Agricultural Intensification and Perimetrics: Ethnoarchaeological Evidence from Nigeria

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Agricultural intensification has become one of the most widely discussed issues in archaeology. Along with the many theoretical discussions of how intensification relates to social evolution [Jolly and Plog 1987:439; Upham 1990; Netting 1990], population [Spooner 1972], environmental change [Nichols 1987], and “social production” [Brookfield 1972, McGuire 1984], there is growing interest in the practical problem of identifying intensification in the archaeological record. Recent work reflects optimism that resourceful archaeologists can discern intensification. Wilkinson [1982, 1989; Stone, Wilkinson, and Mortimore 1994], for instance, measures sherd scatters around Iraqi tells, reasoning that they result from the incorporation of detritus into dung imported as farm fertilizer. McAnany [1992] looks to changes in the locations of lithic debris as an indicator of intensification, and Kirch [1976] invokes linguistic evidence. The approaches are ingenious but eclectic, and their strengths and weaknesses and their generalizability are not well understood. I will explore another line of evidence based on material changes associated with the land tenure arrangements promoted by intensification. I am going to look at the demarcation of agricultural boundaries or perimeters with perimetric features.

I want to sketch a theoretical basis for linking intensification with perimetric features and then illustrate the relationship with examples from Nigeria. I will then consider one factor that may reduce agricultural demarcation, social enforcement of boundaries. Finally, I will consider the archaeological detectability of perimetric features.

Writing about the Pacific, Brookfield (1972:32) pointed out that intensification often leads not to land improvements but only to changes in land allocation and the spatial organization of farming. “These leave no physical trace on the land when they are relinquished. Indeed, the physical evidence of major site transformation, which is often all that remains to be seen of former intensification, and the archaeological record therefore constitute only a partial and biased inventory of past practices.” Yet changes in land allocation and the spatial organization of farming may indirectly provide archaeologists one of our best lines of evidence for intensification. Intensification changes how people work the land, which may be archaeologically invisible. But it also changes how people control the land, and that can be archaeologically relevant.

Intensification is the substitution of labor for land. Intensification increases [or checks the decline of] agricultural output per unit of area and unit of time but only by exacting higher marginal costs in labor or capital [Boserup 1965, Turner and Doolittle 1978]. Its simplest form is the familiar fallow shortening, but it involves diverse tactics some of which rely on technological changes [such as the plow] and landscape modification [terraces, irrigation, ridged fields, wet-rice dikes] and others only on changes in the type and scheduling of tasks [Stone, Netting, and Stone 1990].

The boundaries of cultivated plots are given material form with perimetric features. We can distinguish between manifest or “pure” and latent perimetrics. Pure perimetrics are constructed to mark boundaries [that is, to transmit information] and/or protect boundaries [that is, to control access]. Examples of perimetrics built to protect boundaries range from the Great Wall of China to the walls surrounding orchards in some Omani cities [Bonine 1979]. Latent perimetrics mark boundaries but are not constructed for this primary purpose. They may be constructed for agricultural purposes [such as terrace walls or grape arbors] or nonagricultural purposes [such as roads] or they may be natural [such as rivers]. Pure perimetrics may have latent agricultural functions. English hedgerows are pure perimetrics—in fact, during the parliamentary phase of enclosure, farmers were required by law to bound their fields—but they also benefited production by providing shelter to cattle, reducing evaporation and deflation, and possibly raising the soil temperature [Davis 1951:353].

The theoretical basis for associating intensification with boundary marking is fairly straightforward. Intensification is a basic response to land pressure [defined as increase in the ratio of food demand to productive land], although it is not the only response to land pressure2 and land pressure is not its only cause.3 Nevertheless, cross-cultural and case studies repeatedly show intensification where rural population density is high [Kates, Hyden, and Turner 1993]. Here land is increasingly scarce and increasingly being improved by tactics such as

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2. Other responses to land pressure include abandonment [Stone n.d.] and increased craft production [Feinman, Blanton, and Kowalewski 1984, Smith 1975].
as fertilizing, ridging, irrigating, draining, rock clearing, terracing, and tending of economic trees that further increase its value. Therefore there is more potential for land disputes, and it becomes worthwhile to attempt (and to contest) increasingly minor encroachments. Intensive plots therefore tend to require boundary protection.

Intensification also tends to immobilize agriculture and promote permanent land tenure (Boserup 1965, Netting 1993). This means that there are more enduring boundaries to be marked and both opportunity and need to mark them. These incentives to demarcate ephemeral plots are generally lacking in extensive farming systems.

