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13. Northeast Tanzania: comparative observations along a moisture gradient

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From Mombo to Kulasi, a crow would fly the 40 kilometers (25 miles) in 3 hours, a Land Rover would labor all day, and a bus would not attempt it. Along the way the landscape shifts from dry open woodland to moist woodland, to rain forest, to moist woodland, to dry open woodland again; the elevation more than triples from 400 to 1,400 meters (1,300–4,600 feet); the annual rainfall doubles from 675 to 1,350 millimeters (27–54 inches). Cutting across the Western Usambara mountains of northeast Tanzania with its dense, predominant Shambala-speaking smallholder farming population, this study seeks to trace those variations in farmer activity relative to drought that seem to coincide with differences in the steep gradient of available moisture. By limiting these observations to a very short transect across a homogeneous population, this particular study seeks to relate the variations in environmental opportunity to the well-being of the population, the adaptive capacity of local agricultural systems, the drought-hazard experience, and the adjustments undertaken to minimize drought impacts.

Expectations of hazard, well-being, and available moisture

The road from Mombo to Kulasi follows a steep gradient of moisture available in the soil plants. What expectations may we have as to the drought experience of farmers along this gradient and its relationship to their overall well-being? Can we turn to intuition or theory to suggest these relationships?

Consider first our expectation of how drought hazard might vary along the gradient of environmental potential. A simple expectation based on the dominance of environmental factors would be for drought experience to correlate inversely with available moisture given an absolute reduction in moisture and a general association of greater variability with diminishing precipitation. But hazard is as much a function of the agricultural and social system as of nature. Porter (1965, p. 411) states this well in the east African context:

> Subsistence risk is not given in nature, it is a settlement negotiated between an environment and a technology. Just how much risk an individual or a community can tolerate, how often a failure of crops or decimation of herds can be borne, is a problem that each culture must solve. A community has institutional and technical means of coping with risk. It can tighten its belt, develop surpluses, or raid neighboring territory. Danger to the individual can be decreased by sharing out risks, through dispersal of fields, timing of harvests, cattle deals, and the like.

Irrigation, either by advanced technology or natural oases, is an example of successful "negotiation" and its net effect may be to virtually eliminate the drought hazard for the population involved. Our expectation of the conflicting dynamics of the process involved can be seen in greater detail considering moisture and well-being.

The notion of some overall well-being of population is indeed nebulous. Under the rubric of well-being we can subsume the biological needs of the populace for survival, food, water, shelter, absence of disease, economic desires for material goods and opportunities, and social needs for security, respect, and leisure. The mix of needs, desire, and hope is not constant; some factors are even contradictory, such as leisure and economic opportunity.

Nevertheless, given some vague but shared notion of relative well-being, let us examine its relationship to available moisture in an agricultural system with a strong subsistence component. An environmental theory might suggest the relationship of Fig. 13–1a. Here our expectation is for well-being to increase with available moisture, not linearly and with local variability, but following some sigmoid curve suggesting a minimum threshold of moisture to improve the lot of the area's inhabitants, rapid increase of well-being with moisture, and then asymptotic diminishing benefits until levels of excessive moisture limit or diminish well-being. On the road from Mombo to Kulasi, we would expect relative well-being to rise with elevation and rainfall, perhaps modified but essentially not changed by other factors.

Cultural theories would deny us this tidy relationship, indeed they would prepare us for a null relationship as shown in Fig. 13–1b. Such theory acknowledges differences in environmental opportunity, but assert that these will be compensated for by culture. The settlement pattern, the demographic mix, the agricultural system, indeed the concept of well-being itself—all will adjust to the level of environmental opportunity. On the arid end of the continuum, settlement will be sparse, population numbers small, and livelihood will have a pastoral orientation. A smaller, more mobile society will substitute extensive quantities of sparse resources for intensive use of resources of higher quality. For the limited numbers supported, diets with easy access to milk, meat, and blood may be superior to those of better-watered areas, and wealth—measured in livestock—may be considerable.

