

# Soil and Water Conservation in Semi-Arid Areas of Tanzania: National policies and local practices

Hatibu, N<sup>1\*</sup>, E. A. Lazaro<sup>2</sup>, H. F. Mahoo<sup>1</sup>, F. B. Rwehumbiza<sup>3</sup> and A. M. Bakari<sup>1</sup>

<sup>1</sup>Department of Agricultural Engineering and Land Planning, Sokoine University of Agriculture, Tanzania.

<sup>2</sup>Department of Agricultural Economics and Agribusiness, Sokoine University of Agriculture, Tanzania

<sup>3</sup>Department of Soil Science, Sokoine University of Agriculture, Tanzania.

## Abstract

*On the basis of agricultural potential, it is estimated that more than 50% of the land in Tanzania is semi-arid or arid due to three main factors; namely: low amount of rainfall, high evapotranspiration rates and erratic temporal and spatial distribution of rainfall. The objective of this paper is to assess the extent to which different macro policies relevant to soil and water conservation relate to the local realities in semi-arid areas. A historical analysis of the relevant policies, strategies and programmes was conducted and supplemented with case studies conducted in three districts, namely Dodoma, Same and Shinyanga. The findings from the analysis of trends show that adoption of soil and water conservation practices is affected by many factors but with two being critical; namely: (i) rules and regulations and their enforcement; and (ii) benefits to the individual. The results further show that there has been a gap between the emphasis given in macro-policies, strategies and programmes, on one hand and what is really practised by farmers in semi-arid areas. For example, while policies, strategies and programmes have put more emphasis on drought-resistant crops and erosion control, farmers have directed their efforts to the effective management of rainwater for the production of high water-demanding but high-value crops such as rice and vegetables. It is proposed that sustainable adoption of soil and water conservation practices in semi-arid areas of Tanzania requires policies and strategies that: (i) ensure strict but fair customs, rules and by-laws; (ii) lead to appreciable direct tangible benefits to the individual; and (iii) emphasise the management and conservation of the scarce rainwater. The paper concludes that there is an urgent need to re-orient Soil and Water Conservation strategies and programmes pursued by government in semi-arid areas, so as to focus less on drought-resistant crops and tree-planting and more on soil-water management practices such as rainwater harvesting.*

**Keywords:** Policy analysis, soil and water conservation, rainwater, environmental policies

## Introduction

On the basis of agricultural potential, it is estimated that more than 50% of the land in Tanzania is semi-arid or arid (LRDC, 1987). The semi-aridity is caused by three main factors; namely:

- Low amount of rainfall - only about 22% of the land in Tanzania receive 570 mm or

more of rainfall in 9 years out of 10 (Nieuwolt, 1973).

- High evapotranspiration rates - nearly throughout the country, potential evapotranspiration exceeds rainfall during more than nine months of the year (Nieuwolt, 1973).
- Erratic temporal and spatial distribution of rainfall - often long dry spells occur dur-

\* Corresponding author

ing the growing season to the extent that crop and pasture production become poor even when seasonal rainfall amount is high.

The primary problem facing farmers in the semi-arid areas is therefore, shortage of soil-water available to plants. This is made worse by the secondary constraints of low level of plant available nutrients (Steiner, 1996). As a consequence, the semi-arid areas have an inherently low and unreliable crop and livestock production. For example, maize yields in Dodoma are only 800 kg ha<sup>-1</sup> as compared to national average of 1400 kg ha<sup>-1</sup> (MoAC, 1998). The average live weight of cattle in Shinyanga is only 200-250 kg (Hatibu and Mtenga, 1996).

Sustainable development of agriculture in semi-arid Tanzania is very much dependent on effective utilization of the scarce rainwater. This requires methods for improving soil-moisture availability for crop and pasture as well as improved practices to make effective use of the soil-water. However, the conventional approach to soil and water conservation has focused more on the control of soil loss caused by erosion rather than the loss of water. Often rainwater was viewed as the enemy, hence cut-off drains were used to lead the rainwater away from crop fields (Hudson, 1987).

Historically, soil and water conservation in Tanzania has been guided by four major national policies. These are Land, Agriculture and Livestock, Forestry and Water policies. Recently, the National Environmental Policy has also become an important framework under which soil and water conservation is planned and implemented (VPO, 1997). Other policies that have affected SWC in the country include economic and administrative policies.

The objective of this paper is to assess the extent to which the objectives of different national policies relate to the local realities in semi-arid areas with regard to SWC. The specific objectives are to:

- Examine the historical trends in the relevant national policies and their effect on

implementation of SWC by farmers in semi-arid areas.

- Identify SWC technologies practiced by farmers in the semi-arid areas and assess relationships with policies, strategies and programmes of the government.
- Highlight the necessary adjustments in the focus of macro-policies to enhance the implementation of SWC measures in the semi-arid areas of Tanzania.

## Methodology

### Assessment of Policies and Strategies

This was done through a review of literature and policy documents especially in relation to context and trends in policies on land, agriculture, forestry and water. Policy documents are not generally available in the public domain. To obtain them it was therefore necessary to visit relevant Ministries and offices to obtain copies. Important policy documents, dating back to 1950s were obtained and studied.

### Case Studies

Three case studies were used to assess the relationship between macro-policies and actual soil and water conservation practices in specific locations in the semi-arid areas. The case studies were undertaken in three different districts; namely Dodoma (1997), Same (1999) and Shinyanga (1996). The studies were conducted in the villages of Bahi Sokoni and Uhelela in Dodoma, Hedaru and Mgwasi in Same and Bulambila in Shinyanga. Both qualitative and quantitative data were obtained. Qualitative data were captured using two approaches:

- (i) Informal discussions with villagers at general meetings which were organized for either the whole village (Shinyanga) or each sub-village (Dodoma and Same).
- (ii) Focus group interviews (Chambers *et al.*, 1989) with groups such as:
  - Village leaders,

- Primary school teachers,
- Religious groups,
- Residents of different sub-villages, and
- Farmers on given biophysical zones, e.g. those on very steep slopes vs. those on low and flat lands.

