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A Spatio-Institutional Approach to Planning Soil and Water Conservation for Sustainable Land Productivity in Southern African Countries

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Abstract

At a global level agricultural production is growing though at a slow rate whereas the human population is increasing exponentially. The consequence is massive soil and water degradation combined with dramatic impoverishment of the quality of life. Low agricultural production caused mainly by soil degradation and inherent fragile characteristics of the land complicates the problems of increased populations in sub-Saharan Africa. Various research scientists and development planners have proposed different approaches to these problems. After a careful analysis of the historical development of soil and water conservation strategies since the German colonial era to-date, it has been found out that most soil and water conservation projects failed due to among other things, a top-down approach; use of techniques which are complicated to design and indeed expensive both in terms of labour and capital coupled with the neglect of participation of stakeholders - local farmers especially female farmers' knowledge and attendant training opportunities. Subsequently, the vital indigenous knowledge was disregarded or frustrated. Today modern conservation and land use planning and management lack the most important link between researchers and development agents on the one hand and gender desegregated land users on the other as a basis for searching for improved land productivity. An alternative approach, therefore which ensures community participation in programme and policy formulation and implementation on land surface units on a scale from micro to macro levels in various stages of degradation is proposed.

Introduction

Global agricultural production is generally growing and is likely to continue to grow, though at a slow rate. At the same time, about 90 million people are being added to the world's population every year, putting more pressure on the world's food production systems (Hammond 1996). A more critical problem at present is that the world suffers from massive land and water degradation over

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(Landqvist et al. 1985); Report of Independent Commission on Population and the Quality of Life 1996). In the face of the decreasing agricultural production and productivity, tremendous increase in population and increased degradation of land and water resources, the developing countries, are becoming the definite victims.

From the global perspective, about 11% of the land area is cultivated. In areas with pronounced and long dry seasons, crops are grown once in three years, whereas under highly favourable conditions two or three crops can be grown annually. Grassland is found on 22% of the land area (Hammond 1996). According to Pimentel (1995) the developing countries (excluding China) have about 2.5 billion hectares (ha) of land on which rain-fed crops could achieve reasonable yields. Further, the estimation by the FAO is that by the year 1010, the current 710 million ha of land currently in crop production globally could increase by 21% of 850 million ha (Pimentel 1995).

However, the potential to expand cropland is limited by many factors, including environmental costs and costs of developing infrastructure in remote areas (Andersen and Pandya-Lorch 1994). In addition, underdeveloped areas usually are not prime cropland, so yields will generally be less than average.

In the developing countries, notably Sub-Saharan Africa, low agricultural production, food insecurity and undernutrition problems that are relatively intractable complicate the problems of increased populations. Various systems of low-yielding, traditional and subsisting farming are in common use, except in special plantations and in some more advanced regions such as river basins and deltas of the Nile (Landon 1984). Moreover, the average yields are low compared to those obtained in areas with improved management (Landon 1984; Andersen 1994). The agricultural production trends are most critical, especially for countries characterised by high economic dependence on agriculture which is dominated by women farmers (i.e. with more than one third of the economically active population engaged in agriculture) (Andersen and Pandya-Lorch 1994).

Further, it has been found that 45% of the potential cropland in Sub-Saharan Africa is under forest or protected areas, and about 72% of potential cropland suffer from soil and terrain constraints (World Bank 1992; Ehrlich 1993). According to these sources conversion of such areas would entail high financial and ecological costs, including the loss of biodiversity, increased carbon dioxide emissions and significantly decreased carbon storage capacity.

Lowering crop yields in many developing countries, notably Sub-Saharan Africa has been associated with many factors. Soil degradation has been singled out as the major cause to this problem. In many parts of this area, lack of inputs, combined with inherent fragile characteristics of the land, shortening of the fallow periods and continuous cropping crease conditions in which nutrients are steadily lost and production declines.

It should be remembered that the present population demand for food, pasture, fibre and fuel has increased well beyond the limits that nature can provide unassisted (Nana-Sinkam 1995). Further, future demands on the resources base for these products will be even greater. The potential of the land to produce is set by soil and climate conditions and by the level of inputs and management applied to the land. Any over-exploitation or `mining' of land beyond these limits results in degradation and declining yields which is now happening in many parts of Africa.

Due to the existence of problems in expanding the cropland and yields in developing countries, strategies to conserve the deteriorating resources should be given due emphasis. This, further, calls for interdisciplinary teamwork in solving the identified problems, because land degradation is attributed not to one discipline alone (Buringh 1979).

