The Role of Traditional Irrigation on Small Scale Agriculture in semi arid Environment, southern Highland Tanzania

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ABSTRACT

*The roles of traditional irrigation practice on crops and vegetables production was investigated in selected catchments in southern highlands Tanzania. Findings revealed that traditional irrigation farming (*vinyungu*) is a cultural practice and is becoming more important to peoples' livelihood. It was also revealed that a maximum profit is achieved when a mixture of crops (maize, beans and tomato) and vegetables are grown together and irrigated. Income generated per HH were in the order $ 243.3, 439.1, 540.4 and $ 545.7 per year in zones 3 (upper), 14 (middle), 8 (low) and 16 (lower) respectively. The productivity and profitability also varied within zones, being higher in areas with wider valleys and flood plains (lower), in areas close to marketing centre and also in areas with good road network. Major problems limiting productivity include declining soil fertility, water shortage and crop pests and diseases. Strategies to ensure water availability opening of small shallow wells in wetlands or sometimes in river tributary, valleys diversion of tributaries to farms and conservation of indigenous tree species. There is also increasing conflicts over water resource uses for agriculture. Integrated Soil and Water Resource Management plan needs to be prepared in the area for sustainable productivity and resource conservation.*

Key words: Agriculture, Farming, Iringa, Livelihood, Water, Valley, Zones

BACKGROUND

An Overview

Agricultural sector is the leading sector of the economy of Tanzania and accounts for over half of the Gross Domestic Product (GDP) and export earnings (URT, 2001). It is estimated that over 80% of the poor are in rural areas and their livelihood depends upon agriculture in order to sustain their livelihood. Moreover, about 80% of the population live and earn their living in rural areas with agriculture as the mainstay. Agriculture in Tanzania is mainly rainfed and this is undertaken by farmers, sometimes in semi-arid areas, with less than 800 mm of rainfall (Shao, 1999; Kangalawe *et al.*, 2004). This kind of agriculture is severely constrained by drought, which drastically reduces crop yields significantly (Boesen and Ravnborg, 1993). The Tanzanian government has identified irrigation farming as one of the strategies for agricultural development (URT 1997; URT 2001). Further, the World Summit on Sustainable Development (WSSD) in 2002 recognized the need for promoting agriculture through Integrated Water Resource Management (IWRM) (J nch-Clausen, 2004).

Since 1980s to date, there had been a number of efforts in Tanzania to promote irrigation farming in order to increase food security. These efforts concentrated on large-scale irrigation schemes, which were often too mechanized and expensive for most Tanzanian farmers. There is ample evidence that most of these schemes or projects failed partly due to their poor management and environmental degradation such as sedimentation and salinization. However, traditional irrigation that utilizes natural moisture or water from either natural springs or river diversions has been increasingly practiced as a means of ensuring food

security and income generation to smallholder farmers (Adams *et al.*, 1994). In Iringa Region where the land is characterized by varied landforms and relatively high water table, valley bottom farming systems of *vinyungu* have been reported to supplement food and income generated from rain-fed farming. *Vinyungu* farming is a traditional farming system in Iringa Region practised by smallholder farmers usually in valley bottoms or flood plains. Ideally, these areas are characteristically moist for a long period of the year, allowing the cultivation of multiple annual crops. However, the socio-economic and environmental implication of this type of farming practice is not clearly known. This study was planned to fill this knowledge gap.

Deforestation and soil degradation has been reported to threaten traditional irrigation schemes in Kilimanjaro (Banzi *et al., 1992*). Kaswamila and Tenga (1997) reported that over-cultivation around water sources is a threat to traditional irrigation practices in Lushoto District due to accelerated soil erosion of riverbanks. Sustainability and productivity of traditional irrigation (*vinyungu)* farming systems in Rufiji basin is now a big concern due to associated land degradation (Mtatifikolo and Comoro, 1999; Mkavidanda and Kaswamila, 2000; NORPLAN, 2001; Majule and Mwalyosi, 2003). It is feared that the *vinyungu* farming practices is likely to aggravate the soil degradation process due to river bank cultivation and excessive utilization of chemicals.