Key informants were selected from each category to form the focus group. In few cases (e.g. primary school teachers) the focus group involved every member. Efforts were made to ensure an adequate representation of women, the elderly and the youth. An assessment of the historical development of SWC in relation to policies was undertaken in focus group discussions. The opinion of the farmers regarding the expansion of a given SWC practice was ranked on a scale of 0 to 4. A score of 0 means that the practice has been entirely abandoned. A score of 1 during a given period means that the farmers were of the opinion that the practice was just introduced during that period or experienced very little expansion. A score of 4 meant that the practice expanded rapidly during that period. On the other hand, if the practice was considered to have shrunk during the period it was given a score of -1 to -4. Where -4 meant rapid shrinking or even disappearance. This assessment was made using four questions, namely:

- Did the size of land covered by this practice expand rapidly, stay the same or shrink during the period,
- Did the number of households practising or benefiting from this practice shrink or expand,
- Did the benefits accruing from this practice increase or go down during the period, and
- For a supplementary irrigation system, how well did it meet the demand.

A questionnaire survey was also used in all the three case studies for the purpose of collecting quantitative data. In all cases, the respondents were selected from each sub-village in proportion to the number of households. The sub-village leaders were requested to provide a list of names of the heads of household in-groups

of men and women and also divided into old, middle and young age groups. From these lists, the respondents were picked randomly to ensure a mix of gender and age groups of respondents. The collected information was analyzed using the Excel Spreadsheet programme and the SPSS programme to produce a descriptive, frequency and cross-tabulation analysis (Carnea, 1985).

## Findings

### Historical trends of soil and water conservation in Tanzania

The policies affecting soil and water conservation in Tanzania in general and in semi-arid areas in particular have passed through three main phases. These are:

- Colonial and post-Independence (1906–1967).
- Post Arusha Declaration (1967–1985).
- Liberalization (1985 to date).

#### Colonial and post-Independence period

The agricultural policy during the colonial and post-independence periods focused on cash crops and plantation economy (Shivji, 1998). During the colonial period, cultivation of cash crops was enforced through the imposition of poll tax (Mshana, 1991). In order to get cash to pay poll tax, farmers were compelled to grow designated cash crops.

It was not until the early 1930s, when the colonial government started to think about conservation, especially erosion control in semi-arid areas. During the 1930s therefore, several anti-erosion rules were made and enforced by the then Native Authorities in the most threatened districts of the country. Initially the central government tried to promote these measures through demonstrations and education and, for sometime, encouraging results were observed in several districts for example Moshi (current Moshi, Hai and Rombo), Pare (current Mwanga and Same) and Mbulu Districts.

But due to slow progress in other districts especially those dominated by pastrolists in Central and Lake Zones, regulations were intensified. For example, in 1943, territorial regulations were made and enforced to try to prevent uncontrolled bush fires. The desire by the central government to undertake SWC directly led to the formation of the Soil Conservation Service in 1945. The work of the service was implemented in all parts of the country, mainly through eleven Land Usage Schemes between 1946 - 1958 (Kauzeni *et al.*, 1987).

However, due to the top-down approach adopted by the colonial government, anti-conservation was part of the campaigning platform for politicians fighting for independence. As a result, very little SWC was included in government policies and programmes pursued immediately after independence, as evidenced by the two major programmes implemented during the post-independence period. These were the First Five-year Plan and the Land Settlement Schemes. After independence the new government amended the socio-economic plan inherited from the colonial government, and called it "The Peoples Plan" (MoA, 1982). One aspect of the amendment was the relaxation of soil and water conservation rules. Therefore, by the time the first five-year development plan (1964-1968) was adopted, it contained no SWC plans (Kauzeni *et al.*, 1987).

### Post Arusha Declaration period

In 1967 the Arusha Declaration was made and introduced the policy of Socialism and Self-reliance (TANU, 1967). In relation to agriculture, the major thrust of the policy was collective production at village level for purposes of facilitating the delivery of modern techniques of production. The most dramatic consequences came from the concentration of people in small areas which led to deforestation, over-grazing and other elements of land degradation (Kikula *et al.*, 1999).

The Decentralization policy was introduced in 1972 in order to ensure that "the planning and

control of development in the country is exercised at the grass-root level..." (MoA, 1982). The main outcome of this policy was the establishment of district and regional offices of technical ministries such as Agriculture, Natural Resources, Lands, Health, Education, Works and Water. However, major co-ordination problems existed since each regional/district office continued to be supervised by the respective Ministry. There was no effective coordination of the technical departments and each continued to implement independent programmes designed by respective sectoral ministries. So, Lands, Agriculture, Water, Forestry and Works Departments implemented different elements of SWC independent of each other in the same area. This led to duplication of efforts and wastage of resources. Often activities of one department directly contradicted those of the others. For example, Works department would construct road drainage without any concern on the erosion that the concentrated water will cause down slope.

The decentralization process was probably the most contradictory process in the post Arusha Declaration development efforts. It was presented as a process of transferring decision-making powers from the central level to the local authorities. However, it involved the abolishment of democratically elected Local Governments and the very successful Cooperative Unions. These were replaced by "local authorities" which were appointed by the President in the form of Regional Commissioners, Regional Development Directors (RDDs), District Commissioners etc.

