# Indigenous soil conservation methods: Fulo and Bekpong catchments of Upper West Region, Ghana

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## Abstract

A survey was carried out for baseline information on soil and water conservation (SWC) methods in two catchments, Fulo and Bekpong, in the Upper West Region of Ghana. Information was gathered along transects on causes and features of land degradation and farmers' indigenous soil and water conservation practices, using participatory rural appraisal techniques. Soil erosion was the main type of land degradation. It was attributed to climate, relief and soil type of the area, and deforestation, cultivation methods and overgrazing. Indigenous SWC practices involved partitioning the land into grazing and cropping fields. Different land preparation methods including stone bunds-terrace systems, beds, mounds and ridges are used and mixed cropping systems of cereals and legumes in rotation practised. Mounds are the most popular land preparation method. To conserve soil and water, mounds could be set up in straight lines and staggered across slopes or tied to reduce runoff velocity. Square bunds and tied ridges are also recommended.

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## Introduction

African agriculture is dominated by subsistence farming. Besides this, the soil resource base is ancient in origin, widely varied, fragile and characteristically low in inherent fertility (Zake, 1993; Ofori, 1993; Sant'Anna, 2001). The principal constraints on soil productivity in Africa include nutrient availability and retention, nutrient toxicity, water availability and management, and physical degradation due to erosion (Woomer & Muchena, 1993; Quansah, 2000; Sant' Anna, 2001). The development of appropriate and effective management strategies is, therefore, very crucial to the maintenance of the soil resource base for high agricultural output.

Water management and soil fertility improvement are very important for agricultural production in the semi-arid regions of Ghana. Among these regions is the Upper West Region (UWR) in the interior savanna zone (ISZ), where the rainfall regime is characteristically unreliable. This makes productive agriculture in these regions, particularly UWR, only possible through supplemental irrigation (FAO, 1984), otherwise agricultural development is a very risky venture (Rudat *et al.,* 1993; Nsiah-Gyabaah, 1994). Soil management in the semi-arid zones of Ghana depends on climate, human and livestock population pressure (Antwi *et al*., 1997a). However, the situation is aggravated by the high evapotranspiration rates and shallow rooting depths of most soils. This presents the African soil scientist with great challenges in attempting to ensure high crop production levels (Antwi & Asiamah, 1977).

Studies have shown that soil erosion is a major soil degradative factor affecting crop production in the ISZ of Ghana (Antwi *et al.*, 1997b; Quansah, 1981; Quansah *et al.,* 1990). Mando (1997a) reported that soil degradation and erratic rainfall are major factors militating against sufficient agricultural output in Burkina Faso. Farming practices in such circumstances require careful timing of production practices (Darko, 1987). This includes the choice and timing of soil and water conservation (SWC) investment to maintain soil fertility and conserve soil moisture. Among some of the conservation practices advocated for sustainable and effective crop production are zero tillage and conservation agriculture. Zero tillage operates very well within the framework of conservation agriculture. In this situation, farming practices are believed to be feasible under a wide range of climatic, soil and social conditions regardless of the scale of farming (Veneph & Benites, 2001). Conservation agriculture, in itself, works with no mechanical soil disturbance, ensures permanent soil cover and judicious choice of crop rotations (Parr *et al.*,1990; Opara-Nadi, 1993; Benites & Ashbumer, 2001). This notwithstanding, conservation agriculture is considered to be energy-demanding and, in some cases, costly when it comes to herbicide usage. Undoubtedly, this puts the adoption of this technology beyond the reach of the resource-poor African farmer (Ofori, 1993).

Over the years, farmers have developed their own indigenous systems to cope with soil, water and nutrient problems associated with crop production, especially legumes and cereals. Some of the indigenous measures used to enhance the soil's productivity elsewhere include vegetative strips (Mieton, 1986), stone and earth bunds (Reij *et al.*, 1988) and management of organic material (Hien, 1995; Mando, 1997b).