Description of the Study Area

A detailed description of the study area is found in Majule and Mwalyosi (2003). Agricultural production in the region is the major socio economic activity and is strongly influenced by the pattern of rainfall which decreases from highlands in the Southeast to the lowlands in the Northwest. The rainfall pattern in Iringa Region is mono-modal with a single rainy season from November through May and dry conditions during the rest of the year (RADP, 1986). Mean annual rainfall is about 1000 mm whereby 900 mm fall during the rain season (December-May) and about 100 mm fall during June-November. The region has a number of perennial streams which are potentially important for both wet and dry season farming, making agriculture possible for two seasons (DANIDA, 1982). The total land area suitable for agriculture in the region is 4,194,800 ha but only 414,517 ha are currently utilized in the production of different crops and vegetables. The 2002 population of the whole Region was 1,495,333 people and it is estimated that 20% of population live in the big and small urban centres of Iringa, Mufindi, Makambako and Njombe while 80% of the population live in rural areas.

Purpose and objective of the study

The main purpose of this study was to explore the socio-cultural and economic issues associated with traditional irrigation farming practice and develop sustainable management strategies. Specifically, the study explored the characteristics of the different types (practices) of *vinyungu* farming and their socio-economic importance to the local people.

RESEARCH METHODOLOGY

The study was confined in Iringa Regions and study sites (Figure 1) were selected with the assistance of the Agriculture and Livestock Development Officer (DALDO) for the then Iringa Rural District. The selection of sites was based on; (a) variation in farming system zones based on agro ecological zones; (b) the dominance and economic relevance of *vinyungu* to the livelihood of people in the area; (c) the intensity of management such as levels of input use and; (d) the closeness to the main road and marketing centre. Study sites were strategically selected within four major agro ecological zones found in the basin. Agro ecological zone 3 is found at an altitude of 1600-2700 m.a.s.l and is characterised hilly mountains with narrow valleys. It receives between 1000 and 1600 mm of rains and is characteristically wet. It included Mlafu and Itungi villages. Agro ecological zone 8 if found at an altitude of 1200-1800 m.a.s.l and receives between 600 and 1000 mm of rains per year. It

includes Mtitu, Lulanzi and Lukani villages. Agro ecological zone 14 is found at an altitude of between 1300 and 1800 m.a.s.l and receives less than 1000 mm of rains per year. It has wider valleys or flood plains and it includes Kitwuli, Mbalano and Tanangozi villages. Agro ecological zone 16 is found in the lower part of the basin (900-1200 mm a.s.l) and receives less than 600 mm of rain per year.

Figure 1. Location of Study Sites in Iringa District

Data Collection

Secondary data was collected through review of various reports, published papers, relevant government documents related to *vinyungu* farming practices. Various offices were visited in Iringa to acquire major documents. Discussions with key informants were also held with different people including the DALDO for Iringa District.

Primary data were collected at field, household and individual farmer levels. This was achieved through administration of structured questionnaire and Participatory Research

Assessment (PRA). A 1-2 hour Participatory Rural Appraisal (PRA) meeting was conducted in each of the selected villages involving a maximum of 20 people of both gender and mixed age. PRA discussions were guided by few leading and exploratory questions. A semi-structured questionnaire was used to gather specific detailed data/information of interest from households. For interview, 10% of total households who practice *vinyungu* farming in the village were identified and interviewed.

RESULTS AND DISCUSSION

Characteristics and Status of Traditional Irrigation (*vinyungu*) Farming

Vinyungu farming is a traditional farming system in Iringa Region practised by smallholder farmers usually in valley bottoms or flood plains. Ideally, these areas are characteristically moist for a long period of the year. *Vinyungu* is a local term, which refers to farmlands or fields in valley bottoms or floodplains cultivated during the dry season utilising natural moisture or water diverted from rivers/streams or harvested from rain to produce food and cash crops. In doing so, farmer to a large extent cope with the problem of moisture stress common during the dry season. This type of farming is possible in Iringa because the ground water table in most places is relatively high (Ravnborg, 1990; Lema, 1996). A detailed historical account of traditional irrigation (*vinyungu*) in the study area has been provided by Majule and Mwalyosi (2003). However the scale of farming has been progressively increasing being associated with an increased use of agricultural inputs in order to maximize production due to commercialisation of crops and vegetables. Thus, due to evolution in agricultural practices, traditional *vinyungu* are being transformed in order to increase productivity. However, experience from this study indicates that there are still areas (such as Mlafu Village) where a minimum level of agricultural input is being used in *vinyungu*.

The role of vinyungu in the study area

The *vinyungu* farming practice is gaining popularity in the study area. The reasons for expansion of this type of farming practice as advanced by the farmers are summarised in Figure 2.

