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Burkina Faso: Integrating Indigenous and Scientific Rainfall Forecasting

This case study describes how farmers of Burkina Faso predict seasonal rainfall and examines how their forecasts relate to scientific ones. In recent years, meteorological science has made enormous progress in predicting climate. The realization that sea surface temperatures (SSTs) influence global atmospheric circulation enables scientists to formulate forecasts of seasonal rainfall. These are presented as the probability of total seasonal rainfall quantity being in the above normal, below normal, or normal compared with an average resulting from analysis of thirty- years series. In West Africa, seasonal rainfall relates to the three months of July, August, and September, during which 90 percent of total annual rainfall occurs.

Rather than conceiving local and scientific knowledge as absolutely incompatible, our research shows that farmers are used to operating in multiple cognitive frameworks and that they are interested in receiving scientific forecasts because they perceive local forecasts as becoming less reliable due to increasing climate variability. But to effectively convey scientific forecasts we need to understand how people think about rainfall, including how they perceive and predict variability. Understanding local cultural models is essential for effectively communicating research products and development technology.

Locality and livelihoods

Bonam is a village located in the Namentenga Province, one of the poorest of forty-five provinces in Burkina Faso. Most of Bonam inhabitants are Mossi, the dominant ethnic group in the country, and draw a livelihood from rain-fed farming of grain and leguminous crops, combined with some livestock production, petty trade, and labor migration to Côte d'Ivoire. Some Fulani pastoralists have also settled in the area.

Rain falls during a single season lasting from May to October, characterized by extreme inter-annual and non-uniform distribution within seasons. The long-term mean annual rainfall is 674 mm. At the onset of the rainy season, farmers decide what, when, and where to plant. They do so according to their expectations for seasonal rainfall, striving to minimize risk by combining the

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water retention capacity of different soil types and field positions with the water requirements of various crops and crop varieties.

Farmers' forecasting knowledge encompasses shared and selective repertoires. Experienced (mostly elderly male) farmers formulate hypotheses about seasonal rainfall by observing natural phenomena, while cultural and ritual specialists draw predictions from divination, visions, or dreams.

Shared forecasting knowledge

Environmental indicators that farmers use to predict seasonal rainfall become available for observation at different times of year. Among the earliest and most widely relied upon indicators are the timing, intensity, and duration of cold temperatures during the early part of the dry season (November–January). Farmers believe that intense cold (below 15 degrees C) during this time corresponds to abundant rainfall during the rainy season and that if this cold period begins early or ends late, the rains will do likewise. Following the cold-dry period is a hot-dry period (February–April): intense heat at this time is also believed to predict good rainfall.

The second most common forecasting indicator is the production of fruit by certain local trees, which occurs between April and June. According to farmers, good yields from trees such as *taanga* (*Butyrospermum parkii*) and *sibga* (*Anogeissus leiocarpus*) predict a favorable season. On the other hand, farmers link abundant fruit production by *nobga* (*Sclerocarya birrea*) and *sabtuluga* (*Lannea acida*) trees to drought.

Trees are also used as signs for the approaching of the rains or the presence of water. When *sibga* begin fruiting and *sabtuluga* lose their leaves farmers know that they should get ready for planting. *Kankanga* is a fig-like tree that grows where the water table is near the soil surface. Therefore, it signals herders where to dig wells to water their cattle and farmers where they can plant water-demanding crops, such as cotton.

Another indicator that becomes available at the onset of the rains is the water level in streams and ponds. If it remains consistently high after the first rains, farmers believe that the season will be favorable since heavy rains at the onset are believed to be a propitious sign. Herders who pasture animals in the bush watch the nesting of small quail-like bird (known as *koobre* in Moré) and believe that when nests hang high on trees then the rains will be heavy; when nests hang low, the rains will be scarce.

Women also observe insect behavior at water sources and in rubbish heaps outside compound walls. For instance, *bugvaré* are black insects of the *Orthoptera* sp. that dig concave nests in rubbish heaps outside compounds. After the first rains, larvae emerge, filling the nests with dirt. Women said that they expect a good farming season if *bugvaré* fill their nests to the brim with dirt, which symbolizes a full granary.

