SOIL AND CULTIVATION IN THE PAPUA NEW GUINEA HIGHLANDS: 1. INDIGENOUS APPRAISAL OF THE VARIABLE AGRICULTURAL POTENTIAL OF SOILS

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ABSTRACT

The hypothesis that some Southern Highlanders of Papua New Guinea do not inspect the soil on potential garden sites before clearing for cultivation is examined. How Wola people assess the cultivation status of their soils is explored. It was found that properties central to their appraisal of soil are depth, strength, stoniness, 'grease' content and water state. Factors assisting the long term protection of Wola environment are briefly outlined.

Key words: Papua New Guinea, Southern Highlands Province, shifting cultivation, soils, ethnoscience, land use, appraisal.

INTRODUCTION

Soil is essential for plant growth, yet the Wola people of the Papua New Guinea highlands, who are highly skilful semi-shifting cultivators, contend that assessment of it does not feature in their selection of garden sites. Their apparently offhand attitude to soil on potential cultivation sites is unexpected. According to them, an inspection of the soil before clearing it of vegetation for cultivation is not among the considerations that constrain and influence their choice of site, which include issues like cultivation rights as stipulated by their kin-founded land tenure system, site aspect and ease of enclosure, location relative to house and other gardens, and so on.

It is possible to 'explain' away their apparently nonchalant attitude to soil on the grounds that its validity is difficult to assess. The people know their local regions so intimately that they have no need deliberately to look closely at the soil at any place before deciding to cultivate it. They already know its status on those territories where they have rights of access to garden land by virtue of living there, constantly walking over them in the course of their daily lives. But Wola insist that even if they found themselves in an entirely unknown part of their region (e.g. by virtue of affinal connections) they still would not closely inspect the soil before cultivating it.

Alternatively, we may try to account for their assertions by arguing that while they think that they do not look closely at the soil before establishing a garden, this is only their perception, and that they are unconscious of their assessment of their soil resources (e.g. walking around barefoot that they are tactually aware of texture and structure). Furthermore, we might suggest that the vegetation growing on a site may give an indication of the soil's worth, by its health and the prolificness of its growth, even the presence of certain species above others. But again the Wola deny that this is so, and casual field observations support their assertions (neither vegetational features seem to be associated with their soil assessments nor different soils).[1]

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ATTITUDE TOWARDS ENVIRONMENTAL ISSUES

The casual attitude that the Wola evince towards soil assessment reflects their off-hand attitude towards environmentalist issues. Unable to foresee soil agricultural potential, they acknowledge little control over or responsibility for their soil environment. The soil is there to be exploited, to the full, even if that exploitation is somewhat random and not finely judged. They push the soil to its fertility limits, until costs oblige them to relent.

The Wola follow their semi-shifting agricultural strategy and abandon some garden sites to natural vegetation and regeneration, not in their minds to protect the environment, but because crop yields decline beyond a tolerable point where the labour put into their cultivation is inadequately repaid. This is not to suggest that they invite environmental degradation, for example top soil erosion, if they can avoid it, although again not because of the environmental damage, but because of the wasted labour. No one likes to work to establish a new garden for example, to see their efforts swept away, although the steep slopes they are obliged to cultivate leave them vulnerable at certain times, and intense rainfall can result in serious erosion losses.

THE WOLA

Speakers of the Wola language occupy five valleys in the Southern Highlands of Papua New Guinea, from the Mendi river in the east to the Ak in the west. The region comprises many territories identified with bilaterally-constituted patrifilially-biased communities known as *semonda*, subdivisions of which structure rights to, and tenure of, garden land. They live in small houses scattered along the sides of their valleys, in areas of extensive cane grass land; the watersheds between are heavily forested. Dotted across the landscape are their neat gardens. They practice a largely sedentary variation of shifting cultivation, featuring alternate cropping and fallow periods of variable duration, and subsist on a predominantly vegetable diet in which sweet potato is the staple (Sillitoe 1983).

They keep pig herds of considerable size. They hand these creatures, together with other items of wealth such as sea-shells and cosmetic oil, around to one another in interminable series of ceremonial exchanges, which mark all important social events. These transactions are central to the ordering of their fiercely egalitarian acephalous society (Sillitoe 1979). Their supernatural conceptions centre on beliefs in the ability of their ancestors' spirits to cause sickness and death, in various other forest spirit forces, and in other's powers of sorcery and 'poison'.

