Archaeology consists of both reconstructing what happened and explaining why it happened. Ethnoarchaeology has always been conducted with an eye towards reconstructing the whole, and so it seems ill-advised not to emphasize the linkages between human behavior and material residues. Other studies have been inspired more by difficulties in explaining the urge, and others have explored the causes behind modern phenomena that must have occurred in the past. My research on a group of farmers in Nigeria is an example of the latter; I went to Africa to study how farmers' strategies shaped the unfolding of a settlement pattern. How those settlements might be detected and interpreted in years hence was of secondary concern. In fact, the questions that led to this project crystallized while doing archaeology in an area where the problems of detection and interpretation were radically different.

A Southwestern Beginning to an African Study

When I first saw it, site D:2025 was a scatter of rock and pottery around a shallow depression. It had been built, exactly 1,117 years before, as a farmstead for a small group of Aasanzi farmers. One part of the sparse Aasanzi population that had hunted and farmed on Black Mesa in what is now northern Arizona was also small and also populating a site that comprised a pit-house, a waddle-and-daub summer hut, and a few storage structures. A sparse scatter of refuse that suggested a fairly short stay. But it was while I excavated this site for the Black Mesa Archaeological Project that I was led to a theoretical question: how did farmers' decisions on farming and settlement change over time? Would they stay close to the same valley, or would they move from one to another?

Several of us were interested in the relationship among the three sites. They were probably part of a temporary or seasonal settlement of Aasanzi farmers. Perhaps it was a prehistoric village on a small flat-topped mesa, or the remains of a family's moves. Until tree-ring dates were available, these questions couldn't be answered empirically. Therefore my thoughts turned to theoretical approaches: what factors should affect the locations, spacing, and abandonment rates of such settlements? There must have been variables that played a role in these farmers' decisions on farming and settlement; was there any way to separate those who would be overruling from those that would have been overruled?

The Idealized Plain

Geographers have dealt with this problem of type before, and they have worked out a solution: imagine a situation unainted by the quirks of history, landscape, or human behavior—an idealized, uniform and rational and knowledgeable people. This provides a mental laboratory for isolating the basic dynamics of settlement and the relationship between settlement patterns and the activities of the people in settlements.

This is what J.H. von Thünen did in the early 19th century. Concerned with the underlying principles of land use, he reasoned that, when other factors are held constant, the farmers in a town will maximize profit by planning land use according to the costs of transporting crops to town. Since transport cost is largely a function of distance, land-use patterns should be explained by the distance between town and a given plot. This explained the concentric rings of land use that occur not only around towns but, as the geographers later showed, around individual farmsteads as well (Chisholm 1979).

Knowledge of what factors govern land use on an idealized surface provides a basis for understanding real situations, where variables aren't so controlled. Figure 2 shows the classic model of concentric land use.

Walter Christaller used the same approach to isolate the logic underlying the arrangement of market towns. He demonstrated that, on an idealized surface, geometric hierarchies should develop in response to the rate at which people could themselves of stores, services, and other "central functions." The result was Central Place Theory, which offers key insights into market settlement patterns.

Both Central Place Theory and von Thünen's land-use theory have been useful to archaeologists, but they shed no light on agrarian settle-
ments such as those on Black Mesa. What I really needed was not a model of the relationship between a single town and its farming, or of the relationship between a market town and the marketing its people do, but of the relationship between small farming settlements and the farming done. Could we not imagine a small population of rational farmers on a uniform plain? Is there any way to predict how they will settle, and how their settlement pattern will change through time?

Attempts at modeling these processes have not been especially successful. The model usually used by archaeologists interested in the problem, borrowed also from a geographer (Hudson 1969), envisaged settlement evolving through three stages. In the first, farms are located randomly, like plants. In the second, clusters of farms might be formed by fissioning; this follows the conventional assumption that daughter settlements would stay as close to the parent as possible. Or, new immigrants would avoid existing farms, producing unclustered settlements. Finally, competition over land would force the small farms to sell out to the larger ones, leaving widely spaced farms.

