Natural Hazard Research

AGROCLIMATIC HAZARD PERCEPTION, PREDICTION, AND RISK-AVOIDANCE STRATEGIES IN LESOTHO

by

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SUMMARY*

Although environmental hazards are commonly thought to hinder agricultural operations in Lesotho, there have been no systematic studies either of hazard frequency and severity or of farmer attitudes and responses. This report presents the results of a survey of hazard perception, prediction, and risk-avoidance strategies among 346 Lowland and Mountain farmers in this tiny southern African kingdom.

Rather than arbitrary criteria such as a fixed temperature or minimum precipitation, Basotho farmers recognize adverse events by crop damage primarily, but also by soil and ground water conditions and animal behavior. Drought is rated the worst hazard, followed by worms which are associated with dry weather. Hail and too much rain complete the list of major hazards. Wind is considered a minor threat, as is erosion, contrary to widespread official concern.

Except for a few disastrous years in the past, farmers generally identify most recent years with "last" and "worst" events. Similarly, expectations of future adverse events are concentrated in the next year or two, suggesting either that farmers are generally pessimistic, or that they interpreted the question as one of possibility (i.e., "could happen") rather than of probability ("will likely happen"). There is little evidence of belief in periodicity (i.e., regular or cyclical event occurrence), or of association (i.e., event occurrence precludes or assures repetition).

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Basic and operational risk-avoidance strategies include the crop mix itself as an adaptation to local conditions, shifts into more tolerant species or varieties, adjustment of plowing and planting dates, plant densities, fallowing, and application of amendments. Specific strategies such as rearrangement of surface geometry (e.g., furrowing, mounding) and insecticides protect crops against particular hazards. Avoidance rituals or ceremonial procedures relieve anxiety in the face of hazards against which there are no effective measures.

Predictions of future conditions range from immediate forecasting of hail or heavy rains in the presence of towering cumulus clouds, to long-range forecasting based upon winds, winter precipitation, and animal activity. Although plants figure strongly in hazard definition, they play a little role in hazard prediction.

Hazard perception, prediction, and avoidance are fundamental to the structure and scheduling of the farming system that has proven effective in maintaining this agrarian society within a marginal and hazard-filled agricultural environment. Although improvements are possible, they must be evaluated carefully to insure compatability with the physical environment and the present farming system.

SESOTHO SUMMARY

Leha koluoa tsa thloleho e le ntho e atisang ho hopoloa e le ts'etiso ts'ebetsong ea temo Lesotho, ha ho e-so be liphuputso tse phethahetseng ho ithuta maikutlo a lihoai kapa tsona liteko tseo ba eeng ba li etse mabapi le seoa.

Sephetho sena se hopoletsoe ho beha poaneng a mang a maikutlo a lihoai, le tsela eo a eeng a qobe koluoa tse oelang temo ea bona. Phuputso ena e ile ea ama lihoai tse 346 tsa mabalane le maluting a Lesotho.

Ho fapana le ts'ebeliso ea mechini ea mahlale ea ho lepa, Basotho ba lihoai ba na le tsebo e itseng ho hlokomela lietsahala tse senyang lijalo tsa bona 'me hona ho hlahlobjoa ka ts'enyo e bonahalang lijalong, mobung, mets'oets'oeng, liphoofolong, joalo-joalo.

Komello e pakehile e le eona sera se seholoholo sa lihoai, 'me eona e lateloa ke seboko seo hangata se tloaelehileng nakong ea eona komello, sefako le pula e ngata li hlaha borarong le boneng ka ho latellana lethathamong. Ha khoholeho ea mobu le sefefo li e tla qetellong leha ho bonahala tsona tse peli tsena tsa ho qetela, ho Baokameli le Baeletsi, e le tsona tseo ba li behang pele-pele.

Lihoai, ntle ho lilemo tseo ho hlileng ha oa sekoboto, li ts'oaha feela lilemo tse bileng mpe tse haufinyane, 'me le bonohe ba tsona bo fella lilemong tse peli (kapa se le seng) tse tlang. Hona ho ka 'na ha supa hore lihoai mohlomong li hlotsoe ho utluisisa potso hantle kapa li nkile potso ena e bolela ho ka etsahalang eseng ho ka 'nang ha etsahala ho latela seo ba tloaetseng ho se bona lingoaheng tseo ba li phetseng e le lihoai. Ho bonahala hose se ka re susumetsang hore re lumele hore

seoa se na le ho ipheta-pheta nakong tse tloaelehileng kapa hona hore ketsahalo e itseng e se e lupa tse ling.