Alternatively in the most favored range of the continuum the abundance of fertile soil and water will encour-

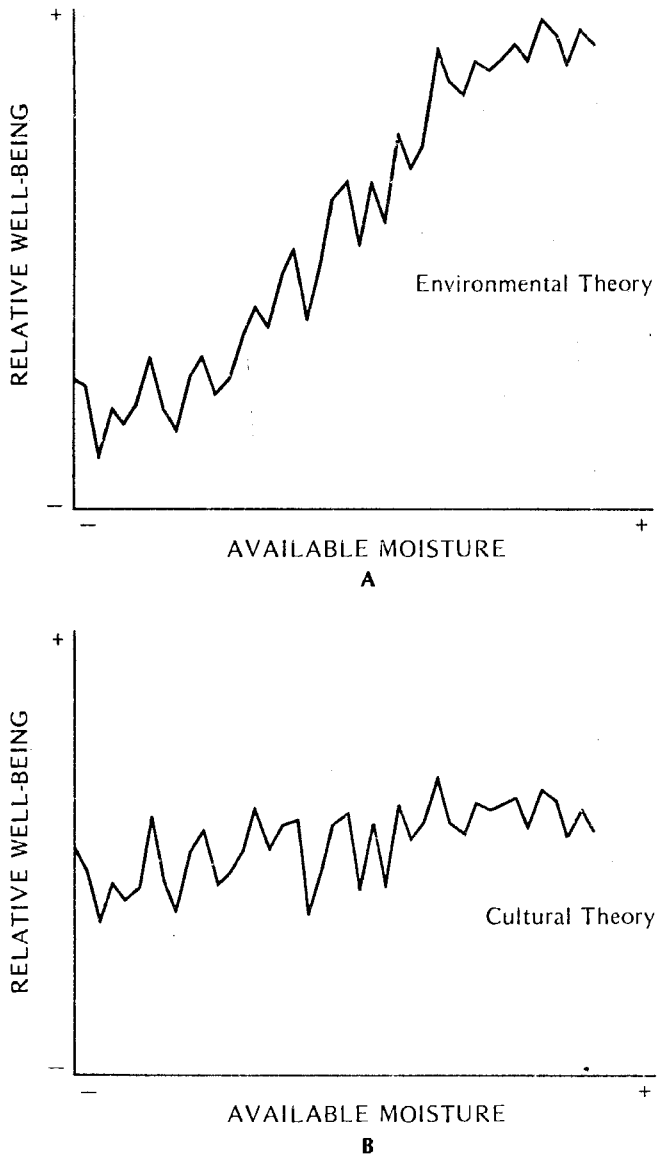

Fig. 13–1. Relative well-being and available moisture theoretical relationships: (a), environmental theory; (b), cultural theory

age permanence of settlement, and with little out-migration, rapid population growth will lead to fragmentation of land, declining fertility, and diminished well-being. Thus, culture theory would lead us to expect a relative constancy of well-being along the road from Mombo to Kulasi, mobility increasing the access to resources on the dry margins, while, as rainfall increases, social and demographic pressures also increase, reducing well-being below the level of environmental opportunity.

Complicating the human ecological patterns that emerge from the interplay of natural environment and human culture are cultural opportunities superposed external to the transect from Mombo to Kulasi. These differential opportunities may include the accessibility of the major north-south road that passes through Mombo, the level of encouragement given to cash crops of coffee, tea, or cardamom by the structure of world markets, the alternative employment opportunities in sisal, or leadership differences in agricultural instruction or political exhortation, even the differential values of Islam and Christendom, both of which claim substantial numbers of Shambala adherents.

The expectation then is for complexity and some unclarity; the intellectual path from Mombo to Kulasi is no less difficult to traverse than the road itself. There is a steep gradient of environmental opportunity, subtle variation in cultural opportunity, and a changing pattern of settlement and agriculture seeking to adapt to these differences.

Data collection

This paper relies heavily on an analysis of responses from 254 farmers to an extended questionnaire containing about 170 questions dealing with six major topics: characteristics of the respondents, their households, sites, and farms, their perception of and experience with drought, their patterns of adjustments to drought. It was administered primarily during May 1971 following a particularly dry crop year by a group of university students from the rural research group of the Bureau of Resource Assessment and Land Use Planning of the University of Dar es Salaam working along with a survey group of the Lushoto Integrated Development Project composed of young men mainly with primary school education. The entire group were Shambala-speaking and administered the questionnaire in that language at ten sites. In the remaining three sites containing some non-Shambala speakers a slightly different Swahili version was used.

The sample is nonrandom, and in clusters. Thirteen sites were chosen to provide a transect of the moisture gradient. In each site a minimum of 20 interviews were sought and 6 interviews less in total were obtained. Instruction for choosing respondents was to secure a point of entry in the community, usually through the local leader (the Tanzanian Government party, TANU, has leadership at the level of the householder) and then interview areally around that household to fill the quota. In most areas, 20 respondents would include a 50–100 percent sample of the location, given the prevailing pattern of settlement.