### Liberalization period

The political environment, under which the Government is implementing SWC, changed dramatically after 1985 following political and economic liberalization (Planning Commission, 1996 a). The restrictive state controls were relaxed gradually and in 1995, multi-party democracy was re-introduced. In relation to agri-

culture, policy instruments under liberalization have included the removal of controls and restrictions on:

- (i) markets and prices for agricultural inputs and outputs;
- (ii) ex ports and retention of income;
- (iii) the importation of inputs;
- (iv) exchange rates; and
- (v) investments and financial services.

## Policies and Strategies

### Land tenure

One of the most serious aspects of the land policies pursued since independence was the view that land had no value, except when developed. The term developed was never well defined, and for example the Land Acquisition Act, of 1967 (URT, 1967), restricted compensation of any land acquired by the President as elaborated in Box 1.

As a consequence of this Act, SWC works done on land were not valued and thus not compensated in case of land acquisition. This had more effect on areas where large-scale farms and other public projects were implemented. Recently, new land policy and laws have been enacted. These are the National Land Policy of 1995 (MLHUD, 1995) and Land Act of 1999 and Village Land Act No.5 of 1999 (URT, 1999). The policy emphasises the need for a clear land tenure system as an important factor ensuring both optimal and sustainable use of land. According to the land policy, all land in

Tanzania is public and vested in the President as a trustee on behalf of all citizens. Three categories of land are recognised in the policy these are General, Reserved and Village land. The most important aspects of the Act with effect on soil and water conservation are summarised in Table 1, and indicate a more favourable environment.

**Box 1: Article 12 of the Land Acquisition Act: No. 47 of 1967**

- (i) No compensation shall be awarded in respect of any land, which is vacant ground.
- (ii) Land shall not cease to be vacant ground for the purpose of this section by reason only of it:
  - (a) having been fenced or hedged; or
  - (b) having been levelled; or
  - (c) having been ploughed or cleared, or
  - (d) consisting of a cleared or partially cleared site of some former development.

(URT, 1967)

**Table 1: Aspects of the Land Act of 1999 expected to have effects on soil and water conservation**

POSITIVE EFFECTS		NEGATIVE EFFECTS	
(i)	The recognition that: the occupation of land shall be deemed to be property [4(6)]	(i)	The declaration that: all land in Tanzania shall continue to be public land [4(1)].
(ii)	Categorization as reserved: land parcel within a natural drainage system... from where water... originate [6(1)(b)]	(ii)	The provision that " A granted right of occupancy shall not confer on the holder any water rights... [22(2)]
(iii)	The requirement for payment of: full compensation for loss of any interests in land... [34(3)(iv)]	(iii)	Retention of the Land Acquisition Act of 1967
(iv)	Power to sell or lease a right of occupancy		
(v)	Power to create mortgage.		

## Agriculture and livestock

The development of Agricultural Policy in Tanzania started in the form of directives of the Ruling Party. The first of this kind was the *Siasa ni Kilimo* ("Politics is Agriculture") directive of 1972 (MoA, 1982). The directives recognised soil erosion as a major problem but focus was put on rehabilitating highly eroded areas such as Kondoa (Christiansson *et al.*; 1993). No mention was made of the causes of erosion and how to protect cultivated lands. This policy was followed-up by another directive called *Kilimo cha Umwagiliaji* ("Irrigated farming") of 1974 (MoA, 1982). This was prompted by the 1973/74 drought. The emphasis was put on small-scale traditional irrigation schemes.

The next directive was issued in 1975 in the form of *Kilimo cha Kufa na Kupona* ("Agriculture as a matter of life and death"). This was a programme instituted by the government in an attempt to achieve food self-sufficiency. This led to unplanned clearing of land for cultivation, especially near urban areas. The outstanding outcome of this programme was the rapid expansion of urban and peri-urban agriculture. It is estimated that more than 30% of urban population consider agriculture to be their main source of income (Planning Commission, 1996 b).

The first comprehensive agricultural policy was made in 1983 in two parts for crops and for livestock (MoA, 1983 (a) & (b)). The policy objectives did not contain any mention of land resources management and conservation. For example, the livestock policy document did not mention water at all. The policy was designed in a form of directives and contained too much detail on strategies and programmes. For example the agricultural policy stated that soil conservation will emphasize on:

- Tree planting on the principle of *kata mti, panda mitatu* i.e. "cut one tree, plant three".
- Protection of water sources by prohibiting cultivation near water sources.
- Control of erosion on steep land using terraces or tree planting.

Thus, there was an unnecessarily high level of prescription of solutions at policy level, based on an inadequate understanding of the underlying factors in different areas.

A new Agricultural and Livestock policy was made in 1997, and its goal is the improvement of the well-being of the people whose principal occupation and way of life is based on agriculture. The main strategy is commercialisation of agriculture. Nine specific objectives or strategies for pursuing this goal have been identified. One of the specific objectives is "to promote integrated and sustainable use and management of natural resources such as land, soil, water and vegetation", (MoAC, 1997).

The rainfed crops sub-sector is the largest and is estimated to account for 68% of the agricultural GDP (MoAC, 1997). Therefore, the goal and objectives of the policy will only be met by paying close attention to this sub-sector. Apparently management of rainwater for crop production is given very little mention in the strategy for rainfed crops. On the other hand, drought resistant crops are covered by six policy statements. Strategies for "soil conservation and land use planning have also been defined", but water is not mentioned in any of them. This is a serious weakness and contradiction in the policy since shortage of soil-moisture is the main constraint to crop production. However, the strategies for rangelands development given in the new agricultural policy, give some guidance on soil-water issues (Box 2).