But, while signs are observed throughout the dry season, it is at the onset of the rains that farmers consolidate their expectations for rainy season. An early onset, especially with a regular succession of rains that enable good crop establishment, is the most widely considered indicator of a good season. The number of times farmers must plant is also key in evaluating the nature of a season and predicting crop performance. For example, when a drought affected the region in 1997, farmers had known a food crisis loomed ahead by the end of planting time (early August), half a year before official famine early-warning systems registered distress signals.

Some elders are also able to interpret constellation movements and lunar phases. For instance, they consider the visible phases of the moon, especially the full moon, to be more likely to be dry than dark phases because moonlight exerts a force that prevents rain from falling. Stars also signify suitable planting periods for different fields and crops. The appearance of *Souci* (Pleiades) in early May indicates that it is time to prepare valley bottom fields for planting. Shifts in the position of the *Budb Kutoega* (Ursa Major) identify the start and end of the period for planting sorghum. The appearance of *Tatba* (Orion) in July coincides with heavy rains (*sa nyanga*) that favor maize planting.

Specialized forecasting knowledge

In contrast to the observation of environmental signs which is available to most farmers, divination and other spiritual practices are the prerogative of select groups or individuals. The most authoritative among them is the *Tengsoba*, the eldest descendent of the clan that first settled the land. He performs sacrifices to mediate between the living and the ancestral and earth spirits that inhabit fetish sites, some of which influence the rains. Predictions are drawn from the behavior of sacrificed animals, how long it takes to fall, in which direction it falls, and where the blood spills. The *Tengsoba* and other traditional specialists might also receive forecasts from ancestors or deities in the form of dreams or visions.

Marabouts are spiritualists who situate themselves within the Islamic tradition, although Islamic orthodoxy frowns on their practices. These spiritualists range from Islamic clerics (*Limam*) who are versed in the Koran to diviners who mix Islam with indigenous beliefs and practices. The *Zambende* ceremony, which marks the beginning of the Muslim year, is the key venue for *marabouts* to issue their forecasts. *Marabouts* base their predictions on the day of the week that marks the first day of *Zambende*. Each day is associated with a different prophet and the year that follows is characterized by symbolic events in the life or time of that prophet. Prophecies are written in Arabic texts along with instructions for ritual offerings and other measures to stave off inauspicious events.

Unlike the *Tengsoba* and the *marabouts* who can only issue predictions and offer intercessory prayers, there are other specialists, known as *sa tatta*, who claim direct command over the rains. But their powers are feared as rainmaking is considered to endanger both practitioners and the community. Invoked rains are believed to be mostly violent downpours (*saraogo*) accompanied by heavy wind, sharp thunder, and lightning that cause damage to crops, houses, and animals. For this reason, a government cloud-seeding project at the beginning of the 1998 rainy season caused anxiety rather than relief among farmers in Bonam.

Some spiritualists foresaw the 1997 drought and their responses have implications for their potential role in diffusing scientific forecasts as well. The *Tengsoba* admitted having had dire premonitions during the dry season, but he did not reveal them. Other spiritualists confirm that they tend not to publicize dire predictions because to do so "would be like launching a curse" against those under their authority. Verbalizing negative forecasts would reify them into an inevitable outcome by voiding any possibility for supplication and negotiation with the spirits. The failure to alter dire predictions may also undermine the credibility of spiritualists responsible for interceding between the living and the spirits. Furthermore, a bleak forecast may also discourage people from farming and induce them to migrate, undermining the social order on which the elders' authority rests.

Integrating local and scientific forecasts

Bonam farmers recognize that both society and climate have undergone significant changes in the last few decades. Traditional leaders lament that formal education, monotheistic religions, and modernization ideologies have diminished their authority, especially among the youth. Climate variability has also weakened farmers' confidence in local knowledge. Elders recalled that in the past they were able to predict the rain onset so accurately that they could mobilize family labor plant on dry soil, knowing that the rains would soon follow, but now their sons refuse to go to the field until it actually rains.

But this does not mean that farmers perceive scientific information as a threat to local culture. On the contrary, because they perceive local forecasts to have become less reliable, farmers are keenly interested in alternative sources of information. Rather than being static and uniform, their cognitive landscape already incorporates a plurality of knowledge frameworks. Local forecasting combines empirical observations and spiritual insights that draw from a variety of religious traditions. Farmers mix local and introduced practices and technologies and families pragmatically combine modern medicine and local treatments when one of their members is sick. It is the imposition of any one knowledge system as representing the totality of truth that is resented and resisted.

