SOIL AND WATER CONSERVATION IN BANANA PRODUCTION BETWEEN MOUNT CAMEROON AND BAMBUTUS MOUNTAIN

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Abstract
Mountains in the Gulf of Guinea, Central Africa are volcanic and run SW-NE from the Atlantic ocean. They need investigation for banana (*Musa spp*) production alongside soil and water conservation strategies. Between mounts Cameroon and Bambutus, banana production units were identified and characterized using soil and water conservation factors. Variation in production was noted and management strategies were recorded, developed and combined into conservation areas. Banana production units were of 2 types (dessert and cooking) with industrial and traditional methods practised. Industrial production was on the best lands (the foot slopes of mount Cameroon on volcanic ash, phonolites and basalts at Buea, Molyko; the Tiko sedimentary and volcanic basin; and the Kupe-Maneguba foot-slopes at Mbanga, Njombe, Penja and Loum). Dessert bananas are produced elsewhere on flat lands and slopes for local consumption. For cooking types, small scale production cuts across different land types. Five main units are carved out. On steeper slopes and highlands, locally consumed dessert and cooking types are produced. Dessert bananas are also produced for export on flatlands and foot slopes. Non-banana producing units are marginal to moderate areas.

Topsoil and mulch management differences exist (inter row waste disposal). Planting strategies are specific (flat, gentle or steep), fallow and weed management, irrigation and drainage. Erosion types (rill, sheet, gully and streams) vary. Spectacular floodplains show brown waters (Menoua, Nkam and Mungo). Hardpans and laterites develop at slope breaks creating shallow soils (Tiko and Bambutus footslopes). Common management practices include bench terracing in undulating and rolling plateau (the Bambutus) to reduce surface and mass erosion and improve rooting in stony and rocky parts, surface runoffs, landslides and gullies. Mechanisation and levelling is the comparative practice in industrial production to homogenise planting, effective rooting and drainage. Within farms and plantations, banana plants accumulate rain and irrigation water in pseudo-stems moved down-slope or leached. In all units, land cover (vegetation, weeds or residues) and effective fallowing is observed.

Additional Keywords: agriculture, horticulture systems

Introduction

Mountains are the highest areas with the steepest slopes (Roose *et al*., 1998) the world over. In South Western Cameroon, the Gulf of Guinea, Central Africa are volcanic mountains that run SW-NE from the Atlantic ocean in the south west (Figure 1) towards Lake Chad. These mountainous area need investigation for banana (*Musa spp.*) production. This investigation will include the use of soil and water conservation strategies. Foot slopes of volcanic mountains are however known to possess soils that are amongst the best for agriculture (Driessen and Dudal, 1991). This is not withstanding the high altitudes and steep slopes that create diversity seen in most mountainous areas. The sustainable use of these soils in the diversity of their location is a call for concern especially for the production of exigent crops like banana (Lahav and Turner, 1989; Landon, 1984). Banana and its immediate relative plantains are *Musa* crops produced also for cash. The need to assess these lands using soil and water related factors and to identify sustainable soil and water management strategies for banana production can not be overemphasized. This should especially be along foot slopes of volcanic mountains that are increasingly being used for the production exigent crops. *Musa* production require at least 1000 – 1500 mm year^{-1} average rainfall (Landon, 1984; Sama-Lang *et al*., 1998; Blomme *et al*., 2000). Soils should drain freely and provide good aeration. They should be fertile loams without waterlogging. Soil conservation based irrigation is necessary in the dry season especially for cash orientated production.

Materials and Methods

Field sites

Mountains in south-western Cameroon, the Gulf of Guinea, Central Africa, NE of the Atlantic Ocean and between mounts Cameroon and Bambutus, are used to identify banana production units. These units are characterized using soil and water conservation factors (USDA, 1994). Variation in production is noted and management strategies recorded, developed and combined into conservation areas.