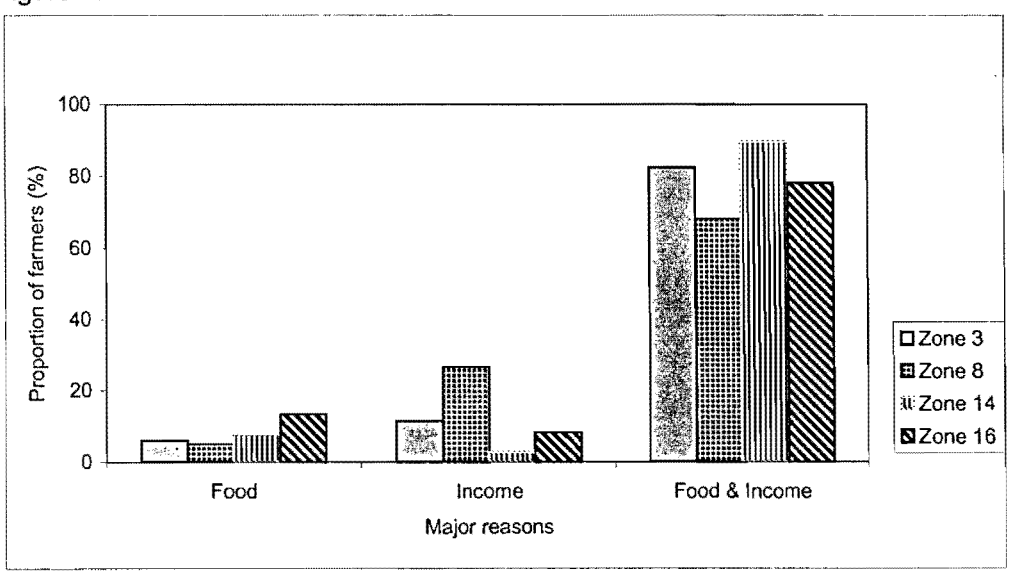

Figure 2. Major Reasons for Undertaking *Vinyungu* Farming

It is apparent that throughout the four agroecological zones, people farm *vinyungu* mainly for production of food crops, generation of cash income or both. Figure 2 indicate that people who cultivate *vinyungu* for food alone are less than 10% in zones 3, 8 and 14 whereas they are nearly 15% in zone 16. Those who farm vinyungu for the purpose of generating income alone (selling all product) are very few in zone 14 (<5%) and slightly many in zone 8 (< 20%).

However the majority (over 60%) of people tend farm *vinyungu* for both cash and food purposes. Decline in crop productivity in upland areas was reported as a major reason for expanding farming in valley bottoms. PRA discussions indicated that *vinyungu* farming is practiced mainly during the dry season. However the same farmer tends to perform upland cultivation (wet season farming) where by major food crops particularly maize, beans and tomatoes are cultivated.

Water sources for vinyungu farming

Due to the increasing importance of vinyungu farming practices, the demand for water for irrigation is also on the increase. Water availability is largely dependent on wetland characteristics, rainfall, temperature regimes, soil physical properties, and location of the farm relative to the river or wetland system.

Figure 3a, A Small Shallow Well with Water for Irrigation

Figure 3b. Irrigation Channel at Ilula

Water sources for irrigation include natural wetlands, springs, rivers, and shallow wells (Figure 3a). Among the different agro-ecological zones, different water sources or a combination of them is used for irrigation farming (Figure 4). It is apparent from the figure that the major source is river water. However, in Zone 16 wells are also relatively important, while in Zone 8, springs are almost as important a source as rivers. Those who use a combination of water from a river and well are < 20% in zones 3, 8 and 14. Generally, water inadequacy was reported throughout the study area. However, severe shortage was reported in zone 16 where farming was more intensive, as well as in Kibebe and Weru Villages. The use of natural moisture is still important in Zone 3. In this zone, water sources are well conserved by protecting natural vegetation. In zone 16, the majority of farmers particularly at Ilula and Mtitu villages claimed water conflicts due to water shortage for irrigation and poor distribution. This problem mainly affects farmers using water in fields located in the lower stream.