INDIGENOUS APPRAISAL: VARIABLE SOIL PROPERTIES

An analysis of soil and site data, presented in Part II of this series of papers, vindicates Wola assertions about having no need to inspect soil closely before cultivating it, not because they already know its status but because of the striking uniformity of the soil resources generally available to them (Wood 1987).[2] There is not a great deal to choose between the majority of soils of their region by readily observed properties (i.e. those not involving laboratory analysis). While the analysis distinguishes

[1] Any correlation that we might assume ought to exist between soil potential and vegetation would require a comparison of a detailed logging of plant development on different sites to prove, because according to the Wola it does not relate to any easily seen macro-botanical feature such as species type, which casual observations in the field confirm.

[2] The findings reported here reflect an emergent concern with others' perceptions of their soil environments, for while interest in ethnopedology is small in comparison to zoological and botanical ethnoscience, it has attracted some attention recently (see Ollier *et al.* 1971; Landsberg and Gillieson 1980; Dvorak 1988; Behrens 1989; Furbee 1989; Guillet 1989; Sillitoe 1991; Philips-Howard & Kidd 1991).

between grossly different soils (such as recent alluvial, gleyed and skeletal profiles), these only cover a small part of their region. The larger part of it comprises 'dark topsoil/clayey subsoil' soils (the humic brown soils, Rutherford & Haantjens 1965; Radcliffe 1986), which the analysis consistently groups together into stable clusters. When the horizons that comprise these soils are further divided into groups some very fine distinctions are necessary, which neither local people nor soil scientists would consider significant.

The Wola cultivate the majority of their crops on very similar soils (the notable exception is wet-soil-loving-taro), which cover by far-and-away the larger part of their country. In the light of this evidence their assertions no longer seem so remarkable, the soils of their region being, by and large, so alike that close inspection would be pointless. Nonetheless not all soils are the same when it comes to cultivation. The Wola do assess soils, if not before gardening, then certainly when they are under cultivation. In this event, how do they judge the worth of any soil, and why is this a post-cultivation process?

The Wola assess the agricultural potential of their soils according to a few properties which they take to be critical to their productivity. They relate to topsoil only, focussing understandably on the horizon in which crops largely root and grow. Nevertheless, while it is the status of the dark *pombray* topsoil that is critical in the appraisal of agricultural potential, the Wola recognise that the subsoil can influence the character of the topsoil, especially if the latter is thin and the former near the surface:

The properties central to the appraisal of a soil's productive status include its depth, strength, stoniness, *iyba* 'grease' content, and water state, as follows:

The depth ***of topsoil, which may be assessed as*** onduwp ***(lit: much) or*** genk ***(lit: little) or qualified versions of these words, is important as determining the amount available of the medium in which crops are recognised to grow well. Although there is really no lower limit to the thickness of topsoil acceptable in a garden, the thicker it is better, and if the subsoil shows through in places the site is likely to be abandoned.***

The strength ***of the soil and its assessment relates in part to concerns over its depth because the clayey subsoils are judged too strong for good crop growth. By strength the Wola are referring to the consistence and friability of the soil. They talk of soil as*** buriy ***(lit: strong) or*** tomiy ***(lit: weak) or as a qualified version of these terms, and assess it as a handling characteristic. If a soil is*** buriy ***strong its agricultural usefulness is low because they say roots and tubers have trouble penetrating it, the mechanical resistance to their growth results in stunted development and poor yields.***

The stoniness ***of a soil only becomes critical when it exceeds a certain percentage, hindering cultivation and acting to increase soil strength, impeding adequate root development. Some stones are judged beneficial to a soil. They act to warm it up according to the Wola, heating in the sun and retaining the absorbed heat longer than soil alone, so promoting the growth of crops which prefer a warm soil to a cold one. Stones also promote porosity, creating cavities and points of weakness in the soil which roots can exploit, and so off-set soil compaction. And some stones they say, especially*** araytol ***chert, promote the development of*** iyba ***'grease' (although silica minerals have no obvious nutritional value to plants).***

The iyba ***(lit: blood or sap) or*** hobor ***(lit: fat or grease) content of a soil derives from rotting plant matter. It is assessed by the soapy, silty feel that organic matter imparts to soil, the greasier the better. It dries out under cultiva-***

tion, little rotting plant material being returned to the soil, until the soil becomes exhausted iyba na wiy ***(lit:*** iyba- ***'grease' not resides) - it is interesting to note that a weak, sick person is also*** iyba na wiy, ***that is someone without blood. The growing crops take up the*** iyba ***until little remains. The only crop that can continue to yield on a considerably*** iyba ***depleted soil is the staple sweet potato. When the garden is abandoned, the rotting of vegetation deposited by the regrowth will replenish the*** iyba ***'grease' levels of the topsoil.***[3]