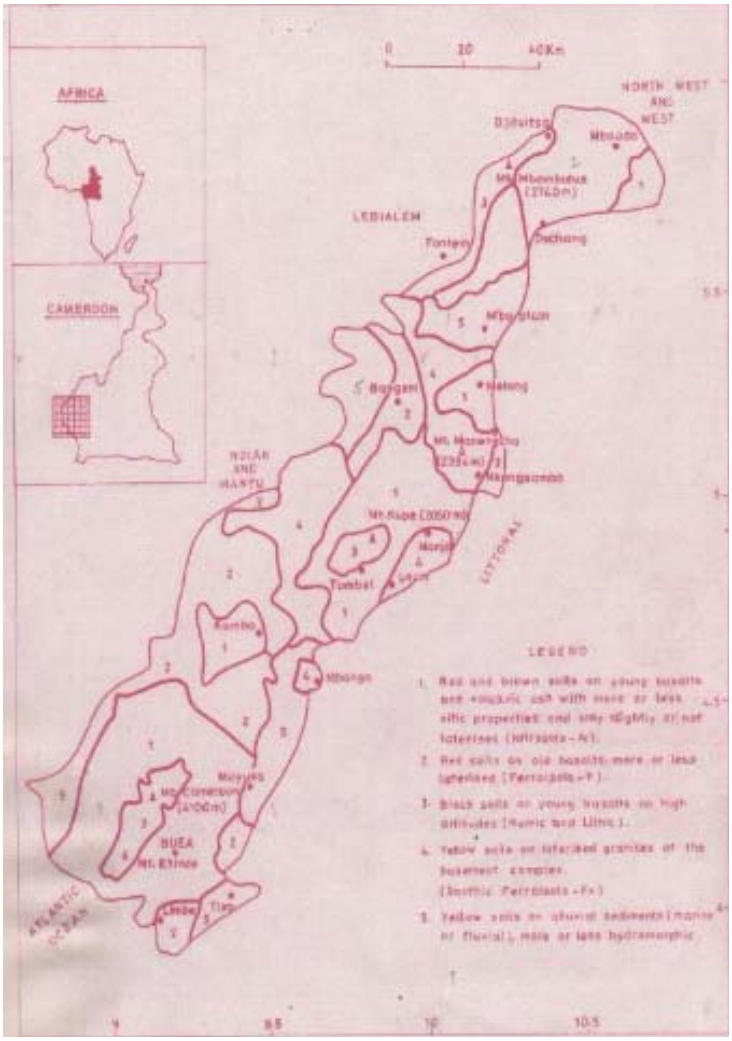

Figure 1. The mountains in south western Cameroon, Central Africa

Analysis

Soil augers, compasses, clinometers, markers, sampling bags and twine are used in a survey based on relevant and available maps (Cameroon Physiographic Reconnaissance Maps, scale 1/100000, 1961: Topographic Maps like the BUEA – DOUALA 1b and 1d, scale 1/50000, 1971: and detail maps like the Ekona Banana Estate CDC soil Map, scale 1/12500, 1971). Aerial photographs and maps are studied and interpreted before selecting the sites (Mulder and Legger, 1986). Soil differences due to topography and other soil forming factors are identified, with soil parent materials especially used. This is along chosen roads, and crossing different land forms. Slopes are measured with the slope-meter and the land-use described based on the *Musa* crop. Soil depth, color, texture and coarse fragments are recorded. These observations are regrouped using soil conservation needs, described and analyzed. Soil conservation based compilation is then done.

Results and Discussion

Volcanic mountains in South Western Cameroon, in the Gulf of Guinea, and in Central Africa run SW-NE from the Atlantic Ocean. They show crop production land use practices by small-scale farmers and agro-industrial plantation owners. Banana or *Musa* production is a common practice by both small scale farmers and the plantations. Soil and water conservation needs are enormous and some strategies are already being used to remedy them.

Between mounts Cameroon and Bambutus, banana production units identified are of two types: (a) agro-industrial plantations of dessert types (bananas), and (b) small scale producers growing cooking types (plantains). The characteristics (soil and water conservation based) are different for both practices. Plantation or industrial production is on the best lands and in three locations:

- The foot slopes of mount Cameroon, the Cameroon Development Corporation (CDC) through AGRISOL and now DELMONTE grows bananas that are exported. This is on soils derived from volcanic ash and mudflows, phonolites and basalts. They are in the Buea, Mussaka, Ekona and Molyko areas.
- CDC through DELMONTE practices same on the Tiko sedimentary and volcanic basin.

- At the Kupe and Manenguba foot-slopes, a group of companies (SPNP – SBM) use volcanic plains and foot-slopes at Mbanga, Njombe, Penja and Loum to produce bananas for the export market.

Dessert bananas are produced elsewhere on flat and on slopes for local consumption using traditional practices. Cooking types (plantains), through small scale production cuts across different land types. Five main units (soils) are identified (Figure 2).