In an attempt to solve these problems many experts are concerned about the capacity of the world agricultural systems to continue to increase production over the coming decades to feed an ever-larger world population. Another concern is whether there are ways to increase agricultural production while at the same time reducing environmental and resources damage.

Problems Facing Agricultural Production and Development

Demographic factors

It is logical that the rate of population growth has an effect on the increase or decrease or productivity of land resources. However, some people have taken the view that rapid population growth leads inevitably to increased poverty and natural resource degradation, through factors such as land scarcity, falling fallow, deforestation and cultivation of marginal lands. One important theory stated by Malthus (1976) asserts that "population is necessarily limited by the means for subsistence". It increased exponentially when developments such as inventions or discoveries temporarily increase the means of subsistence. The problem being due to the law of diminishing returns to capital and labour, the new lands, which accompany the new mouths, do not result in increased productivity.

According to Boserup (1981), increasing population densities will normally bring about successful intensification of land use. Intensification without improved technology can not support continued population growth, however.

Left to its own devices, subsistence agriculture may lead to a technological dead end. Basically, population growth is exceeding the possible production level of that population, resulting in impoverished resources and a negative feedback effect in the form of famines, wars and so forth and leading to the slowing of population growth.

Population pressure and arable land

Bruntland Commission (1987) stated that `poverty and environmental degradation are inextricably linked'. The commission produced a 20 points plan for sustainable development in the developing world, which included the utilisation of indigenous knowledge in the development of any programme with the aim of sustainability on the grounds that ideas from the people for the people are more readily accepted and implemented. One big effect of the population increase is the erosion of sediment from agricultural soils and its associated effects on crop production and water pollution (Rauschkolb 1971).

According to Rauschkolb (1971) tremendous amounts of sediment are removed from topsoil by surface runoff (water erosion). Erosion is further associated directly with the loss of plant nutrients and the latter are related to the crop yield. As a result of topsoil loss there is also degradation through the creation of watches and gullies that make the land unsuitable for agricultural production.

Population pressure and grazing land

According to the 1984 Livestock Census more than 26 million ha or 30% of mainland Tanzania's land area is used for grazing cattle and smaller animals. The grazing zone is part of the semi-arid plateau interior and consists mainly of bushed grassland and grassland with a livestock carrying capacity of 0.17 to 0.33 livestock units per ha if medium-grazed (one livestock unit is equivalent to 0.8 head of cattle). Overall, rough grazing land accounts for about 50% (44 million ha) of mainland Tanzania's total area, a stocking rate of 3.5 ha per head of cattle at the current population size. Thus, the required grazing area would exceed 75 million ha, far more than is available.

Population pressure and fuel wood energy

Of the total woodland areas, 40 million ha, "net productive area" is estimated to be 34.6 million ha (Skutch 1989). The potential sustained yield of fuelwood from *miombo* woodland is approximately three-quarters of a cubic metre per ha per year for a total sustained yield of 24.3 million cubic metres per year.

Overall fuelwood consumption of the 3.4 million households in rural Tanzania therefore amounts of 23.8 million cubic metres annually. Much of the woodland can not be readily harvested because the rural population is concentrated in villages too far from the source. To aggravate the fuel problem, the increasing village population is likely to extend the acreage under cultivation at the expense of woodland or thicket, further increasing the distance to full reserves. Population growth will therefore exert pressure to intensify resource use and to replace the family farm with a more productive system.

2.5 Population pressure and technology

Technological innovations can reduce resource dependency and surmount deficiencies in soil fertility and water and fuel supplies. A successful transition to more intensive and sustainable use of the land depends on many factors. These include the relative cost of labour, capital and fertilisers, the cost and availability of credit, the reliability of markets for input and output, the access to spare parts and repair facilities and the adequacy of information and training systems" (Lele and Stone 1989).

Development of Soil and Water Conservation Strategies in East Africa

General trend

Soil conservation measures in East Africa goes back to colonial times during the German region in late 18th century. The colonial authorities realised the existence of soil erosion problem. However, the first soil and water conservation schemes launched during that time were unsound and unwisely implemented (Temple 1972). Farmers were forced to dig terraces without being educated about the needs and benefits of such activities. In many cases digging of terraces was used a punishment and soil conservation became intimately linked with colonialism (Lundgren 1993).

