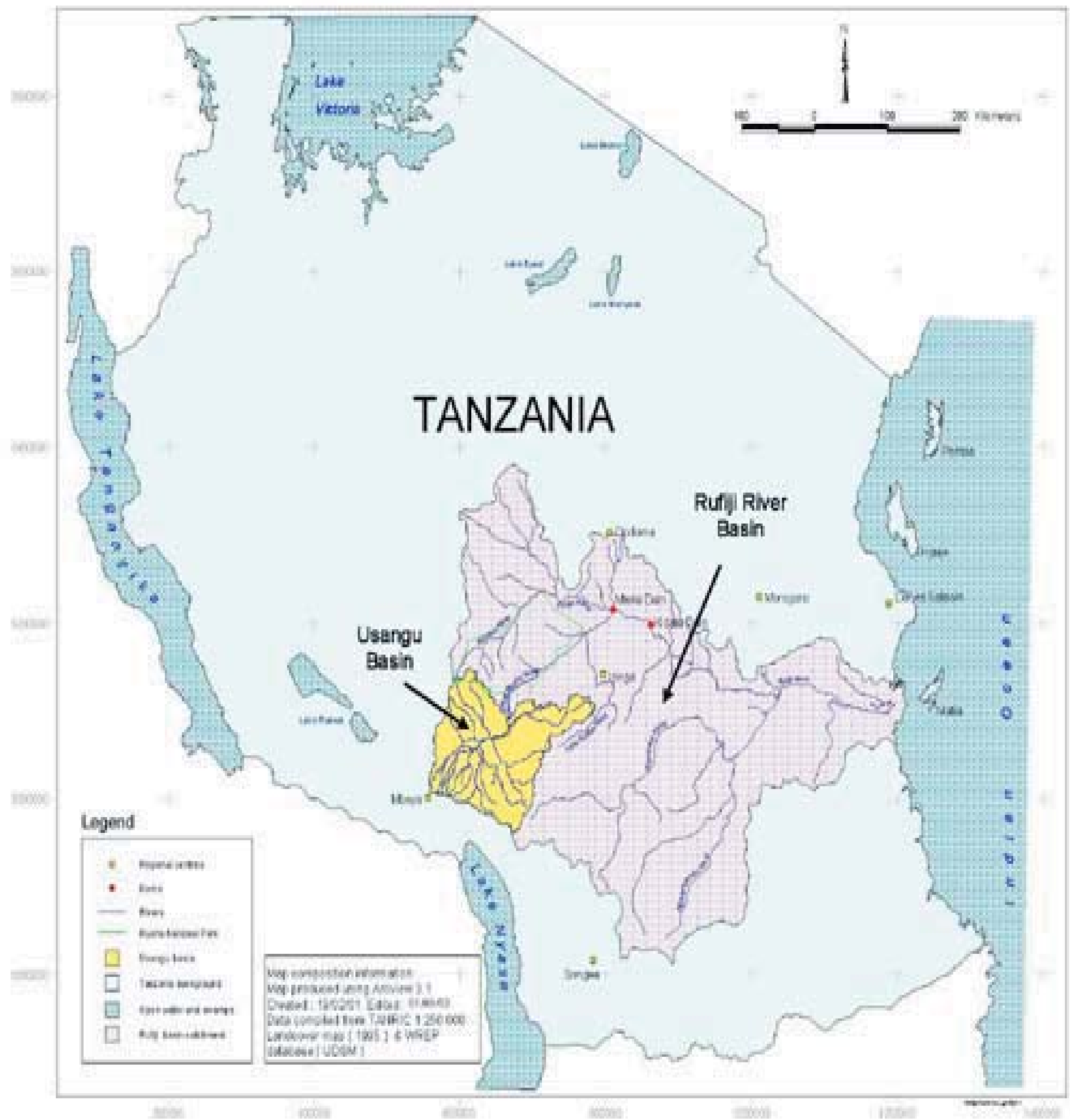

Figure 1: Map of Tanzania showing the Usangu Basin within the Rufiji River Basin

Thereafter, together with the Little Ruaha, the river supplies water to the Mtera reservoir and hydropower plant. Downstream, the GRR joins another major feeder river: Kilombero, to form the Rufiji River before supplying water for hydropower generation at Kidatu. The GRR provides 56% of runoff to Mtera. The Little Ruaha River, which joins the GRR downstream from the Usangu basin, provides an additional 18%, and the Kisigo River 26% of the total runoff to Mtera.