In northern Ghana, though indigenous SWC techniques are available, the knowledge of these systems has not been recorded for research, extension and development purposes. In such circumstances, there is the tendency to prescribe soil and water conservation practices, which are not compatible with those of the farming communities. This paper provides some baseline information on the indigenous soil conservation practices within the Fulo and Bekpong catchments of UWR in the ISZ of Ghana. The objective was to document the indigenous soil and water conservation systems, which could be improved and then extended to other parts of the ISZ.

## Materials and methods

Two catchrnents, Fulo in Lawra District and Bekpong in Nadowli aud Jirapa district within the Upper West Region of Ghana (Fig. 1), were selected based on the degree of soil degradation and geological differences. Information on these catchments was obtained from literature, topographic maps, reports and experiences of researchers who have worked in these areas.

The Fulo catchment covers an area of approximately 6500 ha. It is located between latitudes 10° 33' and 10° 40' N of the Equator and longitudes 2° 49' and 2° 56' W of the Greenwich Meridian (Fig. 2). The Bekpong catchment has an area of about 1100 ha and lies between latitudes 10° 25' and 10° 32.5' N and longitudes 2° 35' and 2° 43' W (Fig. 3).

Prior arrangements were made with the Ministry of Food and Agriculture, farmers, meteorologists, chiefs and opinion leaders within the catchments in respect of the proposed visit and objectives of the study. The study took place in the dry season when farmers were confined to their compound farms. Participatory rural appraisal (PRA) methods were used to gather information from the farming communities. These include semi-structured, group and key informant interviews, farm visits, historical accounts, observations and transect walks. Three transects were chosen on the basis of information available on each catchment. Transects for the Fulo catchment were Zingkaa to Tangpour, Tangpour to Kalsare, and Koule to Tongo (Fig. 2), and those for the Bekpong were Bazuu to Dapori, Bazuu to Tampaala, and Tampaala to Gbari (Fig. 3).

There was no restriction on the number of participating households. About 20 households covering males and females were involved in the group discussions. Some households were selected for discussions on the basis of type of soil management practices used. Agricultural officers, chief farmers, the elderly, and land custodians were used as key informants. The study was carried out by two multidisciplinary teams, each of which comprised a socio-economist, a soil conservationist, a hydrologist, a pedologist and an agronomist. The two teams held a workshop to discuss the results, and made some recommendations.