The water state ***of a soil, its*** iyba ***content, is critical for the healthy growth of crops. The majority require a moist aerobic soil; the staple sweet potato (***Ipomoea batatas***) cannot tolerate conditions too wet. The notable exception is taro (***Colocasia esculenta***) which thrives in a waterlogged soil. While distinguishing between waterlogged*** pa ***sites and others is straightforward, differentiating between moister and drier better drained soils is not easy. When under natural vegetation soils tend to be wetter, and the extent to which they will dry out and improve when cleared and exposed to the sun is difficult to assess.***

The element of chance features in all of these appraised properties, which relates to Wola assertions that they do not inspect soils before cultivating them. They may all be subject to change once a soil is under cultivation. The depth of topsoil is liable to diminish due to erosion, notably in newly planted gardens where the soil is exposed and scarcely protected by vegetation. The considerable slopes on which the majority of gardens are sited and the intensity of the region's rainfall exacerbate this problem. And loss of fine soil particles, leaving the larger stones behind, can increase stoniness beyond the point where it imparts beneficial qualities to the soil, hindering cultivation and crop growth. The soil's strength is thus likely to increase and diminish yield potential, especially if subsoil is exposed with erosion and subsequently mixed with the topsoil during cultivation.

It is not only the incorporation of clayey subsoil that increases *buriy* strength, some topsoils, when exposed to the sun for a considerable period of time in a garden, can become excessively dry and hard, which if they have a non-granular structure can render them unsuitable for further cultivation. The change in soil water content under cultivation is difficult to judge, but it usually falls. Until the sun has 'looked on' the soil, as the Wola put it, they cannot be sure of its water state under cultivation; it is possible that the soil might rapidly become too dry and strong. Furthermore the water state can be adversely affected during cultivation of a site. When establishing a garden for example, people are careful to keep off the site after prolonged heavy rain for fear of pudding it with their feet to a liquid mud state called *suw mondow;* for the same reason they take care clearing areas where there is *gaimb kolowmon*, a thick black layer of rotten water-filled cane grass (*Miscanthus floridulus*) stems, which trodden in will puddle and degrade the soil's structure and render it unsuitable for cultivation.

The organic matter related *iyba* content is certain to decline under cultivation - a fall in carbon content being long associated with fertility decline and site abandonment under shifting cultivation (Nye and Greenland 1960; Brams 1971; Zinke *et al.* 1973; Sanchez 1976). Again rate of depletion is not easy to estimate, although some locations are customarily recognised as more likely to retain respectable *iyba* levels than others (such as folds and down slope locations), but these may be too shaded and not see enough sun for optimum crop growth, sufficient to reduce water content, warm the soil, and give crops maximum exposure to the sun's energy.

[3] There is some parallel between this concept and the early notion of European science of 'juices of the earth' - Wild 1988: 2-5.

AGRICULTURAL POTENTIAL OF SOIL : DEVELOPMENTAL SOIL STATES

While the Wola have no series of appraisal class terms that they can apply to a soil before cultivation, to label its agricultural potential, they have a clear idea of what comprises a good, bad or indifferent agricultural soil. But using these criteria, they talk only in generalities, not specific predictions. A good topsoil for example, should extend to a fair depth, ideally with an abundant store of *iyba* organic matter, have a not too moist water content, and perhaps a modicum of stones. Structure features too in any soil assessment, the Wola having a keen sense of soil structure, referring to aggregates of any size as *suw ombo.*

A good soil has a loosely packed, non-coherent, porous crumb structure. A commonly heard phrase of such a granular soil is *dowhuwniy nonbiy* (lit: sweepings like), the Wola likening it to the crumbs of rubbish, grit and dirt periodically swept from houses. We can perhaps sense in part what they are looking for here in the computer cluster division of horizon 2 (that horizon which most often equates with their *pombray* topsoil class), as described in Part II of this series of papers. Notably the major distinction between loosely packed soils of low density, poor coherence and highly porous crumb structure, and more packed soils of higher density and coherence, and a less porous more aggregated blocky structure.

These criteria, by which the local people assess the agricultural potential of a soil, cut across their soil classification classes (Sillitoe 1991), although they may be used to qualify a class, by referring for example to *pombray buriy* 'strong topsoil' or *pombray iyba wiy* 'topsoil with *iyba* grease'. These criteria relate more to a series of soil states distinguished by the Wola than to soil classification. They serve to demonstrate further how appraisal for soil potential is largely a relative issue for them, closely associated with time and use. It is an ongoing rather than a predictive process, based on observed soil performance under cultivation, and occurs during and after land use rather than before it.