### Box 2: Strategies in improving rangelands development:

- (i) *The Ministry in collaboration with Ministry of Water, donors, NGO and beneficiaries will facilitate and support development of low cost and sustainable rangelands water development and conservation of water catchment areas.*
- (ii) *The Ministry through extension services will advice and train traditional livestock keepers on water use management and maintenance.*
- (iii) *The Government will endeavour to promote integrated and sustainable use of rangelands resources such as land, soil, water and vegetation in order to conserve the environment.*

MoAC, 1997

## Forestry

A forestry policy existed since 1953 and was reviewed in 1963. The policy focused on the management of forestry and tree resources for purposes of sustainability and meeting the needs of society. The central objective of the policy was to preserve forests for public interest (Legislative Council of Tanganyika, 1953). A new policy was approved in 1998. The overall goal of the national forestry policy is to "enhance the contribution of the forestry sector to the sustainable development of Tanzania and the conservation and management of natural resources" (MTNR, 1998). Soil conservation is covered under policy statements for agroforestry but the role of trees in soil and water conservation are not mentioned in the proposed strategies.

## Water

The current water policy dates back to 1991 (MWEM, 1991). Rainfall is fully recognised in the policy as one of the existing water sources. The policy currently states that large quantities of rainwater are lost without being utilised and that emphasis will also be placed on rainwater harvesting through:

- *Construction of dams and charcos in drought-prone regions...*
- *Collection of water from roofs and storing in tanks...*

However, the reality as portrayed by the water management programmes pursued in the country shows that the policy has focused more on water supply for industrial and domestic needs. Very little efforts of the Ministry of Water have been directed to the development and management of water for agriculture and plant growth in general. A new water policy is currently being drafted.

## Approaches and Programmes

There are many government departments, institutions and programmes dealing with SWC (Box 3). Most of these government departments have pursued SWC through programmes and projects. These includes for example the

Soil Conservation and Agroforestry - Arusha (SCAPA), Hifadhi Mazingira (conserve the environment) - Iringa (HIMA), Hifadhi Ardhi Shinyanga (conserve soil in Shinyanga) (HASHI), Land Management Programme (LAMP), and Hifadhi Ardhi Dodoma (HADO) (Kerkhof, 1990). Most of the old projects were started under the Forestry Division. Several other government departments operate new projects.

### Box 3: Several government departments and agencies deal with environmental conservation issues

#### Vice President's Office

- Department of Environment
- National Environmental Management Council

#### Ministry of Agriculture

- Soil Conservation and Land Use Planning Unit
- National Soil Service
- Agroforestry Research Programme

#### Ministry of Lands

- Land Survey and Mapping Department
- Land Administration Department
- National Land Use Planning Commission

#### Ministry of Tourism and Natural Resource

- Forestry Division
- Wildlife Division

An evaluation of HADO undertaken in 1995 by the Ministry of Tourism and Natural Resources and Environment and Sida (MTNRE/Sida, 1995) provided examples of some interesting weaknesses of most of the SWC programmes at that time. These are reproduced here with some emphasis added by the authors.

- (i) The objective and strategies of HADO were oriented towards the land rather than the people in the project area.
- (ii) **The work** on croplands was focused on water runoff **disposal** and addressed the important rainwater productivity aspects only in marginal ways.
- (iii) Key **extension** messages were rather traditional such as improved seed, row planting. **Soil-water conservation** did not figure prominently among messages.

- (iv) Many of the gully reclamation structures have failed due to poor construction and/or maintenance and gully development could still be observed in many places.
- (v) To date, there has been very little follow-up to determine the survival rate of the thousands of seedlings distributed free to villages, schools, other institutions and individuals.
- (vi) The emphasis on the "fanya chini" contour ridging may reflect the limited understanding of soil conservation by the HADO staff, who all came from a traditional forestry background.
- (vii) In Dodoma Region, crop yields are reduced more by shortage of soil-moisture rather than by loss of soil. Hence, there should have been more emphasis within HADO on rainwater management within the croplands rather than erosion control.
- (viii) On-farm soil and water conservation measures promoted by the project over the last twenty years have done very little to increase land productivity within the crop lands.
- (ix) There is need for changing the strategy from a narrow focus on erosion control to broader "holistic" land husbandry approach.

These findings provide good lessons to be observed in future while planning and implementing water and soil conservation programmes.

#### Critical Issues: Farmers' point of view

This section presents some relevant results from a review of three case studies conducted in three districts at different times between 1996 - 1999. The nature of the studies is not similar as they were carried-out for different objectives. However, all three had one central theme - an assessment of the issues that promote the adoption of soil and water conservation by different farmers, in relation to prevailing policies, strategies and programmes.

These case studies are used to draw attention to important issues, which have affected adoption of SWC practices at village level in semi-arid areas.

#### Case study of Shinyanga

##### (a) Land tenure

Land use and land tenure is closely linked and depends on each other at village level. In Shinyanga, up to the villagisation programme of 1974, land in the villages was owned on the basis of inheritance of family land. Historically, villagers claimed a land parcel by clearing it of wood and forests and the claim was then passed down through generations. The right of ownership was guaranteed through customary rights and obligations recognised and respected by all village members.

This customary land ownership was however disturbed in the 1970s during the villagisation campaign, when the state re-allocated a good proportion of this land. In most cases, people residing and farming in *mbuga* areas were re-allocated to areas with sandy soils to establish residence and garden farms. Most of the *mbuga* land was then placed under the village government for communal use. This artificial set-up has now completely collapsed and the village governments have very little control over the *mbuga* soils. Most of the customary owners have re-claimed their *mbuga* lands and are now using them as distant fields (*mashamba ya mbugani*). These lands are most fertile because of annual flooding leading to high concentration of nutrients.