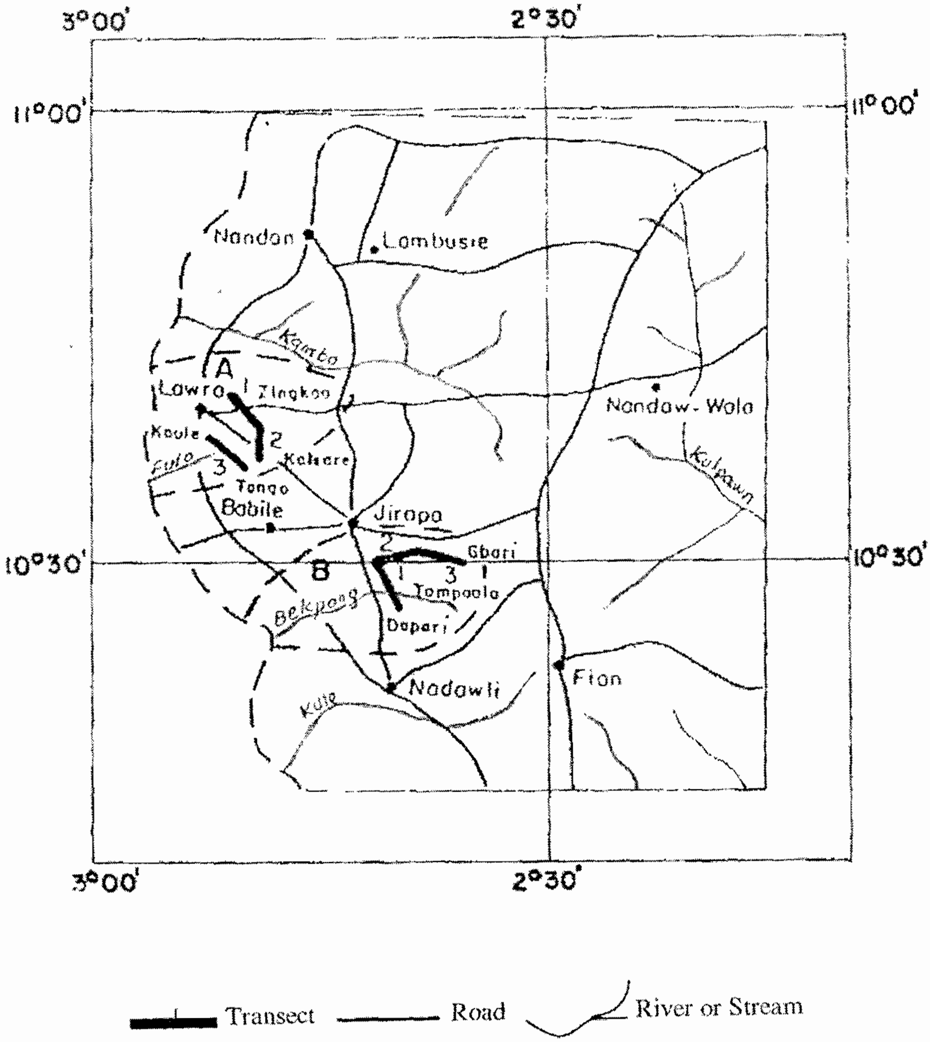


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Fig. 1. Location of Fulo and Bekpong catchments in the Upper West Region, Ghana

## Results and discussions

*Soils*

The soils in the Fulo catchment are developed over Lower Birrimian rocks and belong to the Wenchi-Pale Association. The uplands of the association are occupied by Leptosols, Luvisols and Acrisols while the lowlands have Plinthosols and Gleysols (ISSS-FAO-ISRIC, 1998). The members of this association occur in a catena with variations ranging from very shallow (< 30 cm) and well-drained sandy loams, which contain medium and coarse quartz gravel, stones and ironpan boulders on the surface, to deep (120-140 cm), poorly drained alluvial clays in the valley