Hence, scientific information must be presented in ways that conform to cultural notions concerning the nature of knowledge, its production and validation, and its relationship to society. Local systems of thought emphasize the partial nature of human understanding, which means that no one source of information is considered as having the entire picture. Local forecasts systems rely on a range of indicators that become available to different people and at different times. Farmers do not resolve contradictions among indicators into a cogent scenario. Discrepancies among forecasts or between forecasts and outcomes are explained in terms of the diversity of ecological niches and cropping systems. The probabilistic nature of the forecast may also be explained by reference to the uncertain nature of destiny as the outcome of negotiations between the living and the spirits and, ultimately, of the arbitrary will of the latter.

There are several aspects of method and content where local and scientific knowledge of forecasting converges. For example in formulating predictions, spiritualists use approaches reminiscent of scientific practice. *Zambende* prophecies derive from the exegesis of textual material and from consultations among spiritualists, who then officially communicate them to the lay public. In the domain of environmental knowledge, farmer forecasts resemble scientific methods in their reliance on the systematic observation of natural phenomena. The generation of knowledge from observation is consistent with cultural learning styles whereby

children learn from watching adults rather than through verbal instruction or asking questions.

Meteorologists could build on local understanding of the relationship between temperatures and rainfall to explain the technical aspects of scientific forecasts based on sea surface temperatures. Farmers' interpretations of wind patterns also recognize the ocean as the origin for rain. During the dry season, farmers expect winds to blow westward, that is, to go to the ocean to pick up water, and then return blowing eastward at the onset of the rainy season. Farmers predicted and explained drought from the absence of such winds.

But farmers' forecasts diverge from scientific ones in important ways, particularly the scale and parameters they address. Unlike scientific forecasts, which are formulated in reference to "zones," the production and the application of local forecasts are deeply localized. They derive from an intimate interaction with a microenvironment whose rhythms are intertwined with the cycles of family and community life. It is not the generic *sibga* or *taanga* that farmers usually consider in predicting rainfall, but specific trees near their home or their fields that they might have observed over a lifetime.

While scientific forecasts hinge on estimates of total seasonal quantity, farmers evaluate seasons in terms of types and time of rainfall. For instance, they recognize that the same amount of rainfall can lead to different production outcomes if it occurs as *sa nyanga* (prolonged but consistent rain that leaves the soil moist for several days) or as *saraogo* (localized thunderstorm accompanied by violent wind). Water-deficit periods that occur during establishment or heading will cause more damage to crops than those that occur during other crop growth stages.

The time of onset and of termination, marking the duration of the rains, is such a salient parameter that a forecast of an "above average" seasonal rainfall is invariably understood by Bonam farmers as predicting a longer season. Currently, science is unable to reliably predict either the duration or distribution of seasonal rainfall, but the integration of scientific forecasts with local knowledge might allow some inferences in this regard. For example, the abnormally heavy rains that fell in July and August 1999 could have been predicted by combining farmers' predictions of delayed onset with the scientific forecast for above-normal seasonal rainfall.

Conclusions

Our findings show that neither the experiences of bridging knowledge systems nor the concepts of rainfall forecasting are alien to the farmers of Burkina Faso. Local forecasts converge with scientific ones in some aspects of content and method, but also diverge in terms of practical significance and moral meanings. These contrasts challenge science on two fronts.

On the one hand, the specificity of local forecast parameters urges science to be more responsive to farmers' information needs and more relevant to the livelihood decisions they face. On the other hand, local systems of expertise and leadership tightly link knowledge and social responsibility, calling for scientists to be more aware of and accountable for the impacts of the knowledge they produce and provide to users.

This responsibility propels us beyond the task of integrating local and scientific knowledge in form and content forecasts, to face the challenge of addressing consequences and context of their use. In particular, the provision of information needs to be integrated with appropriate interventions that bolster farmers' ability to negotiate a mitigated outcome of predicted scenarios. Scientists, policymakers, donors, and development practitioners must work together to devise consistent and sustainable approaches to improving the flexibility of local production systems and the resiliency of livelihood security for the resource-limited farmers of the Sudano-Sahel region.

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