##### (b) Agriculture strategy and productivity

The official extension policy is to support drought resistant crops and cotton production in semi-arid areas such as Shinyanga (MoAC, 1997). However, production of rice is increasing at a very rapid rate (Meertens *et al.*, 1999; Kanyeka *et al.* 1994). The villagers indicated that the area under cotton cultivation has been decreasing year after year due to several reasons including unreliability of markets.

and low profitability due to low yields, high production costs and low prices of cotton. Land and/or efforts withdrawn from cotton are re-directed to paddy production. Paddy rice is a crop that has only been introduced recently and is mainly grown on lower spots where water accumulates during the rainy season. The hectareage allocated for paddy growing varies between less than tenth of a hectare to about one hectare. Rice is grown by many farmers for cash income, as a substitute for cotton.

Paddy rice is cultivated in excavated banded basins (EBB) which are constructed on relatively flat terrain. The basins are constructed by digging to a depth of about 0.2 m and the scooped soil is used to build a bund around the field perimeter to a height of about 0.3 m above the ground level. These basins are normally called *majaluba*. The *majaluba* are flooded by collecting and storing direct rain or runoff from nearby catchment areas.

Rice yields are only 3 t/ha compared to as high as 6 t/ha for irrigated rice production in Tanzania. The output of livestock is also very low. For example, milk production varies between 1.0-1.5 litres/cow/day while average live weight of beef cattle is only 200-250 kg/animal. The main problem is that pasture and water supply are in serious short-supply during the dry season.

### Case study of Dodoma

#### (a) Rainwater harvesting

The case study area of Bahi was found to have problems of soil-moisture availability related to wide temporal variations leading to periods of drought and flooding within the same cropping season, both with detrimental effects to crop performance and yield. However, there is adequate supply of run-off in the study area either from local catchments called *mabarangu* or flash floods in Bubu river and other streams.

Farmers at their own initiative have developed techniques for harvesting especially the run-off

from *mabarangu*, for paddy rice production. This has been developed gradually over a period of 50 years (Allnut, 1942). On top of this, five projects have been implemented in the study area since early 1970s to try to control and harness the flash floods of river Bubu through stream flow diversion. These projects were the Tanzania National Freedom from Hunger Campaign (TNEHC), Rift Valley Pilot Rice Project (RVPRP), Rift Valley Rice Project (RVRP), Smallholder Development Project for Marginal Areas (SDPMA) and Special Programme on Food Security (SPFS) (Hatibu *et al.*, 1997).

There are two main techniques of RWH for rice production in the study area. These are:

- Sheet/Rill Flow (SRF) run-off harvesting which is the 'indigenous' technique.
- Stream-Flow-Diversion (SFD) of the floodwater of river Bubu, and its utilisation for spate irrigation. This has been introduced and expanded through external intervention projects.

#### (b) Farming systems

Four farming systems were identified based on the combination of crop and livestock enterprises. These systems are Sorghum-Livestock-Millet (SLM), Sorghum-Livestock-Rice (SLR), and Sorghum-Rice (SR) and Rice (R). SLM and SLR are the 'old' systems and there is some kind of transition from livestock based to rice based (or 'new') systems. Rice production is replacing millet then livestock in the systems. RWH techniques are more developed in the Rice based systems while they are completely absent in the SLM.

The SFD is predominant in the R and SR systems while SRF is the 'traditional' technique and is the main technique in the SLR system. Farmers perceive the SRF to be more reliable. However, its expansion is limited by inadequate matching of good land for rice production with good areas for run-off generation (*mabarangu*). RWH opportunities in Bahi have led to a substantially increased the production of rice.

However, SFD with improved cultural practices produced 48% higher returns than SRF. Without improved practices, the returns were only 27% higher. This shows that RWH practices need to be complemented with other agronomic packages for maximum returns (Table 2).

In sorghum production, returns are relatively lower than those from rice. For example they are about 40% of those from rice under SRF or 29% of rice under SFD, without improved practices or 20% of the rice under SFD with improved practices (Table 3). This could be the reason why farmers do not use RWH techniques for sorghum production.

In relation to livestock production, RWH has

led to displacement of the grazing areas away from the bottom-lands which are good for rice cultivation. This has increased the problem of water shortage for livestock which now have to walk longer distances in search of water, during the dry season.

High variation of the price of rice due to poor marketing strategies is a major constraint facing farmers and sustainability of the rainwater conservation and management schemes. Under the current arrangements, shortage of cash flow forces farmers to sell their crops too early under supply-driven prices which are too low at harvest time or in years of good harvest (Figure 1).

**Table 2: Gross Margin Analysis for Rice Production in Bahi Sokoni and Uhelela Villages**

	SFD		SRF
	with max input	without inputs	Runoff (Mabarangu Fields)
Average yield (kg/ha <sup>-1</sup> )	5,200	3,680	
Average price (TAS/kg)	122.5	122.5	2,800
• Gross returns (TAS/ha)	<u>637,000</u>	<u>450,800</u>	<u>122.5</u> <u>343,000</u>
• Variable costs: (TAS/ha)			
- Land cleaning	6,000	6,000	
- Tillage	28,000	0	6,000
- Nursery preparation/planting	4,000	4,000	0
- Repair of bunds	10,000	10,000	3,000
- Puddling	32,000	32,000	0
- Transplanting	32,000	32,000	32,000
- Weeding	38,000	38,000	32,000
- Pesticide application	3,000	0	38,000
- Fertilizer application	26,000	0	0
- Weeding bunds/canals	12,000	0	0
- Harvesting (TAS 1000/bag)	65,000	12,000	0
• Total variable cost	<u>256,000</u>	<u>46,000</u>	<u>35,000</u>
• Gross Margin	<u>381,000</u>	<u>270,800</u>	<u>146,000</u> <u>197,000</u>