Irrigated agriculture in Usangu basin dates back to the early 19th century, during the era of German missionaries. The missionaries built small furrows to provide domestic water to the missions and to irrigate vegetable gardens. Thereafter, the Baluchis (from Baluchistan) arrived in Usangu in 1920s and introduced paddy irrigation in 1940s (SMUWC 2001). The practice spread rapidly among local farmers. The Baluchis are currently operating several large, family paddy farms, with their own furrows and applying relatively more improved management practices. They are also renowned as important traders and merchants in Usangu area.The most momentous expansion of irrigated paddy probably took place in the late 1980s after Tanzania had adopted the policy of trade liberalization and when a number of private traders began to operate in food grains. During this period, the producer prices for paddy increased rapidly encouraging farmers to increase production and extend the area under paddy cultivation. The establishment of irrigation schemes, like the large-scale Mbarali and Kapunga Irrigation Schemes and smallholder schemes (e.g. the Majengo, Kimani and Motombaya schemes) has also led to a further expansion of the area under paddy production.

According to SMUWC (2001), the maximum irrigated land under paddy in Usangu basin is estimated at about 42,000 ha. This is grown during a normal-to-wet year when average weather conditions are favorable, and when irrigation is essentially supplemented by rainfall. The core-irrigated area found in a dry year is 24,500 ha.

[1] 'RIPARWIN' stands for **R**aising **I**rrigation **P**roductivity and **R**eleasing **W**ater for **I**ntersectoral **N**eeds. It is a research project funded by DFID and implemented by the University of East Anglia and Sokoine University of Agriculture, through the Soil-Water Management Research Group (SWMRG). The project is based in the Usangu Plains in Tanzania. It runs from July 2001 to March 2004.

This area includes a rice crop of 22,000 ha and a non-rice crop of 2,500 ha. Both rice and non-rice crops are irrigated using mostly river flows with little reliance on rainfall. The area planted in such a year depends on the river flows and rainfall in each sub-catchment.

The non-rice cropped area (2,500 ha) includes a mixed cropping pattern of maize, beans, vegetables and fruits, and extends throughout the year, mainly in the Chimala and Mkoji subcatchments. The maximum irrigated area in a normal to wet year is therefore 42,000 ha plus 2,500 ha (44,500 ha). Dry season irrigation plots are usually very small (about 0.1 - 0.2 ha). Land for rain-fed agriculture varies between 50,000 ha and 65,000 ha depending on the amount and distribution of rainfall.

Data Collection and Analysis

This paper draws on both secondary and primary data. A range of Participatory Rural Appraisal (PRA) methods (including *Resource Mapping and Modeling*; *Livelihood analysis*; *System diagrams*; *Historical profiles* and *Timelines and Time trends*; and *Wealth ranking*) were employed as a footing step to the study. At the household level, primary data was gathered using semi-structured questionnaires encompassing questions of rice production and marketing. The questionnaires were administered in three villages namely; Uturo, Ihahi and Ukwavila and a total number of 120 respondents were interviewed. In addition, 20 rice traders and transporters were also interviewed so as to get a greater picture of rice marketing at the local, interregional and national levels. The bulk of secondary data was gathered from the Mbarali District Agricultural Office, SMUWC database, Statistics unit of the Ministry of Agriculture and Food Security. Both qualitative and quantitative techniques were used to analyse the data using computer-based statistical programs (MINITAB and SPSS).

Results and Discussion

Use of Production Inputs

In general, very few inputs are used apart from labour and irrigation water. Some farmers use improved seed varieties but these are relatively expensive and new seeds need to be purchased at the beginning of each season by which time farmers have little capital remaining. Most farmers keep a small proportion of each year's harvest as next years' seed, so that new seeds do not need to be purchased at the beginning of the season.

The use of fertilizers, pesticides, herbicides or manure is rare. Of the interviewed farmers, only 3.3% reported as applying fertilizers. Artificial inputs are commonly not used because they are too expensive. Even if many farmers can afford to purchase them, the extra financial investment involved may expose them to greater economic risk should the rains, and therefore their paddy crop, fail. Use of manure is also uncommon because it is difficult to carry sufficient quantities to the distant paddy fields.