To those familiar with the hazards of the cross-cultural research we urge a cautious outlook. We have grouped the data in only three moisture classes to give larger samples. We have relied on ordering statistics rather than their cardinal values (e.g., the use of the median as a descriptive statement) to minimize effects of extreme values. A large body of supplementary research material including other surveys has been used for verification; one of us, Heijnen, can draw on observations during several years of intensive work and study

Table 13–1. Usambara transect study sites

Site No.	*Name*	*Est. elevation (m)*	*Est. annual precipitation (mm)*	*Supplemental moisture source*	*Available moisture classification*
701	Mombo	410	700	Irrigation project	Moderate
702	Mombo	415	700		Low
712	Mashewa	410	750		Low
713	Kulasi	380	750	Seasonal wet lands available	Moderate
803	Mailitano	710	850	Traditional irrigation	Moderate
804	Vuga	1,220	1,100		High
805	Mponde	1,400	1,200	Stream nearby	High
806	Bumbuli	1,220	1,200	Soils, slopes favorable	High
807	Handei	1,400	1,300		High
808	Upper Kongoi	1,200	850		Moderate
809	Middle Kongoi	1,070	750		Low
810	Lower Kongoi	915	700		Low
811	Mlingano	505	700	Floodplain with high water table	Low

have 1 hectare (0.4 acre) of rice and 1 hectare of maize on the scheme and have additional fields outside where—in part—the same crops are grown. Irrigation is regarded mainly as an insurance against unexpected droughts. Part of the rice is sold; maize, cassava, and rice are the main food crops.

Mombo off-scheme (702)

Available moisture: low. In the same villages where the participants of the irrigation scheme live—called Kwesasu and Jitengemi—other families have settled. They grow the same crops and make use of the surplus water whenever possible for irrigation. Yet they are much more dependent upon the marginal rainfall of about 700 millimeters (28 inches) per annum, as water is available only in limited quantities. Much of their rice is grown in poorly drained areas where the water gathers during the wet season.

Mailitano (803)

Available moisture: moderate. Halfway between Mombo and Soni, along the winding gravel road, a few clusters of houses are perched on the steeply sloping ground. Before the colonial era the local Shambala, ordered by their chief, constructed long irrigation channels and furrows. In this village the system was later expanded to cover the whole valley floor and the lower slopes. The higher land, mostly above the site of the village, cannot be irrigated and depends solely on a rather unreliable rainfall, averaging some 850 millimeters (31 inches) per annum. Nearly all families, however, have access to the irrigated sections of the valley and make full use of this opportunity. The fields are used intensively, especially during the dry season. Tomatoes and—to a lesser degree—onions, green peppers, and some ladyfinger are produced for cash mainly from July to December-January. Maize and cassava are the chief food crops. As elsewhere, however, part of the money earned is used to supplement the diet, mainly on such items as bread, oil, and fish.

Vuga (804)

Available moisture: high. Not much is left of the old splendor, when Vuga was the seat of the powerful Shambala chiefs. The actual site of their residence can