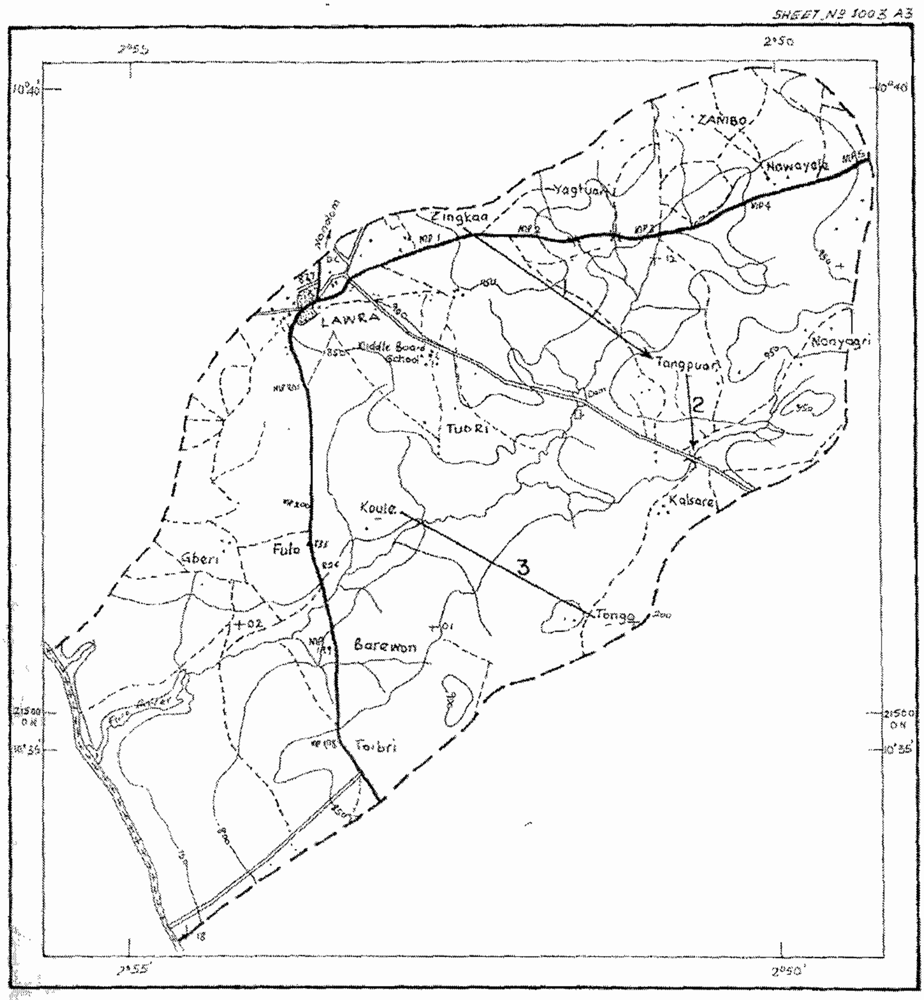


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Fig. 2. The Fulo catchment and its transects

bottoms.

In the Bekpong catchment, the soils are developed over granitic rocks and they are members of the Varempere-Kupela Association. Luvisols and Leptosols are the upland members of the association with the former being more dominant. The lowlands are occupied by Plinthosols and Gleysols (ISSS-FAO-ISRIC, 1998). The soils vary from moderately deep (60-100 cm) to deep, well-drained sandy loams to sandy clay loams on the uplands to deep and poorly-drained silty clay loams in the valley bottoms. Generally, the soils are inherently low in fertility status. The unfavourable moisture and unreliable rainfall regimes make the potential productivity of the soils in the two catchments very low (Adu, 1969; Boateng & Ayamga, 1992).