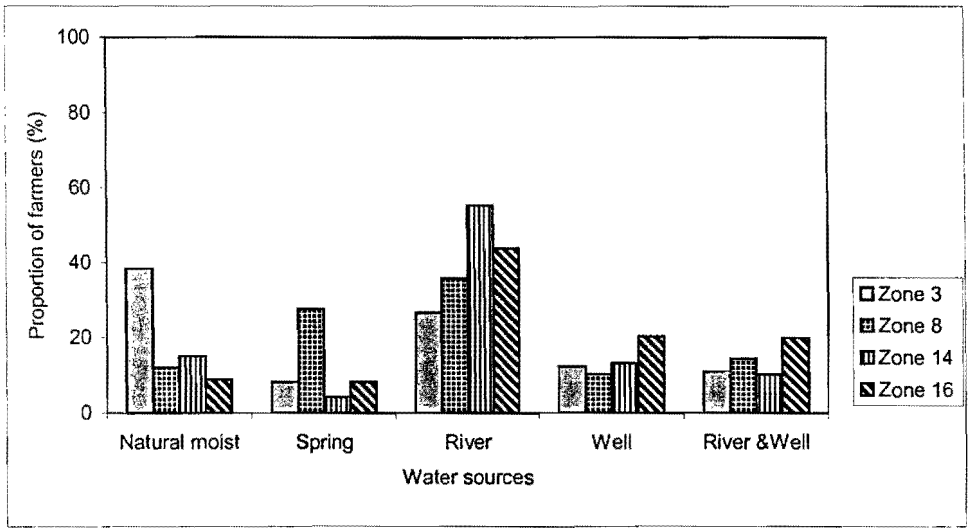

Figure 4: Different Sources of Water for Irrigation

At Ilula viillage in zone 16 it was revealed that there was an extension of *vinyungu* farming into the river gorge created by collapsed riverbanks (Figure 5a and 5b). This is commonly being practices during the dry season. This has serious implications on soil and water degradation and thus a threat on the sustainability of *vinyungu* farming. For example, it was further observed that a massive piece of land had been washed away by floods, thus destroying the hydrology of that farmland to the extent that there is neither no longer natural wetness nor springs to support *vinyungu* farming practices.

Figure 5a Cultivation within a River

Figure 5b. Cultivation on Collapsed River Bank

Vinyungu farming in the study area is characterised by mixed and/or sequential cropping as well as mono-cropping. These practices are variably encouraged by following factors: (a) scarcity in of farmland in narrow valley bottom areas preventing the cultivation of many crops at any one time; (b) differential moisture availability in *vinyungu* pre-determine the specific crops to be grown at any given time (for example, tomatoes are grown on relatively dry soils); (c) seasonal climate variability per site tends to affect the performance of different crops since this is associated with occurrence of diseases and; (d) Market demand for a crop at any particular time.

Major factors affecting vinyungu productivity

Farmers in the study area were asked to assess changes in crop productivity and water availability in their *vinyungu* farms over the years. The majority (over 80%) observed a

decline in crop production over the years. They attributed the decline largely to soil degradation, declining water availability and increasing occurrence of diseases and pests (Table 1). These attributes are further elaborated in the sections that follow below.

Declining soil fertility

The study revealed a number of factors (Table 2) that lead to soil degradation in *vinyungu*. These problems varied though not significantly, across the zones. On average, low fertility was ranked the biggest problem in all the four agro-ecological zones. This problem was particularly noticeable in Zone 8 and 16. The majority of soils under *vinyungu* in the study have been reported to be strongly acidic with the exceptions of areas with high levels of organic residues management (Majule and Mwalyosi, 2003). Similarly, based on the same study, most areas are very low in nitrogen contents but contain a significant amount of available phosphorus ranging from 17 to 62 mgP per kg soil suggesting that P is not a limiting factor.

Table 1. Ranking of vinyungu farming problems in different agro ecological zones

Zone	Village	Major problems by respondents (%) *Low fertility*	*Water scarcity*	*Pest & diseases*
3	Mlafu	21	42	37
	Itungi	56	25	19
	Average	***38.5***	***33.5***	***23***
8	Mtitu	54	15	31
	Lukani	63	08	29
	Lulanzi	39	31	30
	Average	***52***	***18***	***30***
14	Tanangozi	43	49	08
	Mgama	50	25	25
	Mbalamo	35	44	21
	Average	***42.7***	***39.3***	***18***
16	Ibangamoyo	45	28	27
	Weru	39	43	18
	Kibebe	52	22	26
	Average	***40.4***	***30.8***	***28.8***

Source: Survey data, 2002.