**Table 3: Gross margin analysis for Sorghum and millet in Bahi Sokoni and Uhelela Villages**

Parameter	Unit	Sorghum		Millet
Average yield	Bags/ha	20		5
Average prices	kg/ha <sup>-1</sup>	1800		450
Gross returns	TAS/bag	5800		5.800
Total variable costs	TAS/kg	64		64
Gross Margin	TAS	116,000		29,000
	TAS	37,500		37,500
	TAS/ha	78,500		(8,500)

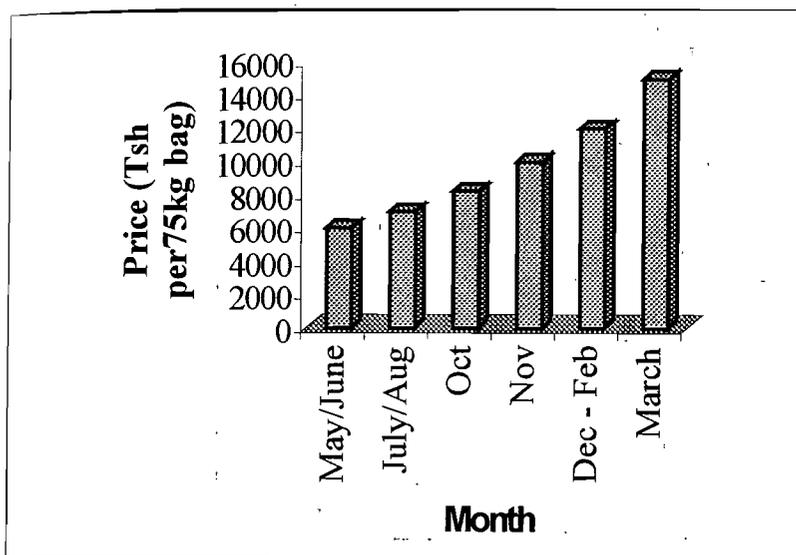


Figure 1: Temporal variation farm gate price for rice in Bahi Sokoni in 1996/97

### Case study of Same

#### (a) History of SWC

Most of the literature on the history of SWC in Tanzania presents the view that colonial SWC efforts were not successful (Kauzeni *et al.*, 1987 and IFAD, 1992). The reasons given for this "failure" are that the SWC programmes often:

- (i) relied on forced penalties, and
- (ii) ignored the indigenous SWC practices.

The findings of the case study of the two villages in Same District reveal three important

aspects, which are contrary to this conventional wisdom. These are:

- (i) Colonial SWC efforts were not a failure in the study area. Farmers indicated that each indigenous SWC practice was actually expanded (in terms of number of practices and land area covered, during the colonial period (Figure 2).
- (ii) The penalties during the colonial time are considered to have been positive in the promotion and adoption of SWC.
- (iii) The colonial SWC programmes did not ignore indigenous practices.

Historical Periods	SWC Practices	Shrinking				Expanding			
		-4	-3	-2	-1	1	2	3	4
Pre-colonial	Live barriers								
	Supplementary irrigation								
	Deep tillage								
	Basins								
	Tree planting								
	Stone bunds								
	Cut - off drains								
	Terraces								
	Trash lines								
	Reserved forests and bushes for traditional rituals								
	Allocation of grazing land (traditional land use planing)								
	Watershed protection from cultivation and grazing								
	Hill top protection from grazing or cultivation								
Colonial	Live barriers								
	Supplementary irrigation								
	Deep tillage								
	Basins								
	Tree planting								
	Stone bunds								
	Cut - off drains								
	Terraces								
	Trash lines								
	Reserved forests and bushes for traditional rituals								
	Allocation of grazing land (traditional land use planing)								
	Watershed protection from cultivation and grazing								
	Hill top protection from grazing or cultivation								
Post-independence	Live barriers								
	Supplementary irrigation								
	Deep tillage								
	Basins								
	Tree planting								
	Stone bunds								
	Cut - off drains								
	Terraces								
	Trash lines								
	Reserved forests and bushes for traditional rituals								
	Allocation of grazing land (traditional land use planing)								
	Watershed protection from cultivation and grazing								
	Hill top protection from grazing or cultivation								
Post Arusha Declaration	Live barriers								
	Supplementary irrigation								
	Deep tillage								
	Basins								
	Tree planting								
	Stone bunds								
	Cut - off drains								
	Terraces								
	Trash lines								
	Reserved forests and bushes for traditional rituals								
	Allocation of grazing land (traditional land use planing)								
	Watershed protection from cultivation and grazing								
	Hill top protection from grazing or cultivation								
Liberalization	Live barriers								
	Supplementary irrigation								
	Deep tillage								
	Basins								
	Tree planting								
	Stone bunds								
	Cut - off drains								
	Terraces								
	Trash lines								
	Reserved forests and bushes for traditional rituals								
	Allocation of grazing land (traditional land use planing)								
	Watershed protection from cultivation and grazing								
	Hill top protection from grazing or cultivation								

**Figure 2: Historical Development of SWC in the villages of Hedaru and Mgwasi, Same District**

According to the villagers, SWC practices were generally better in the pre-colonial, colonial and post independence periods than what it is now. At the same time, villagers are of the opinion that many SWC practices either died out or were practised at a reduced level during the post Arusha Declaration period. The current period of Liberalization was shown to be worse in terms of SWC. The information reveals that only two SWC practices are experiencing expansion during this period. These are the stone bunding and tree planting. This trend can be explained as follows:

- (i) The expansion of the stone-bunded fields is a direct result of liberalization of markets, which has increased the production of vegetables for cash. Because of high slopes of the terrain, it is necessary to build stone bunds for effective management of irrigation water in vegetables fields.
- (ii) Tree planting is expanding due to the on going campaigns and programmes and the rapid establishment of tree nurseries, which has accompanied these campaigns.