*Climate and vegetation*

The catchments fall within the interior savanna

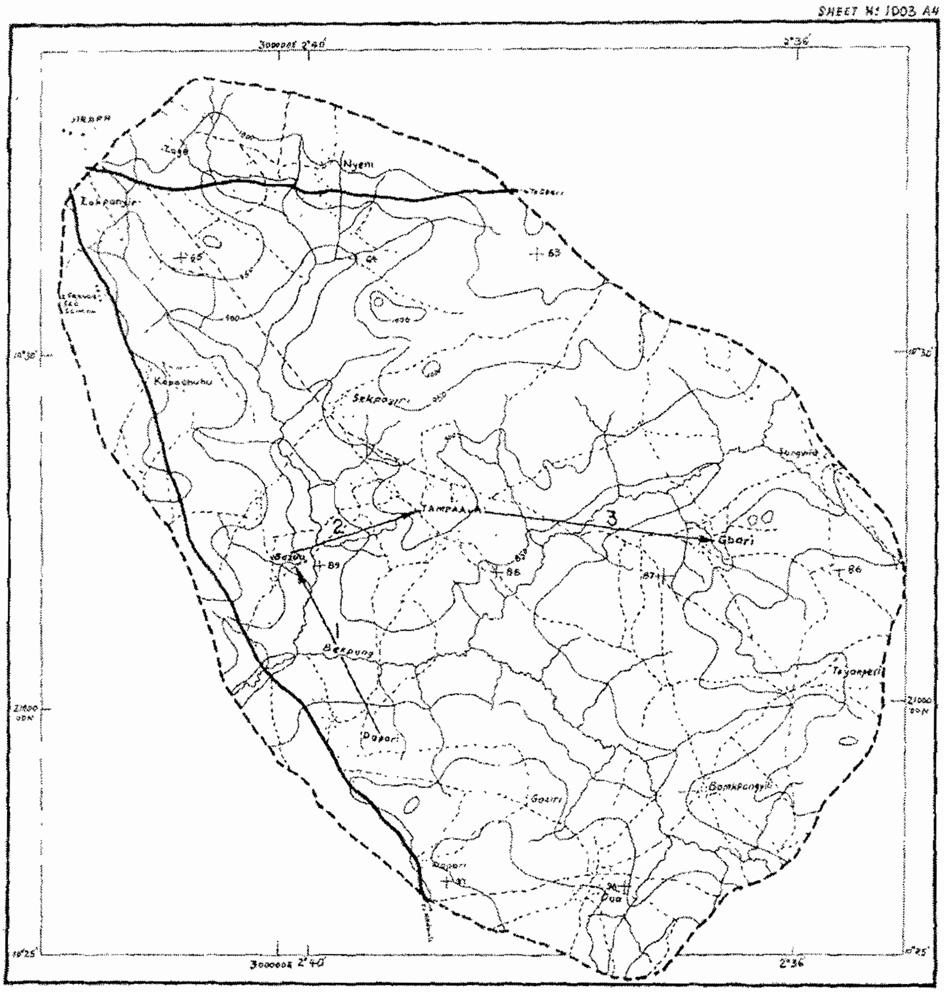


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Fig. 3. The Bekpong catchment and its transects

zone (ISZ), which is characterized by a short and unimodal rainfall regime. The amount of rainfall is low and ranges from 900-1200 mm (MSDG, 1997). The wettest months are supposed to be July and August but more often there is either a delay or no rainfall at all. Dry spells of 3-4 weeks are quite common. The dry season, which is rather long, starts from October to April. During this period, the area comes under the influence of the dry north-eastern trade winds. This is characterized by low relative humidity. However, in the rainy season, the maritime air from the south-west monsoon and strong convection cause rainfall and relative humidity values to rise significantly.

Temperatures are very high throughout the year, and this results in high evapo-transpiration. Mean maximum temperature is about 34.6 °C whereas the mean minimum is 25.1 °C. The lowest average diurnal temperature is in August and the highest in December.

The Fulo catchment is entirely composed of Sudan savanna vegetation. This is characterized by scattered trees and a sparse ground cover of grasses and forbs. Trees commonly found include *Albizzia* sp., *Butyrospermum parkii* (Sheanut), *Adansonia digitata* (Baobab), *Parkia biglobossa* Dawadawa) and *Ceiba pentandra* (Silk cotton). Others include *Azadirachta indica* (Neem), *Mangifera indica* (Mango) and *Blighia sapida* (Akee apple). Of the grassy species, *Brachiara* sp., *Aristida* sp. and *Pennisetum* sp. are commonly found interspersed within the trees, especially the drought and fire-resistant ones.

Apart from the Sudan savanna vegetation, the Bekpong catchment also shows characteristic features of the Guinea savanna. The vegetation density in the Guinea savanna is much higher. In addition to those observed in the Sudan savanna, other dominant trees include *Isoberina doka, I. dalzieli, Daniella* sp., *Khaya* sp. (Mahogany), *Diospyros mespilliformis* (Ebony) and *Faidherbia albida* (formerly *Acacia albida).* With the grasses, *Andropogon* sp. and *Cymbopogon* sp. are common especially during the rainy season.

*Land degradation*

Among the various forms of land degradation processes, soil erosion is an issue, which has gained increasing prominence in the rural communities. Agricultural production seems to be economically unreliable, thus causing migration of the youth to the southern parts of the country. The reason underlying the prioritization of erosion as a major problem is the long-term destruction of the soil resource base leaving gravel on upper slopes and silt close to the valley bottoms.

Climate plays a major role in the degradation process and it influences soil erosion through high intensity rains and erosive energy. The poor rainfall distribution in the zone creates droughty conditions and the unprotected soil surface becomes susceptible to surface crusting, which generates a lot of runoff.

Along transects in both catchments, sheet and gully erosion are common. There are hardpan outcrops, thin topsoils mixed with subsoil gravel, exposed rocks and tree roots on upper slopes. There are large quantities of gravel on farm plots as a result of soil sorting by runoff. In the lower section of the valleys, large clay deposits were observed, while gulleys extend upstream due to the collapse of sidewalls of water channels. Layers of ironpan were undercut and this has resulted in landslides into river channels. The wooded areas are sparsely vegetated. The flat areas have luxuriant growth of *Imperata cylindrica,* which is an indication of poor soil fertility.