Intensification can also alter the farmers’ relationship to crop predators in ways that promote boundary marking. Extensive farmers can afford to be more tolerant of crop predators. Evans-Fritchard (1940:80) could hardly conceal his impatience as the Nuer allowed wild animals to damage and even destroy their millet fields. Extensive farming is characterized by relatively low investment and little desire to maximize output per unit of land; this is inconsistent with investing much time or effort in fencing, even if the crops may attract some predators. In fact, in some extensive systems cultivated fields are meant to lure animals, which can then be hunted as part of a relationship that can be compared to domestication (Linares 1976).

Although intensive farmers are often settled densely enough to squeeze out wildlife that might threaten crops, in many cases they must protect crops from domestic animals. Livestock are not exclusive to intensive farmers (indeed, when pastoralists cultivate it is often extensively), but crop production is often limited by the supply of fertilizer, which places a special premium on animal husbandry in intensifying agricultural systems. This does not necessarily increase crop fencing, as animals may be more easily fenced into corrals than out of fields. Penning means that the animals must be fed, but it averts the need for animal-proof fencing of plots and also allows collection of manure for fertilizer. However, in many parts of Africa the animals range freely in the off-season, so when intensification stretches the growing season (Stone, Netting, and Stone 1990:19–20), animal fences may be needed in the off-season (Gleave and White 1969:287–88).

There are various reasons, then, for there to be a premium on boundary marking in intensive farming systems, and where latent perimetrics are absent we can expect a tendency for pure perimetrics to be constructed. This is not to say that perimetrics will necessarily occur where cultivation is intensive, only that a set of factors exists that should promote them. It is also not to suggest that pure or even latent perimetrics pertain exclusively to land use and control; their form may have social, political, and conceptual implications (Friedel and Sabloff, cited in de Montmollin 1989:295). We may, however, expect them to correlate well enough with intensification to make them a useful archaeological indicator.

Both intensification and field demarcation are measurable, and it should be possible to explore this relationship worldwide. Such data are not available, but I can draw on observations of agricultural systems across Nigeria to examine the relationship nonquantitatively. Nigerian landscapes offer rich variety in population density and agricultural tactics. Nigeria is home to some of the best-known cases of both extensive, mobile agriculture such as the Tiv and permanent, highly intensive agriculture such as the Hausa in the Kano close-settled zone. There also seem to be examples of every grade of intensity in between. My own work has been among the Kofyar, who represent several points on the continuum: they have lived in a crowded homeland, then on an empty frontier, and now on a crowding frontier, and their agricultural intensity has followed each stage in fine Boserupian lockstep (Netting 1965, Stone, Netting, and Stone 1990, Netting, Stone, and Stone 1993).

At the intensive end of the scale, the Hausa of the close-settled zone have a population density that exceeds 300/km². Most of the land is annually cropped and heavily fertilized, and farms are permanently owned by smallholders (Mortimore 1967, 1968). The landscape is rich with perimetric features, pure perimetrics augmenting latent ones (fig. 1). An ancient sunken road

4. The chitemene agricultural system of the Bemba does indeed involve the careful fencing of slash-and-burn plots, but despite its heavy reliance on swidden methods (often taken as a hallmark of extensive cultivation) it is fairly intensive (Stromgaard 1985:70–73).

5. By arguing that intensive farmers should be likely and extensive farmers unlikely to fence fields against wild or domestic animals, I certainly do not want to ignore exceptions such as the Tsembaga (Rappaport 1971), whose fluctuating pig populations force extensive plots to be fenced.

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**FIG. 1.** Ancient road leading out of Kano and, to the right, property lines marked by trees and shrubs. (Photo Michael Mortimore.)
leading out of Kano acts as a latent perimetric, but property lines perpendicular to it are marked by pure perimetrical, perennial trees and henna bushes. Hedges of gamba grass put in by the farmers on both sides of the line create a double boundary [fig. 2]. Boundaries are minded so closely that a few inches may be the subject of a serious dispute. Figure 3 shows a boundary hedge as well as evidence of the intensification that makes demarcation necessary. While these perimetricals are informational, others are built to obstruct traffic. A mat fence may be built around an irrigated, dry-season plot to keep animals out [fig. 4]. This may be done with live stakes or harvested grain stalks. Live stakes are also used to demarcate farmsteads in especially crowded areas in the Igbo area of eastern Nigeria [Udo 1961:6]. Fences in Igbo land may be latent perimetricals, erected principally to protect crops from goats [Karmen 1966:56; Gleave and White 1969:288]. Near Nsukka, in an area with one of the highest rural population densities in Africa, small, privately owned, and very intensively farmed plots are separated by earthen embankments [fig. 5].