Villagers presented a view that all the four practices, which depended on enforcement of by-laws, have disappeared during the liberalisation period. These are:

- Micro-forestry,
- Demarcation of grazing lands,
- Protection of water sources against cultivation and grazing, and
- Protection of hill tops and steep slopes.

They attributed this to the ineffectiveness of government institutions due to corruption, whereby the officials charged with enforcing by-laws do not do so. For example, it was pointed out that officials would take bribes to allow grazing in prohibited areas or cutting trees in reserve forests.

(b) Important factors in SWC

Issues identified by the farmers to be important factors in SWC are: customs and regulations and their enforcement, knowledge, extension and services, perception of benefits to the individual, and external interventions and assistance (Table 4).

Table 4a: Important factors in SWC identified by farmers: Level of SWC in relation to type of assistance

Type of assistance	Level of SWC	Hedaru		Mgwasi		Total sample	
		NR	%	NR	%	NR	%
Training	Non of SWC method	3	12	5	25	8	18
	One or two methods	21	84	15	75	36	80
	More than two methods	1	4	0	0	1	2
	Total	25	100	20	100	45	100
Extension	Non of SWC method	1	3	3	18	4	8
	One or two methods	28	91	12	70	40	84
	More than two methods	2	6	2	12	4	8
	Total	31	100	17	100	48	100
Excursions	Non of SWC method	0	0	1	20	1	7
	One or two methods	9	100	2	40	11	79
	More than two methods	0	0	2	40	2	14
	Total	9	100	5	100	14	100
	Non of SWC method	1	50	3	33	4	36
	One or two methods	1	50	4	45	5	46
	More than two methods	0	0	2	22	2	18
	Total	2	100	9	100	11	100

Table 4b: Farmers perception on Government responsibility on SWC

	Percentage of Respondents						
	NR	Hedaru		Mgwasi		Total Sample	
			%	NR	%	NR	%
Enactment of laws and Regulations	21	28	7	15	28	23	
Supply of input and materials	35	47	38	79	73	60	
Plans and education	16	22	2	4	18	15	
No responsibility	2	3	1	2	3	2	
Total	74	100	48	100	122	100	

Table 4c: Farmers perception of role of NGOs and private organizations on SWC

Responsibility	Percentage of Respondents					
	Hedaru		Mgwasi		Total sample	
	NR	%	NR	%	NR	%
Supply inputs	17	29	4	12	21	23
Plans and education	42	71	30	88	72	77
Total	59	100	34	100	93	100

NR is Number of Respondent

## (i) Customs and regulations

Results from focus group discussions were unanimous in identifying strict customs and regulations and their uncompromising enforcement as the most important factors in promoting SWC. This was a characteristic of the period, up to 1967, under which SWC is considered to have prospered (Figure 2).

## (ii) Knowledge, extension and services

Availability of knowledge through effective extension services was cited as another important factor affecting the level of SWC practices, especially on farmers' fields. Further, farmers said that provision of services such as input supplies was important. Again it was shown by results of focus group discussions that these services were better during the colonial and post-independence period as compared to the post-Arusha Declaration period and the liberalisation period. In relation to SWC, poor supply of inputs and provision of extension services were identified as the most negative aspects of the post Arusha Declaration and liberalisation period.

## (iii) Benefits to the individual

The main reason given for the drastic slow down in SWC during the post Arusha Declaration period, was the lack of clear benefits to the individual. The most significant element of this aspect was the collapse of crop markets, with farmers getting very low income from selling crops in a controlled market. During the other periods, farmers said that they invested in SWC in-order to raise yields for three major reasons:

- They needed high cash income to pay poll-taxes and to purchase social services. Both of these obligations were removed during the post-Arusha Declaration period;
- The markets for selling their crops were available and competitive;

- They could obtain good prices for their produce.

Therefore, individual benefits were identified as the key factor that encouraged farmers to want to produce more from their land. Since SWC contributes to meeting of this need, it was practised more when this need was at its highest, i.e. during the colonial period.

## (iv) Nature of national policies

Farmers identified two categories of national policies that have affected SWC. These are:

- Economic and administrative policies, and
- Environmental policies, which include Land, Agriculture and Livestock, and Forestry.

When asked to rank these policies according to which they perceived to have had the most effect on them with regard to SWC, the farmers agreed on the following ranking:

- Land policies, regulations and tenure,
- Agricultural and livestock,
- Economic and administrative policies, and
- Forestry policy.

Farmers said that they feel secure on the land that they cultivate and thus land tenure policy has contributed more positively on SWC compared to the other policies. The nature of agriculture and livestock policy was related to SWC through some of the strategies such as promotion of certain crop (esp. maize) varieties and control of livestock diseases. Farmers were able to identify how central themes of economic and administrative policies affected SWC. An example of this is given in Table 5, which shows farmers' perception of the effect of components of the economic policies on SWC.

