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GROUNDED IN THE LANDSCAPE: ELICITING FARMERS' UNDERSTANDINGS OF SOIL AND SOIL FERTILITY, MALI (WEST AFRICA)

How do farmers differentiate among types of soil? What are the key indicators for evaluating soil quality and the effect of various inputs? What questions can be asked to elicit farmers' perceptions and assessments of soil quality? How can farmers' models of soil fertility inform environmental conservation policies so that they can motivate positive behavioral changes?

Widespread concerns for soil degradation in developing countries have given impetus to much research on soil fertility management. Most of these studies hinge on the biophysical sciences. But scientific measurements of soil fertility do not motivate farmers to invest in soil conservation. Rather, in order to develop convincing messages and sustainable interventions, it is necessary to understand how farmers themselves perceive soil conditions and how these perceptions influence their soil management and land use decisions.

Compost, called 'sleeping fertilizer', must be watered regularly during the dry season to promote decomposition

This brief illustrates an ethno-scientific methodology for eliciting farmers' conceptualization of soil and soil fertility. Drawing from techniques elaborated in semantics research, ethnoscience has used taxonomies to uncover deeply rooted cultural assumptions that structure decisions and behavior. This study uses ethno-classification as a starting point, but pushes the ethno-scientific approach forward by shifting the analytical focus from fixed categories to dynamic interactions.

Ethnographic interviews revealed that farmers have an extensive and nuanced knowledge of soils. They also indicated that this knowledge is inherently linked to farmers' observations of other aspects of the landscape, such as topography and hydrology. Farmers' assessments of soil fertility extend beyond the boundaries of fields themselves, to encompass relationships between biotic and abiotic components of the ecological system, including humans, animals, crops, trees, and water. This understanding calls for a systems-oriented approach to soil conservation that articulates with broader-scale efforts to sustain ecosystem integrity.

ABOUT SANREM CRSP

SANREM's mission is to assist in the analysis, creation and successful application of decision support methods, institutional innovations and local capacity approaches to support participatory sustainable agriculture and natural resource planning, management and policy analysis at local, municipal, provincial and national levels.

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METHODOLOGY

The analysis is based on 23 semi-structured interviews with a purposive sample of farmers in the SANREM CRSP West African site. These interviews were complemented by informal discussions with another 12 key informants to explore issues and clarify observations. Because agriculture in the area is a largely male domain, interviewees were predominantly male farmers. Interviews were conducted in different villages of the Madiama rural commune, which is situated near the town of Djenné in north-central Mali. The area receives an average of 500 mm of rainfall per year, which falls during a single rainy season from June to September. Local production systems center on agro-pastoralism, with millet and sorghum as the main food crops.

The methodology hinged on semi-structured interviews oriented toward knowledge of soils and soil fertility. Interviews focused on soil classifications, soil management and amendments, and explanatory models of soil fertility. Ethno-science uses sorting and ranking as heuristic tools to elicit principles whereby informants establish similarities and differences among types. Questions prompt informants to identify and label types and distribute them among categories and subcategories, a nested hierarchy or a ranking order is developed. The criteria and concepts that are invoked to explain how types differ or why they fall in one group or rank point to salient links in the cognitive system.[1]

RESEARCH FINDINGS

Soil classification

The interviews indicate a large degree of shared knowledge regarding primary soil categories but less agreement over subcategories. All informants distinguished between clay (*bógó*) and sand (*céncén* or *kénkén*). About two thirds (61%) of them also cited stones (*bélê*), while the rest recognized stones as components of soil, but did not cite as a separate soil type because, unlike soil, stones are seen as 'inert' matter.