Historical accounts by elders of the communities show that the area once had luxuriant vegetation. When the population was low, the people had a land use system where the upper slopes were left under forest and also used for grazing. The forest areas also served as the main source of fuelwood. Crop production was restricted to the middle and lower slopes where shifting cultivation was practised. The fallow periods used to be, between 7-10 years.

With the increase in population, the traditional shifting cultivation with long fallow periods has been replaced with short fallow periods of 1-3 years. Presently, shifting cultivation, in most cases, has given way to sedentary agriculture with no fallow periods. The soil fertility is restored through the use of organic matter in the compound farms, and short fallows at the distant farms. Years of these agricultural practices have rendered most areas devoid of vegetative cover.

Soil erosion is severe where the slope is steep, mostly greater than 10 per cent. In most cases, the summits, which are left for grazing, are gravelly and stony. A lot of runoff is generated upslope, which tends to destroy the pulverized mounds and ridges.

*Current soil and water conservation practices*

The traditional land planning authorities have inherited land use systems, which are geared towards producing enough food for the households and fodder for animals. The communities have developed their land use, farming systems and land preparation methods.

*a. Land use and farming systems*. The land use system in the area emphasizes the use of summits and degraded areas for grazing. The compound farms are used for the most preferred food crops.

The degraded areas in the Bekpong catchment have higher tree density as they serve as fuelwood sources for the women. Grazing strips are used on the summits to prevent excessive runoff from destroying the lower crop fields. However, this purpose is defeated through overgrazing. The sizes of the grazing strips have been reduced over the years as a result of land scarcity, particularly in the Fulo catchment.

Compound and bush farms are used in the two catchments. Mixed cropping is practised on the compound farms, whereas the bush farms are mainly for sole crops, which are usually grown in rotations. Common rotations in the bush farms are i. groundnut-sorghum, ii maize-cowpea-maize, and groundnut-sorghum- cowpea. Where intercropping occurs, millet is the main crop with cowpea and bambara as the intercrop. An essential component of the farming systems is livestock production. Cattle, sheep and goats are allowed to graze in the fields. However, the sheep and goats are tethered during the wet season when the fields are fully cultivated to prevent them from destroying the crops.

*Land preparation methods*. The develop-ment of land preparation methods is based on past experiences of successes and failures. Most of the land preparation methods are based on improvement on the traditionally known methods. The following land preparation methods have been identified:

*Beds*. The bed system observed is the staggered type (Fig. 4a). The beds are staggered in various directions on the middle slopes along the Gbari-Tampaala, Bazuu-Dapori and Koule-Tongo transects. These beds, which impede runoff flow, are mostly planted to groundnuts. Where the beds are high, millet and sorghum are planted.

*Stone bunds-terrace system*. On the stony areas at Zingkaa along the Zingkaa-Tangpour transect in the Fulo catchment of the Lawra District, stone bunds have been constructed to trap soil and water for crops. The bunds, which are square or rectangular, have formed a terrace system on the slopes (Fig. 4b). Since these bunds have not been properly laid according to the contour, they are not effective in controlling the runoff. Farmers, therefore, tend to solve the leakages by adding more stone bunds. This created many partitions, which might be mistaken as plot boundaries. In any case, water is able to stay in the stone crevices for crop use.

*Mounds*. The mounds are usually conical in shape with oval or flat tops (Fig. 4c). The purpose of the mounds is to improve upon the exploitable volume of the soils for crops. The mounds are in straight lines with wide spaces between them to allow runoff flow unimpeded. The sizes of the mounds depend on the topographic position. Small mounds are made on the upper and middle slopes and they are about 30 cm high and 50 cm at the base. These mounds, which contain a lot of gravel with little fine earth, are planted to millet and sorghum for 2 years. They are then broken down into flat beds or flat lands and planted to groundnuts after which the cycle begins.