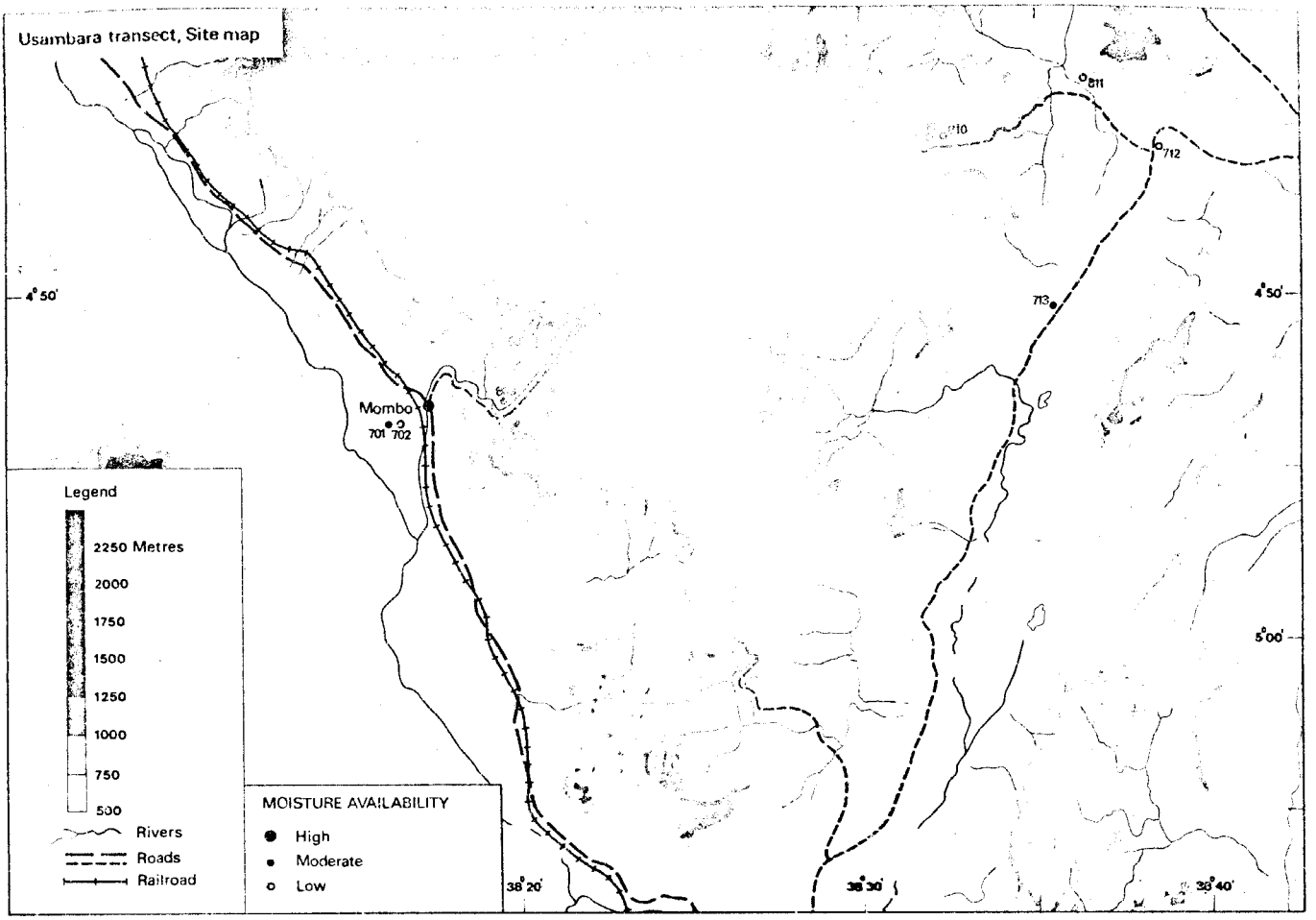

Fig. 13–3. Usambara transect, site map

barely be traced today. Vuga is only a divisional headquarters and a center of Lutheran missionary activities, surrounded by a few shops and a great number of small clusters of homesteads. The population density is high, nearing 200 per square kilometer (520 per square mile). Rainfall, at over 1,100 millimeters (43 inches), is favorable for arable agriculture, so that the risk of total crop failure is minimal. The chief disadvantage of the site is its location, some 5 kilometers (3 miles) off the main access road into the Usambara Mountains, although there is a reasonable road connection. Coffee and wattle are the most important cash crops; maize, beans, bananas, and cassava the chief subsistence crops.

Mponde (805)

Available moisture: high. Isolation is a much more pronounced characteristic of the densely settled Mponde area. There are only a few poorly stocked shops. The only reasonable road connection is with Bumbuli, in the north. Until a few years ago, coffee was the only cash crop of some importance. Altitude, exposure, and rainfall are, however, favorable for tea, which was first introduced in 1964. Today tea covers large sections of the slopes. The result has been that the food growth is sufficient only in favorable years. Often the farmers have to use part of their proceeds from the tea to buy maize and other foods. The valley floor does provide an opportunity to grow additional food, like beans and potatoes, if need arises. In 1970, a development agency, LIDEP, started a vegetable scheme here which was intended to provide additional cash, but especially to improve the local diet.

Bumbuli (806)

Available moisture: high. Bumbuli in former days was the court of the heir to the Shambala chief's throne. At present it is a divisional headquarters and a center for the Lutheran mission, which during the early sixties built a large modern hospital here. Unlike Vuga, Bumbuli retained a central place function for the eastern section of the Usambara Mountains, with a number of wholesale and well-stocked retail shops, transporters, "hoteli," etc. With only brief interruptions, the road to Soni can be used the year round. Soils and climate are favorable for farming. Like Mponde, Bumbuli receives approximately 1,200 millimeters (47 inches) per annum.

Coffee and wattle are the main cash crops; maize, bananas (partly in the coffee fields), beans, and cassava are grown for food. As a rule the slopes are steep and level land is very localized.

Handei (807)

Available moisture: high. Near the main watershed, Handei, a small cluster of houses, is situated on gently sloping or even level land. Some of the men work on the nearby Mazumbai tea estate to supplement their moderate cash income from coffee and (some) vegetables. Marketing opportunities for these vegetables are limited to the local markets of the Mgwashi and Bumbuli. The road to Soni via Bumbuli is often impassable for cars during the rainy season. Water for domestic use is a problem, since nearly all available water is in stagnant pools which are dirty and polluted.