While the soil state classes they distinguish relate to soil assessment, they do so post-cultivation only. Indeed the soil state classes are not so much use assessment classes as a broad developmental sequence soils may follow under cultivation. They run as follows:

1) suw ka ***(lit: soil raw) is either soil under long standing natural vegetation or newly cleared soil that has not been cropped. It has a good*** iyba ***'grease' content but its final water state and strength are difficult to judge.***

2) suw hemem ***is the best soil state, and few soils achieve it. It occurs where a considerable depth of vegetation waste accumulates, notably at the foot of slopes and on small flat areas. It is often human-made as a result of the build up of decaying vegetation and topsoil along a fence line at the bottom of a slope. It rots down to produce a thick layer of soft, black,*** iyba-***'grease'-rich topsoil in which crops flourish. It is common, as a consequence, to see a variety of crops growing at the foot of the slope in an established garden adjacent to the fence where*** suw hemem ***accumulates, the remainder of the site given over almost exclusively to sweet potato.***

3) suw huwniy ***is a soil state achieved in some gardens following exposure to the sun. It is a good soil for sweet potato. It is not as soft as*** suw hemem, ***comprising coarser crumbs, and it is relatively deficient in*** iyba ***'grease'. But it is porous and*** tomiy ***weak, so tubers can penetrate and grow well in it. It only occurs following the break up of the topsoil, when women have heaped it up into mounds for sweet potato. And the more times it is cultivated the better the***

granular huwniy ***structure may become for sweet potato cultivation. If a soil develops into the*** huwniy ***state, the time that it remains cultivable is related to the depth of the topsoil. If it is considerable, and the garden slope gentle such that erosion losses are small when the soil is exposed under a newly planted crop, then it can remain in this state indefinitely and support a sweet potato garden for decades. A common strategy with these gardens is to work in a rotational manner around them, leaving an area to rest for a period under*** bol ***grass (*****Ischaemum polystachyum*****) to replenish its*** iyba ***'grease' levels, a practice called*** suw hombshor ***(lit: soil share-out i.e. share out its use, to conserve a modest organic matter content).***

4) suw taebowgiy ***is the worst soil state. The soil is*** buriy ***strong, hard and cloddy. Sweet potato tubers find it hard to penetrate and grow in, and weeds can compete effectively with the crop. It is deficient in*** iyba ***'grease'. Any tubers that grow are small and stringy, and may be so poor as to become what the Wola call*** hokay haeriy, ***that is bitter tasting with a flesh that turns an unpalatable grey colour when exposed (like a green apple turns brown when cut open). When a garden soil becomes*** taebowgiy ***it is time to abandon the plot. The time that soils take to reach this poor condition varies, from one or two years under cultivation onwards.***

5) suw pa ***is waterlogged soil. It is unsuitable for any crops other than wet-loving taro and skirt sedge (*** Eleocharis dulcis ***), although a range of other crops may be planted on any higher ground, notably around the base of trees whose transpiration demands have somewhat dried out the topsoil and bound it together (Sillitoe 1983). Waterlogged soil does not follow the above development sequence but remains*** pa. ***Nevertheless it quickly becomes tired under cultivation. Taro is a heavy user of*** iyba ***'grease' supplies and these soils are cropped once only and then allowed to regenerate their natural vegetation cover and*** iyba ***'grease' fertility.***

The foregoing gives further credence to Wola assertions about feeling no compunction to investigate soil before cultivating it. They can hardly assess the favourability or otherwise of any soil beforehand, if its character only becomes evident under cultivation. It is necessary to clear a site and allow the soil to dry out somewhat in the sun to appreciate better its potential. It also becomes more apparent following its break up and mounding, when the extent to which it may develop the favourable porous granular *huwniy* structure becomes clear. The extent to which its *iyba* 'grease' reserve might be conserved is also largely unknown, although certain localities are more favourable to this than others, such as down-slope and in folds where the best *hemem* soils are likely to form.

The locations where favourable soils are likely to develop are limited on any site. It would be pointless to assess an entire garden from one of these favoured locations alone, when they make up only a small part of its area. Similarly, assessment of topsoil depth, the criterion that might be thought readily determinable, is not feasible because it can vary greatly over short distances within a garden. There is little point in checking it in one or two places when it will probably differ everywhere else. The same applies to the assessment of stoniness. The gardeners themselves exploit these site microvariations as they become apparent when they plant their crops, siting taro on particularly wet spots such as seepages, and a variety of crops such as greens, pulses and cucurbits along the bottom of slopes and in folds, where the topsoil is likely to be deeper and more *iyba* organic rich.