Land renting is common and its cost varies with location of the irrigation system and relative location along the furrow (top-end or tail-end). For example, a top-end plot in villages close to the urban settlements like Rujewa can cost up to Tsh 30,000 (US $ 29.13) per acre, while a tail-end plot costs Tsh 20,000 (US $ 19.42). A top-end plot in the Kapunga Smallholder Scheme, which is about 26 km from the main settlement of Chimala, can be hired for Tsh 20,000 (US $ 19.42) per acre and Tsh 10,000 (US $ 9.71) per acre at the tail end. Many farmers in the upper alluvial fans rent these plots as they only have paddy plots and do not own land that is in a suitable location for dryseason crops. Dry season plots are rented for between Tsh 10,000 (US $ 9.71) - 15,000 (US $ 14.56) per acre (Tsh 25,000 or US $ 24.27 - Tsh 37,500 or US $ 36.41 per ha).

Farmers who have capital normally also hire oxen to undertake ploughing and labor for puddling, transplanting and harvesting. But most farmers, who do not have enough money, resort to using their own labor in ploughing their fields by hand hoes. It costs approximately Tsh 12,000 (US $ 11.65) per acre (Tsh 30,000 or US $ 29.13 per ha) to hire oxen and/or labour for ploughing or transplanting work. Hiring labour for harvesting costs less at around Tsh 8,000 (US $ 7.77) per acre equivalent to Tsh 20,000 (US $ 19.42) per ha.

Producer Prices

Farmers in Usangu like to plant their nursery fields and transplant paddy as soon as the available water supplies allow them since an early harvest means good producer prices for paddy. Although yields are lower, a farmer who harvests in late April or early May, may be able to obtain up to about Tsh. 27,000 (US $ 26.21) per sack of paddy compared to Tsh 6,000 (US $ 5.83) to 12,000 (US $ 11.65) later in the season (July and August). At the beginning of the harvesting season, the producer price for one sack can be as high as Tsh 27,000 (US $ 26.21). By the end of the harvesting season, this can fall as low as Tsh 4,800 or US $ 4.66 (table 1).[1]

In nominal terms, the average producer prices for paddy have generally shown an increasing trend. The prices have increased from Tsh 10,500 (US $ 10.19) per bag in 1998 to Tsh 18,000 (US $ 17.48) per bag in 2000 (table 1). The highest average price was recorded in 2000 (Tsh 18,000 or US $ 17.48 per bag). The price decreased by 28.3% in 2001 and increased by 16.3% in 2002 to record Tsh 12,900 (US $ 12.52) and Tsh 15,000 (US $ 14.56) per bag respectively. However, a current study by Magayane (2002) has reported a maximum price of up to 27,000 (US $ 26.21) in March 2000. Magayane has gone further into establishing a price he has dubbed a "normal price" or average price of paddy when both tail end and top-end farmers have harvested their paddy crops. According to Magayane (2002), the monthly fluctuations in paddy prices (measured as proportions or percentages of market prices to "normal prices") have ranged from 67% (in August, 2000 and July 2001) to 180% (in March 2000).

In real terms however, producer prices for paddy have declined over time. This has resulted into falling trends for real values of paddy production.[2] In other words, the upsurges in nominal prices have generally lagged behind the inflation rates. Average real producer prices for paddy declined by 22% from Tsh 10,000 (US $ 9.71) in 1994 to Tsh 7,789.29 (US $ 7.56) in 1995. The prices have also decreased by 32% from Tsh 7,742.49 (US $ 7.52) in 2000 to Tsh 5,279.40 in 2001 (table 1). This implies that the question of declining real producer prices and its associated consequences remains one of the important issues to be addressed if the plight of lifting the Usangu's poor farmers out of poverty is to be tackled.

Returns to Labour, Profit Margins and Values of Irrigation Water

Returns to labour, profit margins and values of irrigation water were compared for four systems of paddy production in the study area using both secondary and primary data collected during the study. The results are summarized in table 2.

[2] However, very few farmers are able to store their paddy until the beginning of the harvesting season or at the end of the dry season when prices are high. Correlation coefficient between average real producer prices and paddy production (for the period from 1993 to 2001) = –0.584, $P < 0.10$.