From this model, which has been used widely in archaeology, and other archaeological attempts to capture the dynamics of farm settlements, one could assemble a set of variables that would be useful.
notions about how farms should theoretically behave. Initial settlements should be randomly located. When settlements fail, the "offspring" should be as close as possible to the parent as the cultivated perimeter allows. Immigrants should settle away from established settlements. Curiously, Hudson and others dealt with rising rural population yet assumed no change in agricultural intensity (see box on Intensive Farming).

How should farmsteads, in theory, behave? I considered myself to have a set of baseline expectations for agrarian settlement, such as those provided for market towns by C. H. and land-use patterns by von Thünen and Chisholm. That is, farmers were talking about how fascinating it would be to monitor the evolution of a real agrarian settlement system, beginning at a "zero point" with a small initial pioneering population.

The Kofyar

It was perhaps coincident that I had also been working with Robert Netting, a cultural anthropologist whose work on agrarian ecology has inspired many archaeologists. I was especially interested in reanalyzing the remarkable data he had collected on the Kofyar, a group of farmers in the Jos Plateau of Nigeria. When Netting had first studied the Kofyar in the 1960s, he had concentrated on their homeland, a locally referred to as a "negligible" area. But the Kofyar were also cultivating farmland in a frontier area that was a day's walk to the south, where they could capitalize on the abundant farmland by re- venting to extensive cultivation. They were also marketing agricultural surpluses for the first time. The Kofyar the more frontier seemed to offer a unique opportunity to try to seek the sort of underlying logic of settlement on a real plain that von Thünen and Christaller had isolated on imaginary ones. Although there are no aesthetic or uniform plains in real life (any more than there are perfectly rational or knowledgeable people), the savanna south of the Jos Plateau allowed control over an unusual number of variables. For instance:

1. The area offered vast expanses of good farmland, long empty because of the threat of slaving and raiding (Stone 1988). It was not a settlement system beginning at a "zero point," but it was close.
2. Agricultural potential was not uniform, but the main variation was among three broad, readily identifiable zones of different parent materials. This would allow a comparison of the effects of soil type on settlement.
3. To provide some perspective on how "perfectly rational" were the Kofyar's actions, there was another group also colonizing the savanna—the Tiv, whose traditional system of extensive agriculture provided a perfect contrast to the intensive farming Kofyar.

What, then, was my goal in turning to ethnological and historical studies? It was not to compare Kofyar activities with the remains they left behind (although by the time I left Nigeria, I had learned a lot about that). It was to reconstruct the evolution of this settlement system, and to explore how settlement change related to

Intensive Farming

At the heart of most discussions of traditional farming systems is a broad theory published by Ester Boserup, a Danish agricultural economist, in a 1965 book entitled On the Conditions of Agricultural Growth. Boserup's thesis is as follows: "...agricultural growth in broad terms is a matter of the degree to which people are able to support other people... whereas the degree to which people succeeds in producing more food is limited by the amount of land available for agricultural purposes. It is the ability to increase land productivity that makes possible a longer period of intensive agriculture..." (Boserup 1965). Boserup's work is useful because it provides a theoretical framework for understanding how farming systems evolve over time.

The Kofyar farming system is a good example of this kind of analysis. They have a long history of shifting cultivation, which allows them to maximize the productivity of their land. However, this system is not sustainable in the long term because it leads to over-exploitation of the land. To overcome this problem, the Kofyar have developed a system of field preparation that involves the use of fire to clear the land. This allows them to maintain high levels of productivity over time.

The Kofyar farming system is an example of how intensive agriculture can be practiced in a sustainable way. By using a combination of slash-and-burn techniques and fire management, they are able to maintain high levels of productivity while also protecting the environment. This kind of system is an important model for sustainable agriculture in the tropics.
out to be common. For example, 19th century pioneers in northern Argen-
tina tried to settle in strips rather than in the government-favored pattern
of each farmstead on a 25 hectare square of land; one of the reasons was
agricultural labor mobilization (Eidt 1977).