Kongoi (808–810)

Available moisture: (Upper), moderate; (Middle, Lower), low. Across the watershed, a mere track leads from Mgwashi down to Mlingano/Masheqa. After a shower, only a Land Rover in low gear would attempt to descend and the driver would still have his misgivings about the decision on the way. The missionaries at Kongoi have a rain gauge from which they tapped an average of 946 millimeters (37 inches) during the past two years. The Mission and the nearby school overlook a deep V-shaped valley. From their station one can see the forest trees grading into shrub and open woodland vegetation, indicative of the rapid drop in rainfall below the mission site, to 700 millimeters (28 inches) or even less in places. After the coolness of the highland forests, the observer would not expect to find permanent settlement in this dry and hot wilderness. But below the Mission, perched on protruding ridges he sees three clusters of houses, at altitudes of 1,220, 1,070, and 915 meters (4,000, 3,500, and 3,000 feet) respectively. The past two years have been hard. Twice the maize failed partly, as in the highest settlement, or completely as lower down. Wild leaves, a few pieces of cassava, and a bittersweet extract from wild roots are the main items of the meager diet. The children look severely undernourished, as is shown by the reddish glow of their hair. The area is remote from the district center and no relief food has been forthcoming. A number of young people have left to look for work or to find a better place for farming. Water for domestic use is far away. A few cattle constitute the only barrier against disaster and death. The elder people are resigned. "Formerly there was a rainmaker, who made it rain. He left, because some people did no longer believe in him. That's why." Except for some coffee in the highest fields, there is no cash crop and even the food supply is extremely insecure. There are no large herds of cattle. People live at a bare subsistence level.

Mlingano (811)

Available moisture: low. A somewhat similar situation is encountered in Mlingano, a small village on the valley floor. But the vegetation is more luxurious here, due to a relatively high groundwater table. The same is true for the cultivated fields in the valley. In 1971, for instance, the maize had dried out, but the cassava appeared to withstand the drought. Groundwater and the water in the nearby rivulet are salty.

Mashewa (712)

Available moisture: low. The village is remarkable because of the presence of a relatively large Arab community, not found anywhere else in the mountains. The village site was on the old trade route which ran north of the mountains. Today the Arab traders and African shopkeepers serve the population of a large section of the Northern Plains and some nearby settlements in the Usambara Mountains. Drought has hit the area and the Korogwe District authorities have distributed relief food. The market has little to offer: some dried fish, meat, cassava, onions and ladyfingers. The nearby sisal plantation has been abandoned and the impression is that the standard of living has gone down, probably as a result of the crisis in the sisal industry. Maize and cassava are the main food crops; there is no cash crop of major importance. The annual rainfall is estimated at 750 millimeters (30 inches) with major variations from year to year.

Kulasi (713)

Available moisture: moderate. Near the sisal estates of Magoma and Kulasi a farming community is populated by ex-workers. Although the rainfall is approximately the same as at Mashewa, or marginally better and more reliable, the nearby floodplains afford insurance against total crop failure. Maize, cassava, beans, and sweet potatoes especially are grown in the floodplains, the latter on ridges or mounds. No specific cash crop is available, money is obtained by selling food surpluses, if the harvest permits. Cash income is low; only a few houses have corrugated iron roofs.

Hazard experiences of Usambara farmers

The Usambara farmers' recall of the occurrence of drought parallels the gradient of available moisture but they report that the severity of an individual drought event provides comparable losses of crop and cattle to all regardless of location. Farmers were asked to estimate the number of "bad years" encountered in the years that they lived at the site (if less than 10), or the years since independence (10) or the years since World War II (25 years). From these estimates, the proportion of "bad years" experienced and the median estimates

for each moisture group was calculated (Table 13–2). The median number of droughts experienced, recalled by farmers, showed the same pattern. The proportion of "bad years" and the number of droughts recalled increases by 50 percent as one moves from high sites to medium sites and again from medium to low sites. The 100 percent difference between high and low is only slightly greater than the inverse of the average difference in annual rainfall, seasonality, or the aridity index.

Turning to questions that seek to measure the effects of drought events, a different pattern emerges. Similar percentages of farmers report substantial (greater than 21 percent) damage to major food crops in each moisture zone, although some difference is reported for cattle. These results support the transactional view of drought hazard; i.e., given the prevailing levels of adjustment, events thought of as drought have similar effects across zones. However, a third measure, the frequency of household experience of hunger, strongly differentiates between the high-moisture zone where the experience is rare (15 percent) and the moderate and low zones where it is common (47 percent and 49 percent). For any given drought, crop loss may be similar; but hunger is dependent on the overall resources available, and these are highest in the high-moisture zone. And this in turn can also be modified by accessibility. The isolated settlement at Kongoi (808, 809, 810) and Mligano (811) suffer more than the more accessible dry-plain sites of Mashewa (712) or Mombo (702).