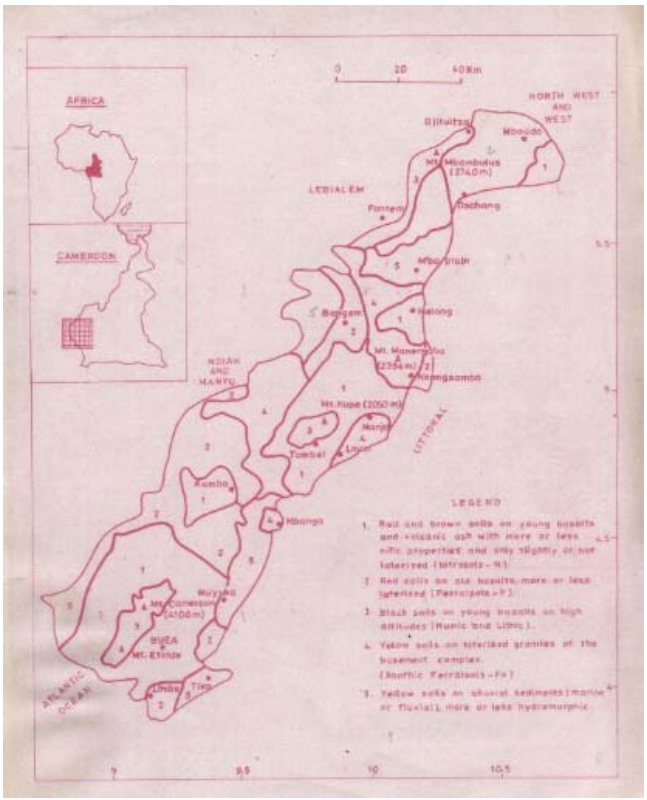

Figure 2. The mountains in south western Cameroon and the main units or soils

Slopes and highlands, for locally consumed dessert and cooking types, flatlands or foot-slopes, for dessert bananas for export, non-banana producing units, home-gardens and marginal to moderate production areas (Table 1). Variation in production noted includes topsoil and mulch management differences. Between planted rows of industrial plantations, research farms and small – scale plantations are inter-rows onto which well cleaned weeds and wastes (dried off and diseased leaves, excess and unwanted successors and damaged plants) cleaned from plants are deposited (inter-row waste disposal). Planting strategies are specific:

- Planting is on flat and gentle slopes with steeper areas if not abandoned left for traditional use.
- Primary and secondary forests hardly exist but fallowing of overused land is practiced but the duration of rest have become relatively very short for all parties. Hardly do they exist for up to 5 years. This is because of acute scarcity of land, more so good land.

Weed is abundant and diverse in this humid and fertile area. Weed management strategies are intensive in the plantations using herbicides of different types accompanied byu strip and ring weeding especially in research areas. The traditional handpicking or slashing is common for small scale production (CTA, 1998). Both systems are used in intermediate cases of up to 10 hectares in research farms. Irrigation and drainage are essential practices for the plantations and the research plots. Erosion types (rill, sheet, gully and streams) vary. Spectacular floodplains show brown waters (Menoua, Nkam and Mungo). Hardpans and laterites develop at slope breaks creating shallow soils (Tiko and Bambutus foot-slopes).

Common management practices include bench terracing in undulating and rolling plateau (the Bambutus) to reduce surface and mass erosion and improve rooting in stony and rocky parts, surface runoffs, landslides (Bafaka of the Rumpi mountains, Limbe and Tole of Mount Cameroon and Wambane of the Bambutus) and gullies. Mechanization and leveling is the comparative practice in industrial production to homogenize planting, effective rooting and drainage. Within farms and plantations, banana plants accumulate rain and irrigation water in pseudo-stems moved down-slope or leached (Rishirumuhrwa, 1996; Barriere, 1998). In all units, land cover (vegetation,

weeds or residues) and effective fallowing is observed to be a provider of erosion control in different ways. Planting should specifically be on flat, gentle or steep areas on newly opened farms or lands under fallow. Weeds should be appropriately managed while irrigating during the dry season and preparing drainage ways before planting (like in the newly opened farms in Mussaka of the Mount Cameroon foot-slopes).

Table 1. The main conservation units around mountains in south western Cameroon.