How can farmsteads be closely spaced without being reduced to
small plots? Simple: farms are elong-
gated, with residences near the cen-
ter. This turns out to be a common
solution, occurring in both Argentina
and Nigeria as well as in Germany,
where the pattern is called Wald-
hufen (Mayhew 1973).

Paths and dirt roads "attracted"
 compounds because of all the foot
and bicycle traffic, and because they allowed
the lorries and pickup trucks of crop
traders to drive close to the farm
fields after the harvest. The attrac-
tion of compounds to each other and
to roads produced strong patterning
in settlement spacing: 82 percent of all
compounds are located between 100
and 200 meters from their nearest
neighbor. Compounds were not
isolated unless they housed an
unusually large group, and even then
there would be attempts to recruit
other farmers to the locale.

The archaeological wisdom that
interaction controls site spacing was
partly right. But it is clear that
there was a particular kind of interac-
tion—collaboration in food produc-
tion—that was critical in shaping this
arrangement of farmsteads. The con-
ventional wisdom that a settlement’s
cultivated perimeter determines
settlement spacing is somewhat mis-
leading. We may be fooling ourselves
in assuming that farmsteads or ham-
lets use circular perimeters, as plot
shape is easily altered to allow sites
to adjust their spacing.

How Do Farmers Pick Locations?

Saying that the farming system
pulls farmsteads towards each other doesn’t tell us where the settlements
end up. Analysis of site location has
been a mainstay of research in archae-
ology, although general rules of
location have been slow to mate-
rize. How the Kofyar criteria for
site selection changed through time
was intriguing.

It is perhaps counter-intuitive that
in placing their farmsteads these
traditional farmers did not make fine
distinctions regarding soil quality.
Kofyar first moved into areas named
Unqua Long and Mangkogom, south
of Nazma and Kwanle (Fig. 3).
Unqua Long has deep, fertile, and
well-drained soils derived from sand-
stones; in Mangkogom, they are
thinner, less fertile, and more rocky.
Yet, despite these difference in agri-
cultural potential, population seems
to have poured into these two areas
at comparable rates.

Instead, compounds were consis-
tently spaced 100-150 meters apart,
forming ragged strips (Fig. 4a). When
I asked these early settlers why
they settled close to each other
with such abundant farmland all
around them, they asked how they
could farm together unless they
settled together. They were referring
to multi-household work parties that
play a key role in their farming
system. Kofyar have both small
household details, which operate on a simple
reciprocal basis, and large parties
called mewaoo (beer farming) at
which are served the Kofyar prized
beer, mili beer. (Millet can be
grown in the same field with sor-
ghum, and it fits neatly into the
Kofyar labor calendar (Stone et al.
1996). It is mostly brewed into a
slightly alcoholic beer for labor par-
ties, but it can also be eaten or sold.)

Archaeologists are aware that set-
tlement spacing can be related to the
interaction that occurs between settle-
ments. In the 1960s there were even
attempts to measure interaction rates,
but the type of interaction had usually
been trade in exotic goods, and settle-
ments had usually been villages and
towns. On the Kofyar frontier, there
were small compound settlements
whose spacing was determined in
large part by agricultural collabora-
tion. Work parties were, after all, the
most common form of interaction; Kofyar
work one hour on other farms
for every four hours on their own
plots, and the overwhelming majority of
this outside work occurs within a
15 minute walk (Stone 1991).

When I looked at other frontiers,
the premium on having access to
supra-household labor pools turned
spread east and west, following the
good sandy soils, but at the same time
it spread south, onto poorer shal-
derived soils with drainage problems
(Fig. 4a). The farmers consistently
avoided only the very worst soils,
where there were obvious problems
with swamps or ironstone (laterite).
They were simply weighting prox-
imity to human labor, the fuel that
to power their farming system, over
access to optimal soils.