The main criteria for the differentiation of primary categories into subcategories was color, and occasionally texture. Most informants subdivided 'clay' into more subcategories: most identified *bógófin*, (dark clay) and *bógóblenman* or *bógówuliman* (red clay) and a few mentioned *bógóguema or bógójeman* (white clay). It is telling that dark clay, red clay and white clay always arose in a nested sequence: no one named red clay without naming dark clay, and no one named white clay without naming both dark and red clay. This indicates a clear pattern of relative salience, based on farmers' degree of interaction with the different soils. For instance, red clay is found directly under the dark topsoil, so farmers see it when they strike the ground with their hoe. White clay, on the other hand, is found only deep below the dark and red clays by those who dig wells.

A few informants identified a type of dark clay that is specific to the floodplains: *manama* and *kirikiri*. *Manama* soil is fine clay, which is sticky, rather than crumbly, when wet. *Kirikiri* is even finer, causing one to sink into it if he/she walks on it when it is wet. This distinction of specific floodplain varieties of clay is at odds with farmers' statements that highland clay and floodplain clay was the same soil. Knowing that the floodplain is planted with rice, whereas upland clay fields are planted with sorghum, informants were asked to describe how rice fields differ from sorghum fields. Their responses stressed hydrology rather than soil itself: rice is planted in clayey soils where water stands, whereas sorghum is planted in clayey soils where water flows.

The other primary category of soil, sand, has a less developed typology than clay, although most informants identified *céncénfin* (dark sand) as a composite type, made of sand mixed with clay. Besides dark sand, a few informants distinguished pure categories of sand, again based on color, namely *céncénblen* (red sand) and *céncénguema* (white sand), both of which refer to soils that are not used for agriculture. All informants recognized that most soils in the area are of mixed type, which suggests an understanding of soil as a continuum, constantly varying through space rather than corresponding to discrete types.

When asked to rank soil types in terms of their fertility, most farmers placed dark clay first and dark sand second. But, when asked which kinds of soil they liked best, most chose dark sand over dark clay. This is because, clay is very difficult to work when wet and becomes compact when dry, and common crops, such as millet and peanut, prefer looser-textured soils. Dark sand, actually connoting a mixed type, combines the 'force' of dark clay with the workability of sand.

Distinct from, though related to soil types, micro-variations in hydrology and topography play key roles in perceptions and management of soil. Informants distinguish low areas (*dinyé*) where water collects and elevated areas

[1] Spradley, J.P. 1979. *The Ethnographic Interview.* Holt, Rinehart, and Winston, New York.

(*tintin* or *kulu*), which do not retain water. Often, clay is associated with lower areas and sand with upper areas. Though generally millet is grown in sandy soils and sorghum is grown in clayey soils, a low area in a sandy field might be planted with sorghum to take advantage of the water that collects there.

Soil management

The central operative concept in farmers' understanding of soil fertility is *fanga,* which translates as "power" or "force". This is not, however, a concept that applies uniquely to soils, but it is used in relation to medicine and food as well. Medicine has *fanga* if it cures quickly; food has *fanga* if it provides energy. For example, although rice is widely liked, millet is believed to be more nutritious and therefore is said to have more *fanga*. Soils and soil amendments (*nógó*) have variable *fanga* as well.

All those interviewed stated that the primary means of improving soil is through application of soil amendments, or *nógó*. This includes manure from cattle, horses, donkeys and small ruminants. Chicken or human excrements are believed to have insufficient *fanga*. Most informants also listed leaves (*furaburu*), grasses (*binw*), crop residue (*kala*), and miscellaneous organic matter (*nyaminyami)*, such as peanut shells or grain chaff as *nógó*. Some mentioned compost (*sunógónógó* or "sleeping *nógó*"), which may contains any or all of the previously mentioned organic matters.

Farmers listed chemical fertilizers as forms of *nógó,* but mostly when prompted. They made a clear distinction between *nógó* and chemical fertilizer (*angéré*,), which they referred to by the modifier *nógó tubab* (European fertilizer), juxtaposed to *nógó farafin* (African fertilizer) for manure. This ambivalence could be due to the fact that the high cost of fertilizer places it outside of farmers' cognitive repertoire of soil amendment options.