In sum, farmers' perception of the frequency of drought inversely correlates with broad moisture zones, but the prevailing pattern of adjustment leads to similar patterns of severity when a drought occurs. In the high-moisture zones, the lesser drought frequency, combined with other resources (money, cattle, longer planting seasons), reduces considerably the overall stress placed on the household.

Table 13–2. Usambara transect: measures of hazard experience

Measures	*Available moisture*		
	High	*Moderate*	*Low*
Recurrence			
Median farmers' estimate, proportion of "bad" years	0.20	0.30	0.40
Median farmers' no. of drought years recalled	2	3	4
Loss			
% reporting experience, at least substantial damage:			
To major food crops	96%	81%	95%
To cattle	71%	93%	95%
Stress			
% reporting common family experience of hunger	15%	47%	49%

Adaptation and adjustment to drought hazard

In the face of drought, Usambara farmers choose from a wide range of purposive actions designed to control or modify the shortfalls of available moisture, to make their crops or cattle less vulnerable to the lack of moisture, and to bear and share the losses of crop and animal production.

When asked what they do when the rains are late or insufficient, farmers suggest a number of preferred actions, the number varying with the available moisture gradient as shown in Table 13–3. The number of adjustments mentioned is greatest in the moderate area and the range measured by the first and ninth decile is considerably greater in the moderate- and low-moisture areas. When asked from a checklist of up to 19 adjustments which they actually employ, the number of adjustments reported by farmers as adopted shows less variation between zones.

While the variation in the number of adjustments adopted is small, a few distinctive differences emerge in examining the favorite adjustments of each moisture zone as shown in Table 13–4. Farmers in all three zones favor seeking alternative cash sources or employing meager savings, employ the labor-saving device of ceasing effort if it appears useless, advocate good practices of early planting with the rains and weeding, undertake increased plantings of cassava and irrigation, and practice the supportive exercise of prayer. In addition to these universal adjustments the high areas, with their more favored environment, even during drought, can employ various alternate options of scattering plots and planting, and seeking low and seasonally wet places for catch crops. The valley floor at Mponde (805) and the adjacent marshy areas at Handei (807) serve this purpose. In the moderate- and low-moisture areas, the

Table 13–3. Usambara transect: number and range of adjustments mentioned and reported adopted

Indicator of adjustment	*Available moisture classification*		
	High	*Moderate*	*Low*
Total number mentioned			
Lowest decile 10%	2	0	1
Median 50%	4	7	4
Highest decile 90%	5	10	10
10%–90% range	3	10	9
Total number reported adopted			
Lowest decile 10%	8	9	7
Median 50%	13	13	12
Highest decile 90%	15	19	15
10%–90% range	7	10	8

Table 13–4. Usambara transect: type of adjustments reported adopted by at least 50 percent of farmers

Type of adjustment	*Available moisture classification*		
	High	*Moderate*	*Low*
Accept self-insure loss			
Work for wages to buy food	+	+	+
Sell cattle to buy food			
Use savings to buy food	+	+	+
Store more than one season's food when crop is good	+		
Distribute and share loss			
Move to another farm	+	+	
Ask help from friends and relatives		+	+
Ask help from the government		+	+
Eliminate moisture waste			
Weed plots	+	+	+
Stop planting when rains are not enough	+	+	+
Change moisture requirements			
Plant drought-resistant crops	+	+	+
Affect source			
Pay for rainmaker			+
Pray	+	+	+
Change location			
Have plots in different places	+		
Plant in wet places	+		
Move cattle			
Improve moisture storage and distribution			
Irrigate	+	+	+
Schedule for optimal moisture			
Plant without rain			
Plant only when enough rains come	+	+	+
Staggered planting	+		

Table 13–5. Usambara transect: indicators of adaptive capacity

Indicator	*Available moisture*		
	High	*Moderate*	*Low*
Farm size			
Per man-equivalent (ha)	0.50	0.74	0.61
Maize-cassava area per person (ha)	0.10	0.21	0.18
Crop diversity			
No. of crops, 10% land	3.1	2.6	2.5
Locational diversity			
No. of other plots	2.2	2.7	2.8
% household heads, 1 wife	14%	13%	35%
Drought-resistant crops			
% of units drought-resistant Crop	32%	55%	57%
% of land in cassava	11%	15%	20%
Normal surplus			
Median farmer estimate of grain surplus in good year (kg)	120	360	300
Cattle			
% farm units with cattle	34%	24%	16%

greater frequency of drought increases reliance on others for help. At Mashewa (712) food was provided and readily accepted by district authorities, and at Mlingano (811) by the LIDEP through the study team. The recourse to rainmaking in the low area is probably not coincidental.