Table 1: Usangu basin: Average producer prices for paddy (Tsh per bag), 1993 - 2001

Year	Nominal prices*	%C Nominal prices	NCPI	%C NCPI	Real prices*	%C Real prices
1993	6,200.00	NA	67.8	25.2	8,248.38	NA
1994	10,000.00	61.3	90.2	33.1	10,000.00	21.2
1995	10,000.00	0.0	115.8	28.4	7,789.29	-22.1
1996	10,000.00	0.0	140.1	21	6,438.26	-17.3
1997	10,000.00	0.0	162.6	16.1	5,547.36	-13.8
1998	10,500.00	5.0	183.5	12.8	5,161.31	-7.0
1999	15,300.00	45.7	197.9	7.9	6,973.52	35.1
2000	18,000.00	17.6	209.7	5.9	7,742.49	11.0
2001	12,900.00	-28.3	220.4	5.1	5,279.40	-31.8
Average	**11,433.33**				**7,020.00**	

Source: Mbarali District Agricultural Office and own calculation
*Prices from 1993 to 1997 were controlled prices (Cooperative prices), 1bag = 85 Kg; after which period (1998 – 2002) prices have largely depended on the market forces and bags are currently modified to carry more weight (1bag = 96 Kg). Average prices for the period from 1998 – 2002 have been calculated as (minimum price + maximum price)/2
**Real price = Nominal price ÷ Deflator; Deflator = $NCPI_t \div NCPI_0$

Table 2: Usangu basin: Comparison of profit margins/returns to labour and values of irrigation water in paddy production, 2001/02

Activity	Farm size ha	Paddy yield* Kg/ha	Gross margins Tsh/ha (paddy)	Gross margins Tsh/kg (paddy)	Gross margins Tsh/kg (rice)	Return to labour Tsh/manday	Irrigation water productivity** Kg/m^3	Irrigation water value Tsh/m^3
I	0.3	788	101,525	128.84	257.68	490.46	0.00	0.00
			(98.57)	(0.13)	(0.25)	(0.48)		(0.00)
II	0.5	1500	94,075	62.72	125.44	514.07	0.00	0.00
			(91.33)	(0.06)	(0.12)	(0.50)		(0.00)
III***	6.0	1600	77,600	48.50	97.00	760.78	0.12	18.75
			(75.34)	(0.05)	(0.09)	(0.74)		(0.018)
IV	0.7	1800	93,450	51.92	103.84	826.99	0.13	20.31
			(90.73)	(0.05)	(0.10)	(0.80)		(0.02)

Activity I = Smallholder farmer cultivating rain-fed paddy, using hand hoe and family labour
Activity II = Smallholder farmer cultivating rain-fed paddy, using tractor, fertilizer and hired labour
Activity III = Smallholder farmer hiring NAFCO farms/plots, cultivating irrigated paddy using tractor, fertilizer and hired labour
Activity IV = Smallholder farmer cultivating irrigated paddy, using tractor, fertilizer and hired labour
*Average paddy yield for the whole of the Usangu basin is 2500 kg/ha (SMUWC, 2001)
** Average productivity of irrigation water (in paddy production) for the Usangu basin is estimated at 0.18 kg/m^3
*** Hired plots in the NAFCO (Kapunga) system are normally 6 ha in size
Numbers in bracket represent equivalent values in US $, calculated using April 2003 Exchange Rate of 1 US $ = Tsh 1,030

As shown in table 2, returns to labour and profit margins vary among different production systems. The return to labour in paddy production for a smallholder farmer who irrigated his/her paddy field and used tractor, fertilizer and hired labour during the 2001/02 season was higher (Tsh 826.99 or US $ 0.80 per manday) than any of the remaining paddy production systems. The smallest return to labour (Tsh 490.46 or US $ 0.48 per manday) was obtained by an average smallholder farmer who cultivated rain-fed paddy using hand hoe and family labour. On average, smallholder farmers cultivating rain-fed paddy using hand hoe and family labour obtained the highest gross margin (Tsh 101,525 or US $ 98.57 per ha), while smallholder farmers who hired the National Agriculture and Food Corporation (NAFCO) farms/plots and cultivated irrigated paddy using tractor, fertilizer and hired labour obtained the least gross margin (Tsh 77,600 or US $ 75.34 per ha). When gross margins per hectare are compared, one would generally argue that the differences among the above four production systems were determined more by the extent to which commercial inputs were used and less by the differences in economies of scale. As the evidences in this study indicate, commercial inputs were relatively very expensive and their use might have eroded a large share of profit margins.