Hara tse ling tseo lihoai li li etsang boits'ireletsong ba tsona komellong kapa lioeng tsa mofuta ofe kapa ofe ke tsena - ho jala lijalo tse tiisetsang, ho atametsa matsatsing a itseng bakeng sa ho lema kapa ho jala, ho fokotsa kapa ho eketsa peo, ho phethola joalo-joalo. E meng ea mekhoa e tobisitsoeng seoa se itseng ke ena - ho ila, le ho hlabela balimo ke e meng ea mekhoa ea ho qobeletsa sefako le seboko masimong.

Pokello ea mobu masimong ha ho hlaoloa le ha ho kofoloa, ts'ebeliso ea meriana khahlano le seboko, ho bala feela e seng mekae mekhoa.

Mekhoa ea bonohe ba boemo ba leholimo e tloha ho boneng sefako ha se e tla le moo tlas'a kiria-tsoana esita le ho se utloa ha se hoba, le benya le tsekema le baka mahlomola. Kapa ho bona pula e e tla e ikentse fito le lets'o kapa meholi. E meng mekhoa ea ho noha e ipapisitse le tsela eo moea o fokang ka eona kapa mongobo oa mariha, e sita le hona ho nkha na pula kapa eona menyakoe ea liphoofolo. Leha lijalo li setse e le lits'upo tsa boemo bo thata, li fumaneha li hloloa ho sebelisoa ke lihoai ho lepa se tlang ho etsahala.

Phuputso ena rea lumela hore e tlaba bohlokoa haholo, ka ha re lumela re tiile hore liphetoho le lintlafatso li ka etsoa feela li ke ke tsa atleha ha maikutlo a mabeoana, bana ba Molimo o Nko e metsi, chaba sa ho thabela mabele se mafolofolo temong, a sa tsejoe.

Kea leboha.

(Translated into Sesotho by P. J. Lehohla)

ACKNOWLEDGEMENTS

The 346 farmers who agreed to be interviewed, together with those on whom early versions of the questionnaire were tested deserve first acknowledgement. Next the enumerators, ranging from professionals to students (some of whom performed like professionals) can be named: Pali Lehohla, Lawson Liholo, Alida Mafike, Clement Montinyane, Nketsetseng Matsinyane, Julius Metsing, Motlatsi Mokhothu, Joseph Moleko, Elizabeth Mphoso, Muso Ntaote, Constantinas Sentla, Alexis Thasi, 'Mapesola Theko, and Fernando Thupeng. In such a survey supervisors are critical. I was lucky, and am happy to publicly thank Susan Crissman, John Gay, and Agnes Ntlopo for their efforts. Marufo Zinyowera, Geography Department, National University of Lesotho made valuable inputs at the beginning of the study. John Gay not only helped supervise enumerators but also was a constant advisor on survey techniques and computer processing. Initial funds were provided by the National Science Foundation of Washington, D.C. Subsequently the Lesotho Agricultural Sector Analysis (LASA) Project (USAID) provided support. In the field welcome hospitality was extended by the Sisters of the Holy Cross at St. Thomas near Mafeteng, and the Brothers of the Sacred Heart at St. Monica's, near Hlotse (Leribe). But in addition to expressing gratitude to those who were so helpful, I must also absolve them of any responsibility for the study. All expressed opinions, conclusions, or recommendations are those of the author and not of any of the individuals or agencies named, nor of the governments of Lesotho or the United States.

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INTRODUCTION

Almost every account of Lesotho mentions the marginal, variable and agriculturally risky nature of the climate and the severe and extensive erosion that is in large part a product of the climate. There is a general feeling that environmental constraints and hazards discourage Basotho* farmers from the efforts necessary to increase the current meagre yields, and deter national efforts to boost overall production. The environment is thought to reduce possibilities for increasing the presently pathetically low income levels from farming (van der Wiel 1977).

This attitude has had a profuond impact upon development thinking and planning in Lesotho, but the expressions of it have been almost exclusively by outsiders--traders, missionaries, colonial administrators, and more recently developers--who often come from environments markedly different from Lesotho's, and certainly from socio-economic backgrounds far removed from that of the semi-subsistence cultivators of Lesotho. Not only has the attitude of Basotho farmers toward their own agricultural environment escaped serious inquiry, but the physical environment of agriculture itself remains almost completely unanalyzed.**

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*Plural *Basotho*, singular *Mosotho*. Words in the native language *Sesotho* will be italicized.