Overall, with these few differences, the purposive strategies of adjustment differ little. It is rather in the everyday agricultural practice that the significance of the available moisture gradient is reflected. We can only draw on a few of these differences in what we might call the adaptive capacity of the agricultural system to deflect, absorb, or buffer considerable amounts of environmental stress or deprivation with a minimum of harm. From the data we have selected a number of measures of such built-in capacity for adaptation (Table 13–5).

The most significant of these indicators is the concept of the normal surplus developed by Allen (1965) with reference to subsistence cultivators. Allen suggests that in the face of the variability of crop production, often related to precipitation shortfalls, subsistence cultivators produce for what they need in a below-average year. This provides a considerable surplus in an above-average year and a modest surplus in a normal year. Overcapacity in production is the norm.

The surplus is not easily disposed of in economically rewarding ways and considerable human effort is required to create it. Thus, there is a real cost in maintaining the excessive productive capacity, as necessary for survival as it may be. A measure of the surplus was obtained by asking farmers in the three moisture areas what was their surplus of grain remaining just before the new harvest in a good year. Their answers provide a measure of overcapacity.

We would also expect differences in moisture to be compensated for by differences in farm size and the scatter of locations. The former, substituting quantity of area for quality of available moisture, the latter hedging the risk of localized failure. One might also expect a greater variety of crops to be planted in the low zone for the sharing of risk by differential crop moisture requirements, and a larger proportion of such areas to be planted in cassava, the major famine food staple. Cattle, one of the few ways of long-term storage of vegetation (in the form of beef) or storing wealth (in the form of the potential monetary value of the cattle), may serve as an indicator of a farmer's reserve.

The expected differences in all but two, crop diversity and cattle, of the indicators are large between the high-moisture zones on the other. The normal surplus of grain in the moderate area is three times that of the high moisture zone, and is almost as large in the low area. The per capita area devoted to the staple crops of maize and cassava about doubles, the amount of cassava increasing with less moisture. The number of plots located away from the immediate household is greater in the moderate and low area, and multiple households are much more common in the low area. The measure of crop diversity (major crops with over 10 percent of cultivated area) favors the high area, reflecting the greater security of wealth and environment which allows or encourages the planting of cash crops as at Vuga (804) and bumbali (806). Cattle in the Usambaras appear to be primarily a wealth measure rather than a storage alternative.

Thus, along the Mombo-Kulasi road, it is not so much the purposive adjustments in response to a specific drought as the adjustments embedded in the fabric of everyday life that serve to mediate the differentials of environmental opportunity. How successful these mediations are can be examined in measures of well-being.

Indicators of farmer well-being and opportunity for improvement

In the language of science we scarcely identify the quality of well-being or at the very least, relative well-being, let along measure it. Therefore, it is with considerable caution that we present a few measures that are derivable from our data: measures of nutrition, wealth, and subjective interviewer appraisal (Table 13–6).

By international standards, Usambara farmers are poor. The measure of nutrition credits eating three meals, makes distinction between usual and unusual staples, maize and rice, the availability of any protein, or having sugar, oil, or other such simple dietary ingredients. The index of material wealth identifies wealth with the ownership of a bicycle, a radio, or home improvements such as a metal roof or a cement floor. The ownership of cattle is another indicator as is the interviewers' classification of households relative to the living quality of the area.

Table 13–6. Usambara transect: measures of well-being

Measure	*Available moisture*		
	High	*Moderate*	*Low*
Median nutrition index[a]	24	17	17
Mean material wealth index[b]	0.97	0.86	0.58
% units with cattle	34%	24%	16%
Interviewer's assessment, % of farms average or above[c]	63%	64%	51%

[a]Index weights variety, number, and nutritional content of meals eaten day previous to interview with maximum value of 38.

[b]Index is a maximum of 5 summing equally possession of bicycle (1), radio (1), galvanized metal roof (1), cement floor (1), and other expensive item (1).

[c]Interviewers were asked to classify farm households as below average, average, or above average for living quality of the area.

It is a measure of the overall poverty that, using the simple nutrition index, the median Usambara farmer food consumption is only half of the maximum value of 38. The median farmers owned less than one of the material items on a five-point scale. In a country where the number of cattle equal the number of people only a fourth of the families had any cattle, where theoretically the interviewer measure of wealth should have shown two-thirds of all families average or above average for the area; significant differences were found in one of the zones.