The conservation schemes and regulations that had been imposed during the colonial periods were abandoned at independence. Further, clearing of forests for new settlements, decontrol of grazing, and lack of maintenance of terraces together with increasing population pressure and settlement in drier areas, resulted in accelerated land degradation. Soil erosion increased, with negative consequences both on-farm and off-farm. Environmental problem such as sediment loaded rivers, siltation of dams, flooding, droughts and so on, reached alarming levels (Temple and Rapp 1972).

Concern about such off-farm environmental effects of soil erosion rose during the late 1960s and the 1970s and several research prospects on soil erosion processes, quantification of soil loss and sedimentation yields were conducted in Tanzania. The main purpose was to obtain reliable data on the types, extend and contemporary rates of soil erosion and sedimentation in the country. It was hoped that such data might form a more rational basis for future schemes of soil and water conservation in areas with severe erosion problems in Tanzania (Rapp. et. al. 1972).

East African catchment experiments done during 1960s and early 1970s dealt much with similar problems and even more on hydrological data (Rapp et. al. 1972). As noted by Rugumamu (1992) these experiments did not address any improvement in agricultural production. Nevertheless, an excuse could be that, the population density in Tanzania was still low and the fertile land ample which could allow shifting cultivation.

The greatest problems with post independence soil and water conservation were the notion of simulating conservation practices as colonial punishment, lack of political priority and focus on the `on-farm soil erosion control' alone. Further, `soil conservation' was often synonymous with `sop erosion' and little or no attention was paid to the relation between erosion and productivity of the land (Lundgren 1993).

Several conservation schemes were initiated, though with the assistance of foreign agencies in early 1980s. This has been attributed to numerous Soil and Water Conservation Conferences, which took place during 1970s and 1980s which are thought to have sensitised most politicians. Examples of the schemes include *Hifadhi Ardhi Dodoma* (HADO), *Hifadhi Ardhi Shinyanga* (HASHI) and several others which were started and using imported high-tech equipment like tractors, planters, etc.

Numerous attempts have been made in recent years to grapple with the question of whether agricultural production can keep up with population growth, and reduce under nutrition in the next few decades. The key issues, included are the potential for expanding cropland area and irrigated cropland, increasing yields and for improving water use efficiency. Other approaches emphasise the importance of resource conservation and alternative production models that are less environmentally damaging than the conventional high-input approach.

In the same ideology, various soil and water conservation schemes have been established in Tanzania in order to address the land degradation, food shortage, poverty and environmental problems in general. These include schemes like the Soil Erosion Control and Agroforestry Project (SECAP) in Lushoto, Tanga region; the Soil Conservation and Agroforestry Project in Arumeru (SCAPA) in Arumeru district in Arusha, the Soil conservation (*Hifadhi Ardhi*) Dodoma (HADO) in Dodoma; the Soil Conservation (*Hifadhi Ardhi)* Shinyanga (HASHI); the Environmental conservation (*Hifadhi Mazingira*) in Makete, Iringa region; and many others.

Such schemes have been and are still mushrooming in Tanzania, yet the county still continues to experience overwhelming poverty, occasional hunger and net-import of food. One important question to ask is that, for how long have these schemes or projects been in existence? What is the minimum period required for such schemes to show their products in this poor nation? It may be agreed that, probably these schemes though important and necessary, do not meet the expectation of the most needy majority of this nation. In fact the achievements accrued from these schemes seems too localised, hence they benefit those people in or near the project area. Further, the approaches used, for instance those of HADO, HASHI and SCAPA are not necessarily similar or cannot be applied elsewhere without conducting detailed studies.

In view of the above shortcomings existing in the current schemes and projects that are underway in Tanzania, it is imperative, therefore, to work out alternative approaches which can solve the problems effectively, efficiently and sustainably. This calls for the design of a model for soil and water conservation, which could promote agricultural production and address food insecurity, poverty and environmental degradation for the present and future generations.

The greatest advantage in these schemes is that they took advantage of traditional knowledge as opposed to the imposition of new high-tech. However, various setbacks appeared to disqualify the schemes. According to Lundgren (1993) soil and water conservation was seen as `isolated' from other farm activities and was usually dealt with by special conservation officers who were trained in agricultural engineering and were not part of the agricultural extension services. This was many other setbacks put such projects ineffective in addressing agricultural production, alleviation of poverty and food production problems.

Later in 1980s the agroforestry concept was developed as an important shift from a top-down to a horizontal, collaborative and participating approach. Agroforestry, as defined by ICRAF (1992) is a collective name for land use systems and practices where woody perennial forests are deliberately integrated with crops and/or animals on the same land management unit. The integration can be either in spatial mixture or in temporal sequences. The latter approach, however, has been criticised for lacking agricultural production promotion, in that it does not address issues like crop or animal improvement, transferability for the conservation packages to newly opened lands etc.