Productivity of irrigation water (paddy produced per drop) was also relatively lower for smallholder farmers within the NAFCO systems than for their counterpart smallholder farmers outside the NAFCO systems [compare productivity of 0.12kg or Tsh 18.75 (US $ 0.018) per cubic meter versus 0.13kg or Tsh 20.31 (US $ 0.020) per cubic meter in table 2]. Furthermore, the productivity of irrigation water in the NAFCO systems was also lower than the overall productivity in the whole of the Usangu basin, which is estimated at 0.18kg of paddy or Tsh 28.13 (US $ 0.027) per cubic meter of irrigation water (table 3).

While it is difficult to specify the main cause of low productivity in the NAFCO systems, weed infestation and poor water level control seem to be some of the major causative factors. Water level control on the NAFCO systems is in essence variable as fields are large, the soil surface is uneven and farmers do not use smaller plots (*vijaruba*) to control water level and movement. On the traditional smallholders irrigation system,

[3] Correlation coefficient between average real producer prices and paddy production (for the period from 1993 to 2001) = –0.584, P < 0.10.

Table 3: Usangu basin: Calculation of amount and value of water used in irrigated paddy

Estimated water abstraction for paddy irrigation	= 46 cumecs
Average annual depth of water applied in paddy field	= 1850 mm
Mean annual rainfall	= 669 mm
Effective annual rainfall	= 479 mm
Irrigation annual demand	= (1850 – 479)= 1371 mm = 1.371 m
Mean wet season irrigated area (paddy)	= 42,000ha
Annual volumetric demand (water use) for 42,000ha	= 42,000 x 10^4 m^2 x 1.371 m = 576 x 10^6 m^3 = 576 Mm^3
Annual volumetric demand (water use) per hectare	= 0.013731 Mm^3 = 13731.43 m^3
Average yield per hectare	= 2.5 tonnes
Estimated irrigation paddy productivity	= 0.18 Kg per m^3 = Tsh 28.13 ($ 0.027) per m^3
Estimated volume of "virtual water trade" per annum	= 60% x 576 Mm^3 = 345.6 Mm^3

plots are smaller enabling greater care over water levels.

Comparing the Usangu figure with that of the whole Sub-Saharan Africa (SSA), the former can be rated as an average value for the region. Water productivity of rice in this region ranges from 0.10 to 0.25 kg per m^3, with average yield of 1.4 metric tonnes per ha and water consumption per hectare close to 9,500 m^3 (Rosegrant, *et al*, 2002). Among developing countries, China and some Southeast Asian countries have higher water productivity for rice, ranging from 0.4 to 0.6 kg per m^3; however, the average for the developed world (0.47 kg/m^3) is higher than that for the developing world (0.39 kg/m^3) (*ibid*).

Irrigated Paddy and its Implications

One of the most challenging issues regarding water resource management and allocation in Usangu basin and in other parts of the world appears to be that of whether water resources should flow to the sector generating the highest *economic benefits* or *pro-poor livelihood returns*. In Tanzania, the sector generating the highest economic benefits is generally perceived as hydropower.[1] According to the neo-classic economic perception, this sector should be given high priority in the country's water allocation arrangements. Since early 1990s, the sector has suffered from shortage of water in one of its major power plant reservoir (Mtera) following drying up of the GRR in the Ruaha National Park. This has even resulted to *power rationing* in the country, particularly during the period from 1992 to 1994. Several studies have attempted to point out the major causes for the drying up. DANIDA/World Bank (1995), for example, has attributed it to increasing irrigation abstractions in the upstream part of the Rufiji River Basin (particularly in the Usangu basin), deforestation and general degradation of environment. Others, (e.g., the report by Charnley, 1997), has attached this to increased livestock and consequent overgrazing.

One of the recommendations provided is to advice upstream farmers to shift from producing water intensive crops (e.g., paddy) to high value crops or crops that use less water. Whether this is an appropriate prescription or not requires that the value of irrigated paddy is, in the first place, well understood. The remainder of this section presents an analysis of the role of irrigated paddy in Usangu basin. It attempts to answer the question of what will be the impact if farmers in Usangu stop producing irrigated paddy.