Conservation Unit	Salient characteristics	Banana and plantain status
Slopes	Red & brown soils (unit 1) and yellow soils (unit 4)	Dessert and cooking types for local consumption
Highlands	Black soils (unit 3) and red soils (unit 2)	Dessert and cooking types for local consumption
Flatlands or foot-slopes	Black soils (unit 3), Red & brown soils (unit 1) and yellow soils (unit 5)	Dessert bananas for export
Non-banana producing units and home-gardens	All 5 units improved using organic residues	Dessert and cooking types for local consumption and markets
Marginal to moderate production areas	Red soils (unit 2) and yellow soils (unit 4)	Tolerant dessert and cooking types for local consumption

The hardpans and laterites developed at slope breaks create shallow soils at Tiko and Bambutus foot-slopes that hinder greatly the deep rooting of bananas. This being an irreversible damage, strategies are needed as remedy. Common management practices however include bench terracing in undulating and rolling plateau (the Bambutus) to reduce surface and mass erosion and to improve rooting in stony and rocky parts. This reduces surface runoffs, landslides and gullies. Mechanization and leveling is the comparative practice in industrial production towards uniform planting, effective rooting and proper drainage.

Within farms and plantations, banana plants accumulate rain and irrigation water in pseudo-stems moved down-slope or leached. In all units, land cover (vegetation, weeds or residues) and effective fallowing is observed. Developed observations combined into conservation areas with soil depth, stoniness and slope as the most limiting factors to *Musa* crop production. Lands around Mt Cameroon like in Muea and Ekona on the lower foot-slopes of Mount Cameroon have a stepwise configuration (topography) with numerous scarps and few escarpments with gentle to steep slopes. The stepped nature of the landscape is as a result of volcanic flows of the Quaternary age, the younger ones deposited on top of the older ones forming the "Young volcanic landscape". In the middle of these volcanic flows is a slightly depressed part compared to the edges giving a concave form that often rises in the form of distinct steps, controlled by the limits and edges of the flows (short but steep). Two types of soil parent material are thus identified. Lava flows or flows of molten basalt ("fire bum") from the fissures of the upper mountain sides observed around Ekona in palm based plantain production systems with stony and rocky surfaces. Mud flows are deposits of loose pyroclastic material (ash, scoria, cinders) from the upper mountain slopes. They have moved down-slope in the form of a sludge after heavy rains following volcanic eruptions. The more important ones carry along stones and boulders and the front of a mudflow is usually very stony with large boulders, partly smoothened during transportation. Mudflows are generally deeper but some are moderately deep and shallow and are underlain by lava-flows. Mudflows vary in age and composition. Examples are in Muea and Buea areas. Recent landslides and soil creeps (2003) in Wambane of the Bambutus mountain can be likened to this.

The climate over a period of ten years in this humid part of Cameroon show two distinct seasons (the rainy and dry seasons). The rainy season starts in March and ends in November with July – October being the wettest months. The months of March – June and September – November are periods of heavy rainfall often accompanied by strong winds that cause damage to bananas and plantains. The total annual rainfall of above 2000 mm attains 10.000mm in the western parts bordering the Atlantic Ocean. On the eastern slopes, the distribution of the rainfall is poor. For bananas that need moisture throughout, it would be necessary to think of irrigation during the dry season. The area is drained by streams derived from rills, gullies and sheets arising from the fronts of the mudflows. They only become permanent streams when they ooze out as springs on the lower flanks. Higher up they mainly flow during the rainy season because of the porous pyroclastic nature observed. The very small number of streams on these mountains is therefore due to the fact that in the young volcanic landscape of lava-flows and mudflows drainage system is not well developed with a direct consequence that there are very few permanent streams or small rivers

formed with the release of large amounts of water after the flows come to a standstill. They are replenished with infiltrated rain water flowing laterally on the floor of the flows.

Banana and plantains are cultivated, fallow ex-banana lands exist and intensively cultivated areas with food crops like plantains are also numerous. Lands around these Mountains are also planted with plantains in palms, robusta coffee and rubber based systems at lower altitudes and in tea and arabica coffee based ones higher up. Soil conservation based assessment showed steep slopes, shallow depths and stoniness in most soils. Adverse soil related climatic conditions were very high and intensive rainfall on the one hand and drought conditions during the dry season on the other hand. Soils are young and old volcanic types. Young volcanic soils are loose and mainly from mudflows, ashes and lava-flows while those from old volcanic materials are on plateau basalts. Mudflow and old volcanic soils are generally deeper and less stony than lava-flow soils. The young volcanic or most recent soils are chemically richer while the old volcanic soils are chemically poorer and generally have a higher clay content (Musaka in Ekona banana area of mount Cameroon).