To ensure adequate moisture for plant roots, the sizes of the mounds are modified where necessary. In the lower slopes and valley bottoms, the soils are subject to waterlogging during the rainy season. Large mounds are, therefore, constructed in these sections of the landscape. The heights of mounds are adjusted to 1 m to provide aeration as well as enough moisture for the plants. After a cropping cycle, the topsoils are loosened and mixed with organic matter and cultivated to the desired crops. Most of the farms have semi-circular bunds at the lower reaches of plot boundaries to trap runoff water. This is aimed at conserving moisture for a longer period since the area has a low and unreliable rainfall regime.

*Ridging.* Ridging is a common method of controlling erosion on farms. Under normal terrain conditions, ridging across the slope is enough to check soil erosion (Antwi & Asiamah, 1993; Antwi *et al.*, 1997a). Farmers usually construct the ridges across the slope. However, the problem of erosion is not absolutely checked by the ridges. They create bunds at the lower end of the plot to conserve water from the runoff. The problem is that the land may slope in two directions so that any ridging across a particular slope direction may shift runoff flow to other areas. At high intensity rains, the bunds break and the fields are destroyed. In some cases, the typical ridge-bund system shown in Fig. 4d is modified to give a tied ridge-bund system (Fig. 4e). This reduces runoff significantly and conserves soil and water much better.

*Basin or pit system.* Farmers on gravelly and stony lands remove the stones and then construct pits in the gravel-free subsoil (Fig. 4f), which as a result of pedogenesis, has a fairly high clay content. This results in better water retention for rice production. These pits are normally constructed around the compound farms. This indigenous technique is referred to as the Zay system in Burkina Faso (Mando, 1997). According to Roose *et al.*, 1995) the system traps runoff, improves the chemical fertility and enhances the optimum use of scarce resources, especially water and nutrients for plant growth. Besides, the system also results in improved soil structure due to increased soil faunal activity.

*Agronomic methods.* Mixed cropping is practiced to ensure food security. The sole crop is either millet or sorghum. This is usually mixed with other crops such as cowpea and groundnuts. However, the cultivation of millet or sorghum is usually followed by groundnut in the form of rotation. Planting a flat area with groundnuts tends to check soil erosion by providing surface cover. Some litter is also produced by leaf fall from the groundnuts.

Soil fertility improvement around the compound houses is achieved by incorporating cowdung from the kraals. This ensures good vegetative growth. Soil degradation problems are less pronounced around the compound houses. The only major problem is water stress. In some valley bottoms, farmers plant rice. However, these areas are subject to occasional flooding and long dry periods.

**Conclusion and recommendations**

In the two catchments, the most preferred conservation method is the mound. Farmers' reasoned that it is easy and the least costly to prepare. To improve on their effectiveness in conservation, the mounds have to be set up in straight lines and staggered across the slopes. This will reduce runoff velocity and avoid excessive erosion. Moisture storage can also be enhanced by tying the mounds.

The use of ridges is not common in the two catchments. However, wherever they are used, they can be tied at regular intervals with permanent bunds established and reinforced with drought resistant vegetative materials like vetiver grass. This would reduce erosion and increase soil and water conservation. Square bunds on flat lands and tied ridges for maize are equally good if soil fertility is improved. Soil erosion can also be reduced by establishing hedgerows at regular intervals along the catena. In this case, runoff downslope will be minimized and infiltration enhanced. Since grass is the main grazing material in the area, legumes such as *Calapogoniurn* sp., *Centroserna pubescens, Stylosanthes* sp. and *Stizolobium* sp. can be introduced in any pasture improvement programme.