If farmsteads were not necessarily
drawn to the best soils, to what were
drawn? Were they drawn to water? The answer is yes.
Rainfall is sufficient for agriculture in the
Beneva savanna, and crops are not
irrigated; but domestic water supply
had been a mainstay of research in
archaeology, although general rules of
drainage have been slow to mate-
rize. How the Kofyar criteria for
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Figure 4a, b. Kofyar settlement patterns in the frontier area of the northern Beneva Valley in 1963 (a) and 1984 (b); an individual settlement is the residential mud hut compound. The pattern in 1963, 11 years after the Kofyar arrival, was
strongly shaped by the location of supplies; residences were pulled inessentially to their farm plots
to each other. There was also attraction to roads and paths, accounting for the linearity in some places. By 1984, the
attraction of settlements to water had been replaced by attraction to soil qualities. (Solid lines = paths; broken lines = streams)

Figure 5. The changing effect of water on settlement location. For 976 compounds identified on aerial
photographs from 1963 and 1978, distances were
calculated to the nearest stream. The distances show that
pioneering farmsteads were much more "attracted" to water than later settlements. The theory of
intensification predicts that farmers avoid agricultural tasks that offer
the most diminished returns, but on the early frontier,
non-agricultural water portage was potentially the

Early (n = 140)
Late (n = 838)
Random (n = 1000)

PERCENT OF SAMPLE

DISTANCE TO NEAREST STREAM (m)

0.0 0.5 1.0 1.5 2.0 2.5 3.0

21
On the early frontier, then, site spacing is neither random nor determined by each settlement's cultivated perimeter. Sites are pulled towards each other by the need for agricultural collaboration, overriding fine distinctions of soil quality. Where these settlements are placed on the landscape is initially shaped by the drainage system, as farmers minimize the potentially greatest cause of unnecessary labor; this I see as an extension of Boserup's basic premise to the settlement system.

Responding to Higher Population Density

By the mid-1980s, settlement had changed dramatically (Fig. 4b). As the countryside filled, the rules that shaped the settlement pattern began to change. Whereas initial settlers were attracted to water rather than soil, farmers facing increasing competition over land quickly reoriented themselves towards large, productive plots, regardless of the proximity of water. This meant two things: first, farms were larger and, second, the distance to water was reduced. Near Nuckles, Ibo farmers live at such great distances from perennial water that they have turned to an intricate system of water harvesting (Fig. 4c). Households live in small farmsteads and practice very intensive, painstaking agriculture—perhaps, the farmers in Ungwa Long will be practicing in the not-too-distant future.

Some Lessons

Cases of recent settlement evolution that cannot be taken as direct analogies for the past; they should be compared with other cases to work towards a more general understanding of settlement. For instance, a crucial difference between farming in the Benue Valley and on Black Mesa is the reliability of water. With the Kofyar, streams played a pivotal role in shaping settlement until farmland became scarce, when access to land came to dominate their decision-making process. In arid areas, water may become the most strategic of resources when population density is high. The way patterns of farm abandonment and intensification differ among areas suggests something important about how agrarian settlement systems work. Whereas the Boserup model assumes farmers cannot abandon their farms, and some archaeologists have assumed farmers always abandon their farms if they can, the Kofyar decision to abandon or intensify is based on the local ecology. The prospects for intensification may be quite different from the prospects for initial slash-and-burn cultivation, and the archaeologist must therefore evaluate land on both counts. This is a critical aspect of the settlement system, and I suspect that if we are ever going to have a reliable theory of how farm settlements evolve, we are going to have to specify how rewarding intensification would be on that plain.

The Kofyar show how agrarian settlement systems can be shaped by the same considerations that shape agriculture. This means that archaeologists are ill-advised to borrow settlement theories that ignore agricultural change, such as the one I described above. There are, of course, many other factors that affect the location and abandonment of agrarian settlements. But while ancient farmers had to consider complex factors that affected and were affected by every settlement decision, we must begin with simple theoretical questions about farming and settling.