**Table 5: Farmers' perception of the effect of elements of economic and administrative policies on SWC adoption**

Elements with positive effects on SWC	Elements with negative effects on SWC
<ul style="list-style-type: none"> <li>• Liberalised input and output markets;</li> <li>• Paying for services e.g. education and health;</li> <li>• Activities of NGOs at village level;</li> <li>• Credit availability through farmers' groups.</li> </ul>	<ul style="list-style-type: none"> <li>• Fluctuation in output prices;</li> <li>• Poor availability and low quality of inputs;</li> <li>• Shortage of credit facilities;</li> <li>• Inflation;</li> <li>• Shortage of extension workers;</li> <li>• Frequent changes in administrative set-up;</li> <li>• Poor implementation of policies;</li> <li>• Laxity in enforcement of by-laws;</li> <li>• Misuse of tax revenue.</li> </ul>

## Discussion and Conclusions

The assessment of the socio-economic trends shows that soil and water conservation as practised at farmers' level was significantly different in the three major socio-economic periods through which Tanzania has passed. The analysis of trends and the results of the Same case study show that, adoption of SWC practices is affected by many factors but two are most important, these are:

- Rules and regulations and their enforcement.
- Benefits to the individual.

On the basis of these two factors, the three socio-economic periods were very different as summarised in Table 6. Thus, the pre-1967 period comes out as the period where the adoption and implementation of SWC was much better. This does not mean to say that the force used during the colonial period to enforce SWC should be re-introduced, but rather that strict but fair customs, rule and by-laws are necessary. The success during the pre-1967

**Table 6: Comparison of the three socio-economic periods in relation to the implication for SWC**

Period	Pre-1967	Post Arusha Declaration	Liberalization
Rules and Regulation and their Enforcement	<ul style="list-style-type: none"> <li>• Strict customs, rules and by-laws</li> <li>• Non compromising enforcement</li> </ul>	<ul style="list-style-type: none"> <li>• Liberal rules and by-laws</li> <li>• Neglect of local institutions</li> <li>• Lax enforcement</li> </ul>	<ul style="list-style-type: none"> <li>• Liberal rules and by-laws</li> <li>• Neglect of local institutions</li> <li>• Lax enforcement</li> </ul>
Direct benefits to the individual	<ul style="list-style-type: none"> <li>• People needed cash to purchase nearly all services and to pay poll tax</li> <li>• High benefits perceived due to existence of markets</li> <li>• Individual properties were valued</li> </ul>	<ul style="list-style-type: none"> <li>• Individual benefits and wealth were discouraged</li> <li>• Lower need for cash as poll tax was abolished and service were "free"</li> <li>• Poor marketing system</li> </ul>	<ul style="list-style-type: none"> <li>• Individual benefits and wealth are encouraged</li> <li>• Poll tax and payment of services have been re-introduced</li> <li>• Markets for crops have been liberalised and are better</li> </ul>
Implication for SWC	Relatively highest success in SWC adoption and implementation	Relatively the lowest success in SWC adoption and implementation	High success in approaches emphasising water availability for production of cash crops such as rice and vegetables

period was relatively high because both underlying main factors were positive to SWC. During the post-Arusha Declaration period, both these factors were negative to the promotion of SWC. Under the current liberalisation period, only one (benefit to the individual) of the factors is positive. Thus, during this period, farmers are implementing SWC in a selective manner. They focus more on those approaches, which lead to improved availability of water for the production of high-valued and marketable crops such as rice and vegetables. A good example is given in the Shinyanga case study, where liberalisation has led to a shift from cotton production to accelerated practice of rainwater harvesting for paddy rice production.

Results from this study show that there has been a gap between the emphasis given in national policies, strategies and the programmes and what is really practiced by farmers in semi-arid areas. It is shown that while policies, strategies and programmes have for example, focused on drought-resistant crops and erosion control, farmers have directed their efforts to the effective management of rainwater for the production of high water-demanding but high-value crops such as rice and vegetables. Previous studies have already shown that in semi-arid areas, conservation of rainwater is more important (Stocking, 1988). The case studies, particularly the Dodoma one, provide evidence that farmers also find this to be the case. The picture that emerges shows that farmers in semi-arid areas have been searching for ways of enhancing the productivity of rainwater. As a consequence farmers have adapted farming systems which provide these benefits, often in opposite direction to the policy. The concentration of water for production of paddy rice in the semi-arid areas while the policy is advocating drought-resistant crops is a good example of this trend. This gap has not been reconciled, even in the new policies, which were enacted in the late 1990s. For example, official

statistics show that rice production in semi-arid areas account for 45% of total production in the country (MoAC, 1998). There are indications that the actual proportion may even be higher than what the official figures show (Meertens and Lupeja, 1996). At the same time, strategies for managing rainwater for crop production in semi-arid areas are conspicuously missing from government policy documents.

Another problem highlighted in this paper is the poor co-ordination of the programmes pursued under different sectoral policies, which are key to SWC; namely land, agricultural, forestry and water. The major SWC programmes have, for example, been designed and implemented under the forestry policy without adequate attention to the needs of agriculture. The consequences of this failure in co-ordination are elaborated by the shortcomings of HADO in relation to water conservation for agricultural purposes.

In conclusion, it has been shown that:

- (i) Sustainable adoption of soil and water conservation practices require policies and strategies which ensure strict but fair customs, rules and by-laws on SWC, and direct tangible benefits to the individual.
- (ii) Farmers in the semi-arid areas prefer SWC technologies, which emphasise the management and conservation of the scarce rainwater. There is a gap between farmers' practices and policy objectives, strategies and programmes.
- (iii) There is an urgent need to re-orient SWC strategies pursued by government in semi-arid areas, so as to focus less on drought-resistant crops and tree-planting and more on practices such as rainwater harvesting, which increase the amount of soil-water available to plants.

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