SOILS UNDER SHIFTING CULTIVATION AND LOCAL KNOWLEDGE

The soils of the Wola region not only display a considerable homogeneity overall, are similar in a broad classificatory sense as the analysis presented in Part II demonstrates, but also, in the variations they do manifest, vary in a largely unpredictable and continuous manner, both in the way some of their properties respond to cultivation and spatially as distributed across garden landscapes. Where soils are generally so similar, and variations between them crucial to crop growth not readily perceived, even canny and experienced farmers find it hard to make reliably informed judgements about their possible potential. They cannot be at all sure about their behaviour. After all, some soils they maintain, progressively improve the longer they are under cultivation, and the only way to find out is to garden them. This is the exact reverse of the current image of soils under a shifting cultivation regime, as experiencing either a swift fertility decline, unmanageable weed infestation or some other rapid agriculturally deleterious change, which forces a change of site.

The shifting cultivation practices of these New Guinea highlanders appear to contradict the accepted wisdom of this agricultural regime. Regarding soil inspection for example, their disinclination to it when selecting a garden site contrasts with the behaviour of people elsewhere who study soil and vegetation, and even reportedly subject it to tests like tasting it (Conklin 1957: Gourou 1962: Allan 1967: Ruthenberg 1976: Allen 1982). The understanding that we have of tropical subsistence agriculture derives in considerable part from work in regions of old soils, like Africa and South America, and there is a tendency to generalise from it to the equatorial tropics as a whole, whereas we should not expect people living throughout this region of the world necessarily to follow similar practices.

The evidence suggests that we should not lump the subsistence cultivators of New Guinea, nor those elsewhere cultivating on relatively young soils (e.g. on other Pacific islands and parts of S.E. Asia), with shifting cultivators living on ancient land surfaces. The uniformity of the soils that occur in the Wola region, as demonstrated in Part II, which is central to understanding local pedological lore, can for example be attributed in part to their comparatively young age. Soils of the Inceptisol order show relatively little variation campared to older orders because they have not existed long enough to bear the imprint of local environmental variations and diverge. The geologically recent volcanic rejuvination of the region's soils has further contributed to their uniformity and youth (Pain and Blong 1979; Blong 1982; Wood 1987).

PROTECTION OF WOLA ENVIRONMENT

We have a long way to go before we understand the dynamics of these tropical agricultural systems. Clearly, those who have lived by them for generations can only help further our knowledge (Chambers 1983; Richards 1986). No matter how technically primitive people may appear, we should not allow this to fool us into thinking that their understanding of their environment is deficient in some regards, nor that their knowledge of the world as they experience it is somehow undeveloped and elementary, even inadequate. If this study has achieved nothing beyond demonstrating that a scientific survey and computer analysis cannot better local lore, so lending support to the tenets of sustainable agriculture now gaining ground, then it has been worthwhile. It is time that experts respected local knowledge and consulted it closely, before they try to improve on it. (Thomasson 1981; Chambers *et al.* 1989).

Nevertheless it would be erroneous to depict the Wola as innate conservationists, as culturally conditioned environmentalists who can be relied upon to use new technologies and innovations in a naturally sound way. They evidence little interest in environmentalism in their use of their soil resources, displaying no apparent cultural recognition of responsibility for the natural world nor act as if they have a duty to conserve it. It will look after itself under the farming regime. If a soil develops favourable agricultural attributes under cultivation they are likely to crop it indefinitely, adopting cultivation strategies, like short term grass fallow and green composting, to extend its useful life (D'Souza & Bourke 1986). There is no notion here of protecting the natural environment from the potentially harmful effects of human activities, but of exploiting it to its maximum.

The Wola have abundant soil resources and can move to new sites as they exhaust old one; with abundant land available they are not exploiting their resources near to the margins given their current technology, when we might expect environmentalist-like concerns perhaps to become apparent. The abandoned sites in turn recover under natural vegetation. This is an inevitable natural process, not one dependent on human agency. It is their agricultural technology, coupled with a modest population density, rather than their cultural ideology, that protects the Wola environment in the long term.

ACKNOWLEDGEMENTS

I thank my Wola friends in the Southern Highlands Province for their assistance and hospitality while investigating the soils of their region, particularly Maenget Pes who helped me throughout, and Ind Kuwiy, Wenja Muwiy, Mayka Yaaliyp, Huwlael Kombap, Mayka Waeriysha and Ind Haendaep who carried equipment for me on my journeys throughout their region. Also Dr. R. Shiel of the Department of Agricultural and Environmental Science at the University of Newcastle upon Tyne for his good humoured assistance with the study, notably with the computer analysis which proved more awkward than we anticipated because of the large volume of data. And the British Academy for a grant to pursue the fieldwork and conduct the soil survey.

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