Farmers are making efforts to sustain their production systems. Opportunities for zoning the lands into specific cropping and soil management systems are likely to reduce the risk associated with agriculture in the area. Promising indigenous soil and water conservation measures exist in the Fulo and Bekpong catchments of the Upper West Region. However, most of these require modifications or combinations with modern

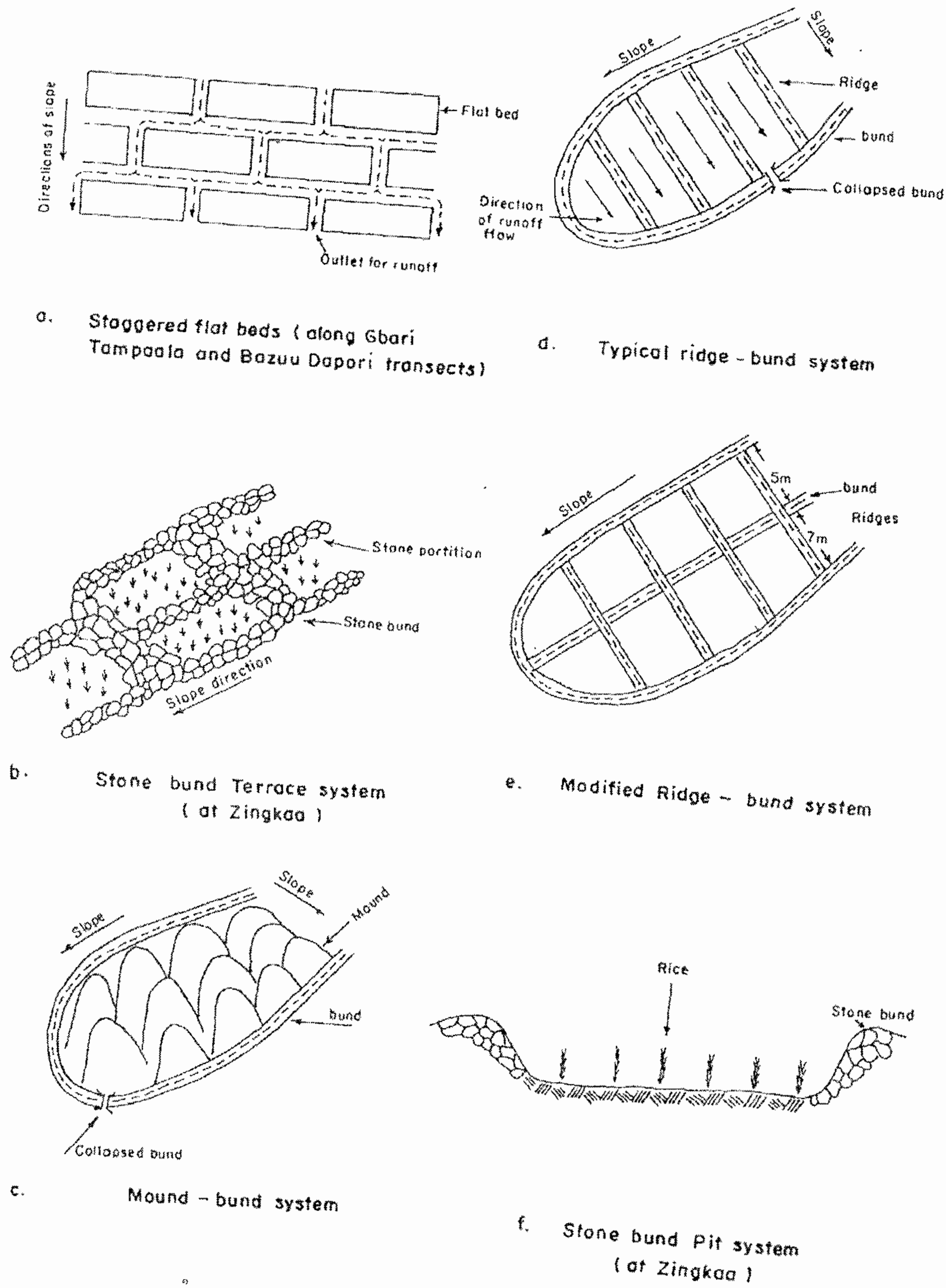


Fig. 4. Soil conservation methods in the Fulo and Bekpong catchments of Upper West Region, Ghana

techniques in any soil improvement programmes. The insurance to the adoption of modified or improved methods is their compatibility with the peoples' lifestyles. This holds the key to sustainable agricultural production for food security in spite of the harsh biophysical conditions typifying the semi-arid environments.

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