Kerang, on the Jos Plateau, exemplifies moderate population density and moderately intensive cultivation. Here infields may be cropped permanently, but there are some fields where cultivation is shifting. The boundaries of these fields are marked with Euphorbia hedges, which also serve as barriers to livestock. They are not as substantial as the Igbo embankments, nor are they as permanent. Boundaries of fields where cultivation is not highly intensive are more subject to change, in which case the Euphorbia hedges may simply be moved [fig. 6]. In some cases perimetricals may be made of plants valuable enough to be maintained because of their own economic value. Hill [1982:136], for instance, describes henna hedges that are not uprooted even when farm boundaries change because of the market value of the henna.

At the extensive end of the agricultural continuum are the northern Tiv, who cultivated largely unimproved plots on a shifting basis, avoiding the high rural population densities that necessitate intensification. The need for more land was handled sometimes by migration but usually by encroachment. The fields had absolutely no perimetric features, a feature immortalized in one of the best sound bites of agrarian ecology: “We don’t have a boundary; we have an argument” [Bohannan 1954a:45; Sahlins 1963]. In contrast, the southern Tiv population was denser, and cultivation was both less mobile and more intensive [Bohannan 1954a, b]. Here the Tiv did indeed mark their fields, although they deplored the boundaries. In addition to the paths that separated fields [latent perimetricals], southern Tiv set rows of sticks in the ground [pure perimetricals].

My own research in the Benue Lowlands shows how the premium on boundary protection and perimetric features changes among one group of farmers as agricultural intensity changes. Since midcentury the Kofyar have been abandoning a homeland on and around the Jos Plateau and settling a frontier on the savanna of the Benue Valley. At first land was abundant and cultivation extensive, but population density now is over 100/km² in most of this area [Stone 1988]. This is less than the den-
FIG. 4. Intensive, irrigated dry-season plot in the Kano close-settled zone, surrounded by a fence of woven mats and high poles. In the lower right is one of the free-ranging goats that helped convince the farmer the fence was a good idea. (Photo Michael Mortimore.)

FIG. 5. Earthen walls demarcating farm boundaries in Anambra State, south-central Nigeria.

FIG. 6. Mwahavul farm near Panyam in Plateau State, with Euphorbia hedges marking field boundaries.
sity of the Kano close-settled zone, but the combination of market incentives and shrinking land base have been enough to produce agricultural intensification on the frontier [Stone n.d., Netting, Stone, and Stone 1993]. Ownership boundaries on the early frontier were marked only by the blazing of trees, and individual plots were completely unmarked. Most boundaries are still marked by little more than designated trees and latent perimeters such as paths, roads, and streams, but, increasingly, neighbors are having disagreements over small areas. Several farmers complained to us about neighbors’ hoeing ridges onto their land while they were off on another part of the farm. The real concern when this happens is that the neighbor will try to parlay this year’s encroachment into next year’s claim to ownership of the few feet of land.

The Tiv may say, “We don’t have boundaries, we have arguments,” but to the more intensive-farming Kofyar the concern is “If we don’t have boundaries, we have arguments.” Since Kofyar farming is much more stationary and dependent on collaboration [Stone, Netting, and Stone 1990; Stone 1992, n.d.], boundary disputes are much more disruptive. The Tiv segmentary lineage is organized around controlled land conflict; the Kofyar lack a comparable organization, and their past wars were fought by stationary villages over things other than land [Netting 1973, 1974]. In the Kofyar homeland, field demarcation had been everywhere, and where the natural landscape did not provide sufficient perimetric features, pure perimeters had been made of rocks and hedges. It was interesting, therefore, to see Kofyar beginning to make pure perimetric features on the frontier when agricultural intensity began to rise. During my fieldwork in 1984–85, I noticed one farmer in the especially crowded neighborhood of Ungwa Kofyar [Stone 1988:168, n.d.] planting a single line of guinea corn to encircle the most intensively cropped part of his land and a line of cassava around another section.

What I have described are only a few of many examples of the perimetric-intensification relation that I saw during ethnoarchaeological fieldwork in Nigeria. Yet neither perimetrics nor any other feature is an entirely dependable indicator of intensification, and it is important next to look at patterning in the cases in which the relationship does not hold. The Nigerian evidence suggests one main contingency—social boundary enforcement—that tends to reduce the demarcation of agricultural plots.