Water availability and quality

On average, water availability for irrigation was ranked next important problem after soil fertility (Table 1). However, the problem was least important in Zone 8 which was blessed with relatively many streams. As pointed out in Section 4.1.4, the major sources of water for irrigation in the study area are rivers, shallow wells and springs. In most cases, water diverted from a river into a farm for irrigation has been reported to be less polluted, but got progressively so as it passed through farm plots (Majule and Mwalyosi, 2003). This therefore suggests poor agricultural practices including an excessive use of agrochemicals are the main cause of water pollution in the basin.

Crop diseases and pests

Overall, pests and diseases ranked third as a problem associated with *vinyungu* farming in the study area, after loss of soil fertility and water unavailability. However, the problem was relatively more serious in Zone 8 and 16 and least in Zone 14 probably due favourable environmental conditions for a disease to occur (favourable moisture and temperature) or

due to the development of resistance pathogen strains due to excessive use of pesticides and insecticides. Comparison among villages showed that the problem of pests and diseases was most severe in Ilula-Itunda Village.

Vinyungu farming and crop yields

Crop yield based on PRA and household interviews

General household data on the productivity of *vinyungu* in the study area is summarized in Table 2. The yield figures are largely snap shot estimates from previous years. The production costs are also estimates based on the following: (a) general field operation costs including land preparation, planting, weeding, irrigation; and harvesting; (b) cost of fertilizers, such as CAN, TSP, UREA, SA and NPK and; (c) cost of pesticides, such as Cocide, Dithane 45, Actelic super, Celeclone, sulphur and Bravo.

Table 2: Average profitability per year in the study area

Zone	Mixture of Crops grown per zone	Cost /acre (Tshs)	Income (Tshs)	Profit/acre (Tshs)
Zone 3	Maize, tomato, beans, vegetables, green peas	60	243.3	191.4
Zone 8	Maize, beans, Green peas, Tomato, vegetables	62.2	545.7	483.5
Zone 14	Maize, beans, Green, peas, Tomato, vegetables	104.5	439.1	334.6
Zone 16	Maize, beans, Green peas, Tomato, vegetables	94.4	540.4	446.0
General Mean		*78.3*	*442.1*	*363.9*

Source: Field data, 2002.

Generally, a mixture of crops and vegetables is produced in all agro ecological zones found in the study area (Table 2). This crop diversification provides risk assurance against crop failure. The productivity of *vinyungu* in the study area is dependent on the agro-ecological characteristics, distance to market centre (urban areas) and communication system. Thus, productivity of *vinyungu* is relatively high in areas close to marketing centres and near the main road to urban areas (Zone 8 and 16). Also, profit margins are well above the poverty level (> US $ 250 per annum) in Zones 8, 14 and 16. Low productivity in zone 3 is probably due to limited land available for *vinyungu* farming as the valleys become relatively narrow in this Zone and also due large dependence on upland farming. Poor communication network and inaccessibility to market centre is another probable reason.

The productivity of vinyungu in zone 3 tends vary due to various factors. Based on household survey (Figure 5a), more income is being generated in Itungi village compared to Mlafu village. Mlafu is located in the far upper part of the Rufiji basin as compared to Itungi which is a bit lower and very close to the main road to urban areas. Also, the rate of adopting different farming technologies is relatively high at Itungi compared to Mlafu village. Field observation revealed existence of wider valley bottoms or wetlands in Itungi. This allows extensive cultivation and sufficient utilization of water resource. An assessment made to ascertain the contribution of individual crops to the total income (Table 3a), revealed that in Zone 3, the main source of income is tomato farming particularly in Itungi village and this contributes

47.9% to the total income. The next major important is the sale of fresh maize "gobo". On the other hand, the production of beans and maize are rather important in Mlafu village. These crops contributes 39 and 33.1% respectively and they are grown in relatively dry areas (uplands) requiring minimum irrigation water. Obviously, commercial farming in Mlafu Village is not significant due to poor communication and distance from crop market centres. This clearly demonstrates the role of vinyungu production under different agro- ecological zones. Crop productivity data in both villages are in broad agreement with data based on individual farmers' assessment (Majule and Mwalyosi, 2003). However, it is notable that tomato farming alone cannot generate much income as compared to incomes generated from mixed cropping as indicated in appendix in Table 1a).