Conclusions

In conclusion, bananas thrive best on the foot-slopes of these mountains because of freely – drained, well-aerated, deep, fertile loam soils (FAO, 1983). But with plantains, they should be grown on a wide range of soil types which respond satisfactorily to good drainage practices and adequate fertilizer applications. This is so because banana roots will not tolerate water logging nor drought. Although loams are the best banana soils, other soils rich in clays and sands found further down-slope can be improved by the addition of organic matter. The pH can be improved using lime to a range of 5.5-7.5 but 6.5 as the optimum since the amount of nutrients needed for bananas vary but depends on the yields. This will help solve critical low levels quoted (about 20 ppm for phosphate and 300 ppm for potash (Landon, 1984). A $CaO/MgO/K_2O$ ratio of 10:5:0.5 is the best to prevent antagonism between these nutrients (Landon, 1984). To concentrate nutrients and water for *Musa* crop production, organic matter concentration and recycling strategies are necessary.

Mountains in the Gulf of Guinea, Central Africa being volcanic and draining into the Atlantic ocean, should be given for *Musa spp* production, soil and water conservation strategies. Banana production units identified and characterized show variation in production and management strategies combined into conservation areas of 2 types (dessert and cooking) with industrial and traditional methods. Industrial production is on the best lands (the foot slopes of volcanic ash, phonolites and basalts and alluvial sedimentary basins. On flat lands and slopes for local consumption, cooking types are produced in small scale cutting across different land types. Main units are on steeper slopes and highlands, for locally consumed dessert and cooking types. On flatlands and foot slopes are produced dessert bananas for export. Non-banana producing units are marginal to moderate. Topsoil and mulch management (inter row waste disposal) strategies are advised planting on flat, gentle or steep areas with specific strategies. Fallow and weed management, irrigation and drainage should be practiced. Erosion types (rill, sheet, gully and streams) towards floodplains showing brown waters should be eye-opener to potential conservation plans, noting that laterites develop at slope breaks creating shallow soils. Common management practices should include bench terracing in undulating and rolling plateau to reduce surface and mass erosion and improve rooting in stony and rocky parts, surface runoffs, landslides and gullies. Mechanization and leveling is the comparative practice advised in industrial production to help homogenize planting, effective rooting and drainage. Land cover (vegetation, weeds or residues) and effective fallowing should be emphasized.

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References

Barriere, O. (1998). Culture bananiere et techniques de gestion des sols acides du Burundi. Pp 32 and 33 in: special erosion, ORSTOM actualites.

Blomme, G., Draye, X., Rufyikiri, G., Declerk, S., De Waele, D., Tenkouanou, A. and Swennen, R. (2000). Progress in understanding the roots of Musa spp. Pp14-19 INIBAP Annual Report 1999, Montpellier, France.

CRBP (1998). Rapport Annuel 1998.

CTA (1998). La gestion des sols par les populations locales, experiences in community based land use management in sub-saharan Africa. Actes du seminaire du CTA, Bamako, Mali 9-14/11/1998.

Driessen, P.M. and Dudal, R. (1991). The major soils of the world. Lecture notes on their geography, formation, properties and land use. Wag Agric Univ and Kath Univ Leuven.

FAO (1983). Guidelines: Land Evaluation for Rainfed Agriculture. *FAO Soils Bulletin* 52. Soil Resources Management and Conservation Service. Land and Water Development Division, FAO, Rome, 1983.
Lahav, E. and Turner, D.W. (1989). Fertilising for high yield banana. IPI Bulletin 7, 2nd ed, Berne / Switzerland, 1989.
Landon, J.R. (ed), (1984) Booker Tropical Soil Manual.
Mulder, M.A. and Legger, D. (1986). Aspects of airphoto interpretation for landscape analysis and soil surveys. 12pp Agric Univ Wageningen. The Netherlands, April 1986.
Rishirumuhirwa, T. (1996). The contribution of banana farming systems in sustainable land use in Burundi. ISCO conference, Bonn Germany, 1996.
Roose, E., Arabi, M., Chebbani, R., Mazour, M. and Morsli, B. (1998). Impact de l'intensification de l'agriculture de montagne sur l'environment et les revenues. Pp 26 and 27 in: special erosion, ORSTOM actualites, 1998.
USDA (1994) Keys to Soil Taxonomy, 6th Ed. (1994). USDA Soil Conservation Service. Washington, D.C. USA.