Importance of traditional soil and water conservation, land use planning and management in agricultural production

Most of soil and water conservation projects initiated during the after the colonial times failed because what has been constructed - often at great expense - has seldom been maintained by the `beneficiaries' (Reij, 1991;

Anderson, 1994). Where adequate maintenance is lacking, conservation works quickly dilapidate and accelerate erosion instead of reducing it.

According to Anderson (1994) the most important reasons for these failures in African soil and water conservation (SWC) works include:

- a dominant top-down approach;
- the use of techniques which are complicated to design and expensive to obtain and maintain both in terms of labour and capital, and therefore difficult for farmers or users to replicate;
- a neglect of native or farmer training;
- a heavy reliance on machinery for construction of conservation works and indiscriminate use of a concept of `work, then be paid money or food'.

From these observations, it is obvious that farmers have adequate knowledge of the soils they work on. They know the good and bad aspects of the land they own. In the case of agricultural production, the African farmers have acquired a working knowledge of the soils he/she uses and a means of recognising and distinguishing them (Allen 1967). Studies from different areas illustrate the extent of this knowledge which includes names for different soils, soil distribution and soil-plant relationships (Knight 1974); soil specialists are mostly unaware of this indigenous knowledge or have chosen to ignore it (Acres 1984). In the case of soil surveyor, this ignorance probably arises, in part from the nature of the surveys and the methods used in which there is limited time to complete the survey.

To learn from farmers requires patient dialogue in a village or farm. According to Benneh (1979) it may be surveyor's obsession with classification systems that has blinded her to the existence and significance of local names. Yet it has been shown that farmers' soil descriptions can be related to those of pedologist and local nomenclature may be compatible with national (Knight 1974) or even international soil classification systems (Bradley 1983). An opportunity to relate· information gathered from local farmers to that gained from a reconnaissance soil survey arose during a rural integrated development project in Tabora region, Tanzania in 1984 (Acres 1984).

Modern soil and water conservation approaches

The concept of soil conservation is relatively new as it only began to be taken seriously in the early part of this century (Hudson 1992). Additionally, soil conservation was appropriate when many people were mainly concerned with increasing the knowledge and awareness of soil degradation, and learning how to decrease the process.

The principles in land husbandry promotion include inter-disciplinarity, participation and sustainability. Lundgren (1993) has identified four specific measures that can promote the three principles among others as institution capacity building; education and training; research; and techniques and technologies. Although theoretically the approach sounds great, it has not yet been practised in the current SWC schemes underway in Tanzania.

It is definitely impracticable to improve the land then control erosion later because farmers jump first to the fertile land then when forced by circumstances they move to the marginal soilscapes. This implies that farmers intending to open new cropland are likely misuse the land, for instance, by cultivating crops like maize and beans in cool acidic soil areas instead of tea and the like. Such a problem has not been addressed properly by the current land husbandry approach.

However, with regard to the modern soil and water conservation schemes currently operating in various parts of this country, there is evidence for the contemporary technology to improve agricultural production and land use practices in the project areas if properly adopted and implemented. Nevertheless, the potential is too low in places where bush-fires, lumbering and overgrazing denude large areas of watershed and where such operations destroy the stability of the soil thus creating erosion problems.

In essence, the so-called modern SWC approach seem to lack compatibility, replication and use of friendship to a wide range of farmers from diverse agro-ecological zones like the ones existing in Tanzania. This calls for urgent determination of acceptable and approach SWC approach which can address the existing ever-growing contradicting issue of agricultural production and land degradation from the farmer (micro) level to national (macro) levels.

An Alternative Approach With Sustainability Component

A Spatio-Institutional Approach to Soil and Water Conservation

At the local level, a village community and its ecosystem setting form an ideal location for socio-economic and ecological planning, thus laying the foundation for a holistic approach to a search for sustainable development. It is at this level that the village ecosystem composed of a complex land-user-crops-livestock-vegetation system should be conceived (Matlock 1981; Agarwal and Marain 1992). Sustainable development is conceived in terms of stability and/or enhancement of a village ecosystem's productivity, because the more stable an ecosystem is, the more economical and sustainable it is to manage (Harrison and Warren 1970; Shiva 1991; Bandyopadhyay and Shiva, 1989). Emphasis should be placed on limiting resources to the sustainability of the agricultural industry, land, capital, technology, market and institutional arrangements (Seidman and Seidman, 1994). It is advanced here that available human and natural resources should be assessed for mobilisation in order to form a development nucleus.