Even holding intensity constant, some variation in field demarcation is due to social and/or legal enforcement. Social authority/consensus backing up ownership boundaries tends to diminish the need for perimetrics [although they may occur even when boundaries are universally accepted, as Robert Frost saw with his conifer-growing neighbor]. Agricultural boundaries usually need at least some degree of social enforcement, because protecting them with purely physical means is next to impossible [the Great Wall of China, for instance, was crossed by the very Mongols it was designed to keep out]. The Tiv themselves ran into a wall built by the colonial authorities to check their encroachment onto neighboring farmlands, but the British colonial presence was too sparse to enforce the boundary and they simply climbed over it [Udo 1970:142]. A case with maximal social boundary enforcement is the one in which a man has given part of his farm to his son. Around Kano, Hill [1982] found that the nearly ubiquitous boundary markers were absent mainly when abutting farms belonged to father and son.

Social boundary enforcement comes from the physical presence of the farmer. The irrigated dry-season plots called fadama in northern Nigeria (fig. 7) are divided into small vegetable gardens. Cultivation is intensive in the extreme, and while some boundaries are marked by embankments, some are totally unmarked. This is a case in which the plots are so small and the farmer spends so much time on them that encroachment of even a few inches would be spied immediately and contested. Here the farmer need not waste any vegetable area on a perimetric feature.

Adler’s [1990] notion of the “social formatting of the landscape,” with its reference to the formatting of computer disks, provides an analogy for the relationship between social enforcement and physical demarcation of boundaries. Computer disks have to be formatted in two ways: there is a low-level [physical] format and a high-level format. The physical format puts electronic benchmarks across the entire disk so that an operating system will be able to locate specific sectors when it is time to read or write data. Very little outside information is necessary to read the physical formatting: it consists of a grid of r’s in a matrix of o’s. The high-level format includes a file allocation table, directory, and other “institutions” native to the operating system, all relying on that system’s concepts of files and space use. Perimetric

7. Controlling land through one’s physical presence is probably a reason for the construction of fieldhouses in the prehistoric Southwest [Kohler 1992].
features provide a boundary with material form the recognizability of which is largely independent of culture. Social enforcement, in contrast, relies on shared or hegemonic notions of authority, land use, and ownership.

Some of the perimetric features described here would probably be undetectable in the archaeological record. From an archaeological perspective, it is unfortunate that organic features such as hedges work so well as perimetrics, because of the obvious problems in preservation. There will often, however, be indicators of perimetric features that survive long after the hedges have decayed. Plants and wooden fences can act as artifact traps [Wilk and Schiffer 1979; DeBoer and Lathrap 1979:129], creating lines of refuse that can survive long after the biodegradation of the plants themselves. New methods for investigating microtextural and microstructural properties of soils [Bar-Yosef and Goldberg 1991] may help us locate organic perimetrics.

Whereas in ongoing systems the hedge may be the most common perimetric feature, rock walls are probably the best-known perimetric features in the archaeological record and have long been recognized as a probable indicator of intensive agriculture [Lundell 1933, cited by Marcus 1982:268]. There is wide variety, however, in the features produced by rock clearing. In the outfield plot shown in figure 8, the Kofyar hill farmer who cleared it of rocks placed them in an alignment that over time will turn into a low retaining wall. The wall is a latent perimetric, serving more to check erosion than to mark the field. The degree of intensification on this field is only moderate—it will probably be fallowed after a few years of cultivation—but it is now clearly bounded by the rock alignment, showing how rocks in the landscape can contribute to especially visible perimetrics for the archaeologist.

The Kofyar homeland offers other examples of rocky landscapes in which enduring perimetrics record intensive cultivation. Long alignments of basalt boulders are still quite visible on now-abandoned land once farmed intensively [fig. 9]. The large basalt wall in the background of figure 10 [arrow] records a similar period of great intensification, but the foreground shows something very different. This area is now depopulated, and fields like this are used on a shifting basis. Some of the rocks in this rice field have been cleared, and they could easily have been placed in a perimetric alignment, but there is little impetus for boundary protection. In fact, an alignment could be an obstruction, since the field might be different in size and shape when it is next brought out of fallow. These cases suggest that in rocky landscapes intensification will dependably be reflected in rock perimetrics; in fact, such perimetrics may occur even under moderate levels of intensification.

The promise of agricultural perimetrics as evidence of intensification seems to be borne out by my survey of Nigerian agricultural landscapes. Like all of our other indicators, it is not reliable in all situations, and we need to examine the relationship between intensification and demarcation in diverse contexts.
FIG. 10. Plot with basalt wall (arrow) outside of Kwalla village.

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