Currently, irrigated paddy in Usangu is estimated to produce about 105,000 tonnes of paddy (equivalent to 66,000 tonnes of rice) per annum. This is about 14.4% of the total annual rice production in Tanzania. If farmers in Usangu basin stop producing irrigated paddy, there will be a shrinkage in annual food supply of about 66,000 tonnes of rice both at the local and national levels. In monetary terms, this is equivalent to an annual income of Tsh 16.4 billion or US $ 15.9 million,[2] which is currently supporting about 30,000 agrarian families in Usangu. According to this figure, the average income per an agrarian family can be put at Tsh 546,875 or US $ 530.95 per annum.[1] Thus, the opportunity cost for irrigated paddy is estimated at Tsh 16.4 billion or US $ 15.9 million per annum. Assuming a cultivable season of work spanning 170 days including land preparation and harvest, this earning amounts to an average daily household income of more than US $ 3.12 per day, which implies that irrigated paddy plays a crucial part in lifting the Usangu households out of poverty.

In a macroeconomics context, the quantity of rice which is produced in Usangu Basin should be accounted for in the Gross National Product (GNP) or National Income and Product Accounts, which also records income from sales of commodities abroad (exports) and payments for foreign-produced goods and services (imports). The net exports term (total exports minus total imports) in the GNP identity is the current account balance of the balance of payments, which is measured by the net receipts from the sale of currently produced goods and services abroad less payment for purchases of foreign-produced goods and services (including rice and other commodities). Using this criterion, one may also argue that the country's GNP or current account balance of the balance of payments will be affected by an average of 66,000 tonnes of rice

[4] Although a current study by the Department of Water Resources, University of Dar es Salaam in 1997 has however, shown that the Benefit-Cost Ratio (BCR) for irrigated agriculture (1.03) is relatively higher than that of hydropower generation (1.00) (Wahure, 1998).

[5] The value (in Tsh) has been calculated using the current average market price and the value has been converted into US $ using the April 2003 exchange rate (US $ 1 = Tsh 1,030).

(valued at US $ 15.9 million) if the *without irrigated paddy* scenario holds. The effect can either be in form of annual drop in rice exports or increase in imports depending on the national supply and demand for rice.

The amount of water, which is currently utilized in irrigated paddy under the *business as usual* scenario is estimated at about 576 Mm^3 per annum (table 3).[1] Out of this 60% (345.6 Mm^3) is inter-regionally traded outside the basin to main consumption centres, particularly in Dar es Salaam, Mbeya and Morogoro as "virtual water."[2] Under the *without irrigated paddy* scenario this water would be utilized in alternative ways, either as evaporation from seasonal swamps within the Usangu basin or made available for other intersectoral uses.

Conclusions

Although irrigated paddy in Usangu basin is asserted as utilizing too much of the available water (about 576 Mm^3 per annum), the same is also playing an important role in enhancing food security, rural income and livelihoods of the local people. It also contributes a large share of paddy to the national production (about 14%). Based on these facts, one would suggest not abandoning the practice but striving to increase irrigation efficiency and improve productivity (paddy produced per drop). The current average productivity figure for the basin (0.18 kg of paddy per m^3 of irrigation water) compares well with figures reported in many other developing countries (e.g., 0.19 - 0.22 kg/m^3 for India). The water productivity of rice in Sub-Saharan Africa ranges from 0.10 to 0.25 kg/m^3. Elsewhere in the world, figures of up to 0.6 kg/m^3 are reported but with intensive management. Thus, the Usangu figures are approximately 30 – 67% of attainable productivity and there is room for improvement, if "wise use" of water resources is achieved. Needed actions include raising awareness, promoting good practice and mobilizing the energy and participation of the local communities in sustainable water resource management.

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[6] It is however worth noting that the revenues discussed in this section do not necessarily imply net losses of income to farmers in the basin as they may shift their resources from producing irrigated paddy to production of rain-fed paddy or non-paddy crops or other income generating activities.

[7] The estimate considers only the wet season abstractions, if dry season irrigation is taken into account (August to November), then the figure might be higher, but the contribution of dry season flow downstream is considered as insignificant because dry season irrigated paddy is uncommon in Usangu Basin.

[8] "Virtual water" is defined as the water needed to produce a commodity or service (Allan, 2003).