All four of the measures indicate a tendency for well-being to diminish along the available moisture gradient, but they do not discriminate equally. On the measure of nutrition, the moderate and low areas are similar, while on measures of interviewer assessment it is only the low areas that show any substantial difference from the expected percentage in the high and moderate area. Crude as the indicators are, the association is clear. This lends considerable substance to our expectations on the basis of dominant environmental theory, that greater well-being is related to greater moisture.

Comparing measures of well-being as ratios between high and low zones with similar ratios of available moisture, we see in Table 13–7 that the mean difference in available moisture as measured by four indicators exceeds the mean difference in well-being by some 18 percent. In line with the theoretical expectations, we suggest that this is an extremely crude measure of the degree to which the steepness of the environmental grade can be moderated by the attributes of culture; namely, the process of adaptation of the Usambara farm system to the expected shortfalls of available moisture and the excessive pressure placed on the environmentally attractive high moisture area. The resource using, space adjusting, hazard controlling or avoiding practices of the Usambara farmers seem to only slightly moderate the differentials of environmental opportunity while providing minimal sustenance to all.

The environmental opportunity can be dampened in two directions: the resource base is overburdened in time in the more favored areas, and the effort to guarantee survival in the more vulnerable areas requires that much of the energy and capacity be directed to subsistence. What might be done to improve moisture management so as to increase the utilization of the favored resource base and to allow for greater diversification of effort in the less favored areas?

In the high-moisture zone, improvement lies in the

Table 13–7. Ratios of high- to low-moisture availability zones on indicators of available moisture and well-being

Moisture indicator[a]	*Ratio of high to low*	*Well-being indicator*	*Ratio of high to low*
Average annual precipitation	1.78	Median nutrition index	1.41
1/coefficient of variation	1.38	Mean material wealth index	1.67
Aridity index	2.14	% units with cattle	2.12
Length of season	2.28	% of farms average, above average	1.23
Mean ratio	1.90	Mean ratio	1.60

[a]Based on the average of two stations adjacent high-moisture areas and two stations adjacent low-moisture areas except for the coefficient of variation, which is based on one station for each area.

more intensive use of the land for production of irrigated vegetables on well-tended terraced plots. A major effort to develop this activity has been underway encouraged by the Lushoto Integrated Development Project (LIDEP). Twelve hundred farmers were involved during 1971 in commercial production of vegetables, working in collective groups including one of our study sites at Mponde (805). The project organized horticultural advice, seed distribution, transportation, and marketing to Dar es Salaam, some 400 kilometers (250 miles) away. Prospects for expansion lie in shipments to Europe by air. A self-sustaining operation by the farmers would be a major achievement and an open door to a new stage of resource utilization (Heijnen and Kreysler, 1971; Heijnen, forthcoming).

Improvement in the moderate-and low moisture zones involves building on the survival wisdom of the traditional culture but combining this with judicious inputs of social organization and technology. Collective production in the form of *Ujamaa* (communal) villages permit increasing the land area source, utilizing more diverse environments, supplementing diets with pond fish or chickens, and developing modest cash cropping with the increased security of the staple production base. An improved short-season maize variety with higher yield potential under dry conditions is needed. Evidence from Kenya suggests that it can be developed (Wisner and Mbithi, chapter 11).

For all areas, the local market for maize needs improvement. As of 1971, the local marketing arrangements seemed inadequate to provide assurance to farmers that would permit further diversification. During a drought, as demand increased and local supplies diminished, prices for locally available maize doubled or trebled. For areas of potential famine, relief grain was given away, but for areas of shortage only, no relief was given and the burden of drought was carried by the householder. However, it is often the case that the shortage of grain is relatively local and adequate supplies exist elsewhere. Yet no provision was made in the government controlled cooperative marketing apparatus (applicable beyond local markets) to funnel available supplies back to local markets to bring the free market price down. Nor is there local provision for interseason storage, all surpluses being sent out of the area. Recent news reports of decisions made by the National Executive Committee of TANU suggest that greater efforts for decentralized storage and distribution will be made.

The most vulnerable period in the life of a developing country is when the reliable mechanisms of the folk society are weakened by change and when the new institutions and practices are still in their formative stage. The agriculture along the road from Mombo to Kulasi is conservative agriculture; it needs change, not only to improve well-being but to prevent rural involution. Successful change will draw from the folk wisdom, institutionalizing, expanding, and improving on the considerable knowledge of the Usambara farmer to both diversify and provide reserves in space and time.

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