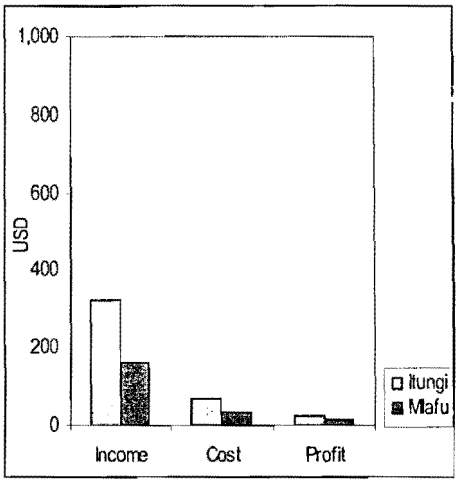

Figure 5a. Agro ecological zone 3

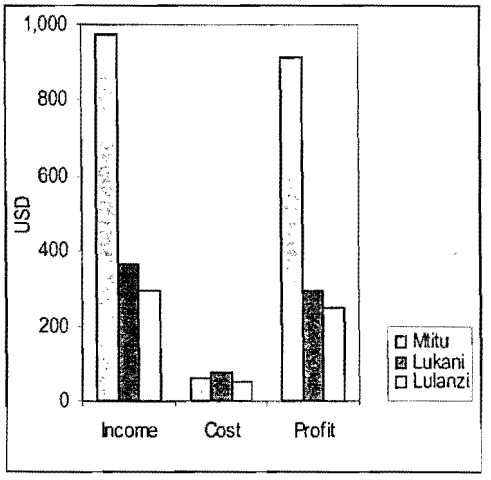

Figure 5b. Agro ecological zone 8

Major crops grown in Zone 8 include maize, beans, green peas, different kinds of vegetables and tomatoes (Table 2). The contribution of each of the crops to the total income is the highest in Mtitu village followed by Lukani village (Figure 5b). Reasons for the variations on yields are a function of both biophysical and social infrastructure of a village. For example, Mtitu village has well-established road network, allowing for easy transportation of agricultural commodities and inputs. The area also is characterised by having wider valleys and enough water, which are both important for crop production. It is also clearly indicated that in Table 3b that tomato production is can contribute significantly to the total income in Mtitu and Lulanzi villages. The results to a large extent indicate that the traditional irrigation being practice in Rufiji basin can significantly contributes to the livelihood of the people based on income generated and food crops consumed.

Table 3a. Contribution of different crops (%) to the total income in zone 3

Crop type	Itungi	Mlafu	
Grain maize	12.4	33.1	
Fresh maize (*Gobo*)	15.0	-	
Dry beans	9.0	39.0	
Green peas	5.70	-	
Tomatoes	47.9	12	
Green vegetables	10.0	15.9	
Total	100	100	

Table 3b. Contribution of different crops to the total income in zone 8

Crop type	Mtitu	Lukani	Lulanzi
Grain maize	11.1	16.7	18.2
Fresh maize (*Gobo*)	7.2	3.6	24.7
Dry beans	15.1	26.9	15.2
Green peas	11.9	30.6	30.6
Tomatoes	54.7	20.1	38.5
Green vegetables	-	2.1	3.4
Total	100	100	100

Different crops grown in Zone 14 are also listed in Table 2. Maximum income based on different crops grown is attained in Tanangozi followed by Mbalano and finally Kitwuli village (Figure 5c). It was also demonstrated that tomato production alone contributes significantly to the total income generated in all villages being the highest contributor in Mbalamo and Kitwuli (Table 3c). However, likewise in other Zones, higher profits from *vinyungu* farming are mainly dependent upon multiple cropping. The impact of closeness to market centres and reliability of transportation system is also manifested by high productivity of vinyungu in Tanangozi Village. Low productivity of *vinyungu* due to poor land availability is also demonstrated by Kitwuli village (Figure 5c)