As a unit, the village community may further be differentiated on various levels including class, ethnicity, gender and so on. These are critical social variables in the development process and must be addressed. It is at this level where most people can easily be met and consulted. The community is capable of facilitating the generation of data necessary for efficient planning, management, monitoring and prediction of land and land use type processes-response relationships both endogenic and exogenic in origin within their ecosystem.

Further, local level institutions both public and private are key to generating policy and programme inputs that promote the quality of resources and the infinite character of humans that depend upon them (Cadwell 1970). Development initiatives should therefore be directed toward empowering the community to make decisions and implement them. The process would facilitate the integration of local community development plans into district (sub-national) and national plans a bottom-up approach. Given this atmosphere, conflicts between local and national levels are likely to be minimised and chances of local needs being increasingly met promoted, thus raising the quality of life.

Operationalization

A field land resources survey based on the nine-unit land surface model (Conacher and Dalrymple 1977) conducted by stakeholders (PRA 1991; Chambers and Childyal 1985) forms the bases for holistic approach to soil-water management and conservation at farm and village levels. In situations where the landscape is monotonously homogenous (e.g. flat terrain) a grid survey to be guided by available resources is recommended.

The stakeholders include all individuals and/or their representatives who depend on the village natural resources for survival and/or charged with the responsibility of facilitating the village development process (PRA 1991). These include, but not limited to male and female land users - a gendered perspective (Rugumamu 1995):

(a) Male and female farmers, pastoralists, businessmen and businesswomen, private and popular groups e.g. Non-Governmental

Organisations (NGO's), Community Based Organisations (CBOs), Government Sponsored Non-Governmental Organisations (GONGOs) etc.

(b) Public institutions

(c) International development agencies

In this case, transect lines designed to cover the village ecosystem should provide the greatest ecological diversity running from interfluves to valley bottoms. In addition, stakeholders on each transect should observe site, land use characteristics and similar aspects which include: soils, vegetation, land use; slope, drainage, water points, cropping, ranching, economic indicators, etc.

Detailed sketching and inventorying should be undertaken as a basis for site distinction on each land unit. Symbols may be used to denote crops, livestock, game, forest, buildings etc. On the matrix, records may be made of different groups (women, men, children, hunters, gatherers, pastoralists, landowners). Records of who is/are responsible for the resource or for proving it to the family should also be made. There is need to symbolise women and men on each site and feature on the landscape as a basis for gendering the resource use pattern.

The use of sketches and tables may guide planning discussions with stakeholders as individuals, groups and/or as a community as well as with technical personnel in order to incorporate distinct NEEDS, INTERESTS and CONCERNS of women and men in site specific soil-water management and conservation. The ensuing debate will help to determine opportunities and constraints at each site on the land unit of the catena as perceived by the stakeholders.

The gendered approach ensures that soils and water conservation and land management are in line with priorities of rural areas given that the stakeholder, i.e. rural community segments and their development partners become the key players in setting strategies, implementing and evaluating development initiatives.

Conclusion and Recommendations

It is evident that population growth cannot continue forever on a finite plane without effective socio-economic and technological interventions. Rapid technological development is still at its infancy and in some instances already exerts unsustainable pressures on the resource base and frustrates efforts to meet basic needs and improved quality of life.

As some human activities are rapidly destroying much of the earth's genetic potential, mainly through habitant destruction, it is reasonably clear what kind of development should be pursued for sustainability. There is an urgent need to promote links between researchers and development agents on the one hand and gender dis-aggregated land users on the other in the field of soil and water conservation as a basis for improving land productivity. This is an effective way of promoting decentralised, small-scale community based development.

Proposed critical areas calling for immediate action include:

- Ensuring participation of women in decision making e.g. whether to raise cash or food crops; to terrace or sesa; where and how to graze livestock and procure fuel wood energy, whether to bear more children or otherwise.
- Identification of the most effective soil and water conservation and management in various stages of degradation.
- Preparation of technical data sheets on different techniques, which can be used for training of extension staff, farmers, pastoralists, NGO's etc.
- Organisation of technical seminars to present research findings, train development workers on various topics and visit demonstration sites and fields where land users have introduced innovations so that researchers can also learn from experience in the deep field. This widens access to information and education on soil and water management and conservation for improved quality of life.

It should be stated by way of conclusion that the success of the proposed actions greatly depends on two key factors: effective participation of all the stakeholders as well as a strong political will to translate vision into reality.

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