Farmers admitted that *angéré* and *nógó farafin* are similar in that they both help crops grow, the quality which unifies the overall category of *nógó*. But they also differentiated *angéré* and *nógó farafin* in several ways: a) although powerful, *angéré* is only good for one year as its *fanga* does not endure in the soil, unlike the effect of *nógó farafin* which can last from 3 to 10 years after application (in other words *angéré* helps plants grow but does nothing to improve soil quality); b) *angéré* requires rain to be effective, without rain it can actually harm crops, unlike *nógó farafin* which actually increases water retention in the soil; c) *angéré* is made in factories and sold in markets whereas *nógó farafin* is produced by households and is not bought and sold.

Farmers describe *nógó* as being food for plants. People cannot live without eating, and likewise, neither can plants. As with human foods, some plant foods give more strength than others. When farmers were asked to rank various fertilizers in terms of their *fanga*, most ranked small ruminant manure highest. The modal response placed small ruminant manure first, cow manure second, followed either by horse manure or compost (which is a composite category). Respondents were reluctant to rank leaves, grasses and residue due to their insignificant *fanga*. Only a few listed *angéré* without prompting, placing it between second and fourth place.

All farmers interviewed evaluated a soil amendment's power on the basis of the duration of its efficacy. Small ruminant manure was described as maintaining its *fanga* anywhere from 3 to 10 years, cow manure from 2 to 3 years, compost from 2-4 years, and *angéré* only 1 year. Horse and donkey manure are believed to be very weak. But they recognized differences in terms of speed of release. *Angéré* was recognized as having a swift but ephemeral effect, in contrast, small ruminant manure had a slow but durable effect. This indicates that farmers understand the difference between feeding crops and building soil and that they manage soil fertility with a longer time horizon than one cropping season.

Small ruminant manure was described as maintaining its fanga anywhere from 3 to 10 years

CONCLUSIONS

The results of this research describe a widely shared and consistent system of soil categorization. But a soil typology alone is inadequate as a framework for soil fertility management, because farmers' assessments of soils are localized in an agro-ecological landscape in which soil is but one feature among many. Soil amendment decisions take into account animals diets and physiology and consider interactions between soil, animals, vegetation, topography, and hydrology.

Therefore, efforts to understand soil fertility from farmers' perspectives need to move away from an emphasis on codification and towards a consideration of ecosystem linkages. The latter can inform programming and policy initiatives in ways that can help leverage local support for environmental conservation (for instance, farmers' appreciation of the reciprocal interaction among trees, water, and soil can be integrated into messages and measures for the protection of local tree species).

Explanatory models of soil fertility

Having identified that farmers perceive different fertilizers as having variable strength, the next question was their explanation of this variation. All farmers interviewed agreed that the goat, sheep and cow manures are stronger than horse and donkey manures because they are all ruminants and double chew their food. They also agreed that goat and sheep manure is stronger than cow manure because where cows exclusively eat grasses and crop residues, small ruminants eat trees and shrubs leaves, which endow their manure with more *fanga*.

In response to why the leaves of trees and shrubs should provide different quality fodder than grasses and crop residues, two reasons were given: a) trees and shrubs, being perennials, have slower and longer growing cycles than annual grasses and crops, which requires them to be "harder" in order to endure the seasonal and annual fluctuations in temperature and rainfall; b) trees and shrubs have deeper roots which draw on deeper *kólónji* (well water), unlike crops and grasses which rely upon *sanji*, rainwater. These two qualities of slow growth and deep-rootedness area said to give trees and shrubs greater strength which is passed on to small ruminants through the leaves they eat, and then passed on to the soil through the manure they produce. This explanation suggests that local models of soil fertility are based on a chain of causality that reaches well beyond the objects and processes that occur in the fields.

This brief draws from a paper by Todd Crane entitled "Ethnopedology in Central Mali." presented to the SANREM CRSP Research Scientific Synthesis Conference, November 28-30, 2001, Athens, Georgia. PDF versions of individual papers presented at the conference can be downloaded from:
http://www.sanrem.uga.edu..

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