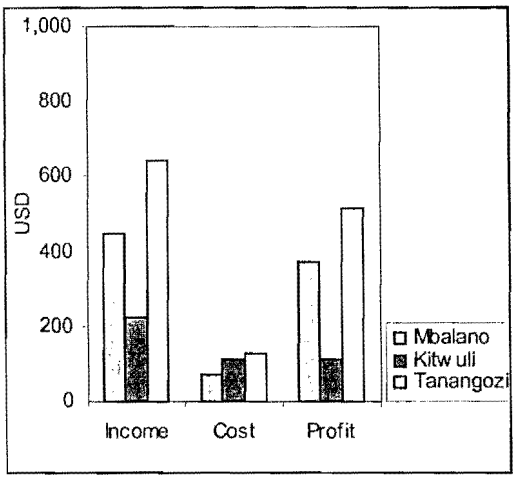

Figure 5c. Agro ecological zone 14

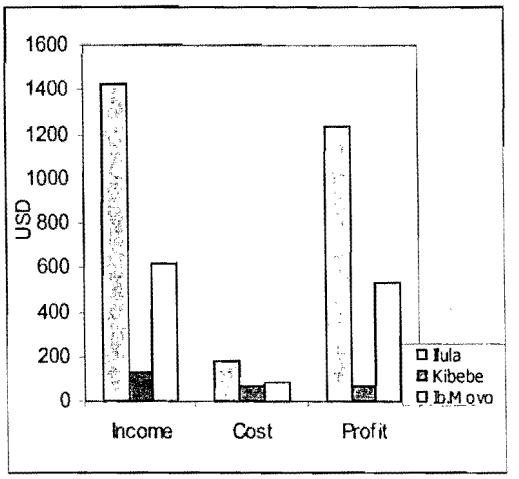

Figure 5d. Agro ecological zone 16

In Zone 16, net profits from vinyungu farming ranged from Tshs 64,775 at Kibebe to Tshs 1,240,818 at Ilula (Figure 5d). The values are within the range of average profitability data based on household survey (Table 2). At Ibangamoyo village the profit was Tshs 517,721. These high profits accrued mainly from the sale of fresh maize "gobo" in Ilula and tomato in Ibangamoyo Villages (Table 3d). Broadly, and likewise in other zones, mixed or sequential cropping results into high profits. Other reasons for the high productivity of vinyungu at Ilula and Ibangamoyo includes location of areas being on the wide little Ruaha River floodplain, which enable farmers to control and manage irrigation water, dominance of fertile clayey black *vertisols* (Majule and Mwalyosi, 2003) and both areas being strategically located closer to Iringa town and have better transport infrastructure and marketing opportunities, including access to Morogoro and Dar es Salaam markets.

Table 3c. Contribution of different crops to the total income in zone 14

Crop type	Mbalamo	Kitwuli	Tanangozi
Grain maize	27.3	17.5	6.1
Fresh maize (*Gobo*)	-	-	18.6
Dry beans	2.9	7.4	5.0
Green peas	22.3	13.8	14.2
Tomatoes	47.5	47.8	30.9
Green vegetables	-	13.5	25.2
Total	100	100	100

Table 3d. Contribution of different crops to the total income in zone 16

Crop type	Ilula	Kibebe	Ibangamoyo
Grain maize	5.7	19.1	13.6
Fresh maize (*Gobo*)	49.9	-	19.4
Dry beans	8.0	15.7	10.2
Green peas	-	-	-
Tomatoes	14.1	26.7	45.4
Green vegetables	22.3	38.5	11.4
Total	100	100	100

Generally, poverty is widespread in Tanzania. Since most rural people (estimated at over 80%) depend on agriculture for their livelihood (URT, 1997), it is apparent that to some degree poverty can be alleviated through *vinyungu* farming. It is argued that households earning less that US $ 250 per year are below the poverty line (URT, 2000). This study revealed that profits from vinyungu farming contribute significantly to poverty alleviation when mixed farming is adopted. The production of a single crop for example tomato alone is not advantageous in many zones. This observation is in broad agreement with findings reported by Mtatifikolo and Comoro (1999; Majule and Mwalyosi, 2003).

CONCLUSIONS AND RECOMMENDATIONS

The study has demonstrated that *Vinyungu* farming has been practiced for many decades, and has thus become almost a cultural practice. It has also been shown that the livelihood and income of many people in the two districts is to a large degree dependent on *vinyungu* farming. Further, it has been clearly shown that *Vinyungu* farming is particularly profitable where mixed or sequential cropping is practiced. It is notable that *vinyungu* farming allows for double cropping due to moisture availability during the dry season. Thus, *vinyungu* farming is important and contributes significantly to poverty alleviation in the study, and needs to be sustained. However, authors would like to recommend that IWRM approach be adopted in the basin. This will ensure a balance between water for livelihood and water for various resources.

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