**The importance of climate in Lesotho is suggested by the national slogan: *Khotso, Pula, Nala*--Peace, Rain, Prosperity. Basotho children often are named after events associated with their birth. Among the most common are favorable and unfavorable weather events, such as *Pule* (masculine) or *Puleng* (feminine) from *puls*, rain; *Sefako* (masculine), hail, and *Kganyapa* (masculine), thunderstorm (Mohome, 1972).

Hazard Perception

The importance of human perception of the environment, as contrasted to objective measurements of physical elements, as long been recognized. Modern perception studies, however, date back less than two decades. All the evidence of an emerging field, such as summaries (Porter 1978), systematic frameworks (White 1974; Whyte 1977), and critiques (Bunting and Guelke 1979) bear recent dates.

Perception studies already have proven of great value in two areas: understanding how people relate to their physical environment, and regulating relationships between people and their environment. The former is of surpassing interest in more than one social science; the latter finds expression in a wide variety of situations from national and international conservation policies, to local or village-level resource allocation and management systems. The purpose of perception studies is to add other levels of understanding and to avoid mistakes. As Porter (1978, p. 6) notes with respect to the subfield of hazard perception:

> Research which ignores the beliefs, ideas and knowledge of environmental hazards possessed by those affected by the hazards is incomplete and can have unfortunate consequences when its findings are used in planning and decision-making. A perception of environment research strategy can assist in creating meaningful research results. It is not, however, a substitute for other kinds of research based in natural sciences and engineering. It is simply a way to gain added insight into the subject of environmental hazards by attempting to see them through the eyes and in the cultural context of those directly affected by the hazards. There is no presumption that local understanding will prove to be scientifically correct; but the local understanding of hazards is important in its own right, and more frequently than is generally believed, local knowledge and practice prove to have scientific and social validity as well.

However, just what constitutes perception research? Although often mentioned as a basic tenet, the idea that people behave in the real world according to subjective images, not objective reality (Bunting and Guelke 1979) misses the mark, and suggests subjective/objective non-scientific/scientific dichotomies that should not be. The individual experience of a traditional farmer and the collective wisdom and oral history of his village must be counted as more than subjective images even though neither is supported by written records or statistical analyses. To do otherwise would be to define objective knowledge in the narrowest of ethnocentric terms.

In fact, the real problem is one of language and image systems, and there is need to develop a basis for understanding both subjective and objective information. One farmer has no trouble arriving at mutually understandable though perhaps different environmental appraisals with his neighbor, nor with the local chief or village leader with whom local resource management decisions are made. But the researcher or government policy maker who does not share their experiences or evaluative processes needs a translation to match local perceptions with what are perhaps erroneously labeled objective environmental facts.

Two methods are available for arriving at a common understanding. The first is to instruct farmers in the modern methods, and scientific language used by researchers and extension workers. The second is to learn the farmers' methods and language. The first process is well-known--it is at the heart of most development training efforts; the latter constitutes a branch of perception research.

The Survey

Farmers' perceptions of their environment and of ways to avoid or meliorate the effects of adverse events were sampled by a survey consisting of four parts: farmer characteristics, perception of hazards, risk-avoidance strategies, and methods for predicting adverse events. The survey was conducted in villages near four lowland locations--Leribe, Mohale's Hoek, Teyateyaneng, and St. Thomas which is adjacent to the Foothills--and in two mountain locations Semonkong and Thaba Tseka (see Figure 1). Locations were selected as representative of their regions. In addition, only villages within ten kilometers of a weather station were surveyed so that results could later be checked against weather records.

TABLE 1 CHARACTERISTICS OF SURVEY LOCATIONS

Location/Station	Latitude	Longitude	Elevation (meters)	No. of Respondents
Lowlands				
St. Thomas	29°45'S	27°33'E	1740	54
Leribe (Hlotse)	28°53'S	28°03'E	1740	61
Mohale's Hoek	30°09'S	27°28'E	1600	57
Teyateyaneng	29°09'S	27°44'E	1750	43
Mountains				
Semonkong	29°30'S	28°06'E	2460	66
Thaba Tseka	29°30'S	28°37'E	2160	65
				346

The survey form itself (Appendix I) was adapted from White (1974, pp. 6-10), but with most of the subjective questions deleted since it was felt that these would cause problems for inexperienced enumerators.

The questionnaire subsequently was tested in two locations and further modified. Once enumerators became familiar with procedures, they could administer an interview in 30 to 45 minutes. Furthermore, since there are few if any sensitive questions, except perhaps for those pertaining to material possessions, there is no reason to believe that respondents deliberately hid or distorted information in the interviews. Sample follow-up interviews and internal checks have revealed no serious discrepancies in the responses.

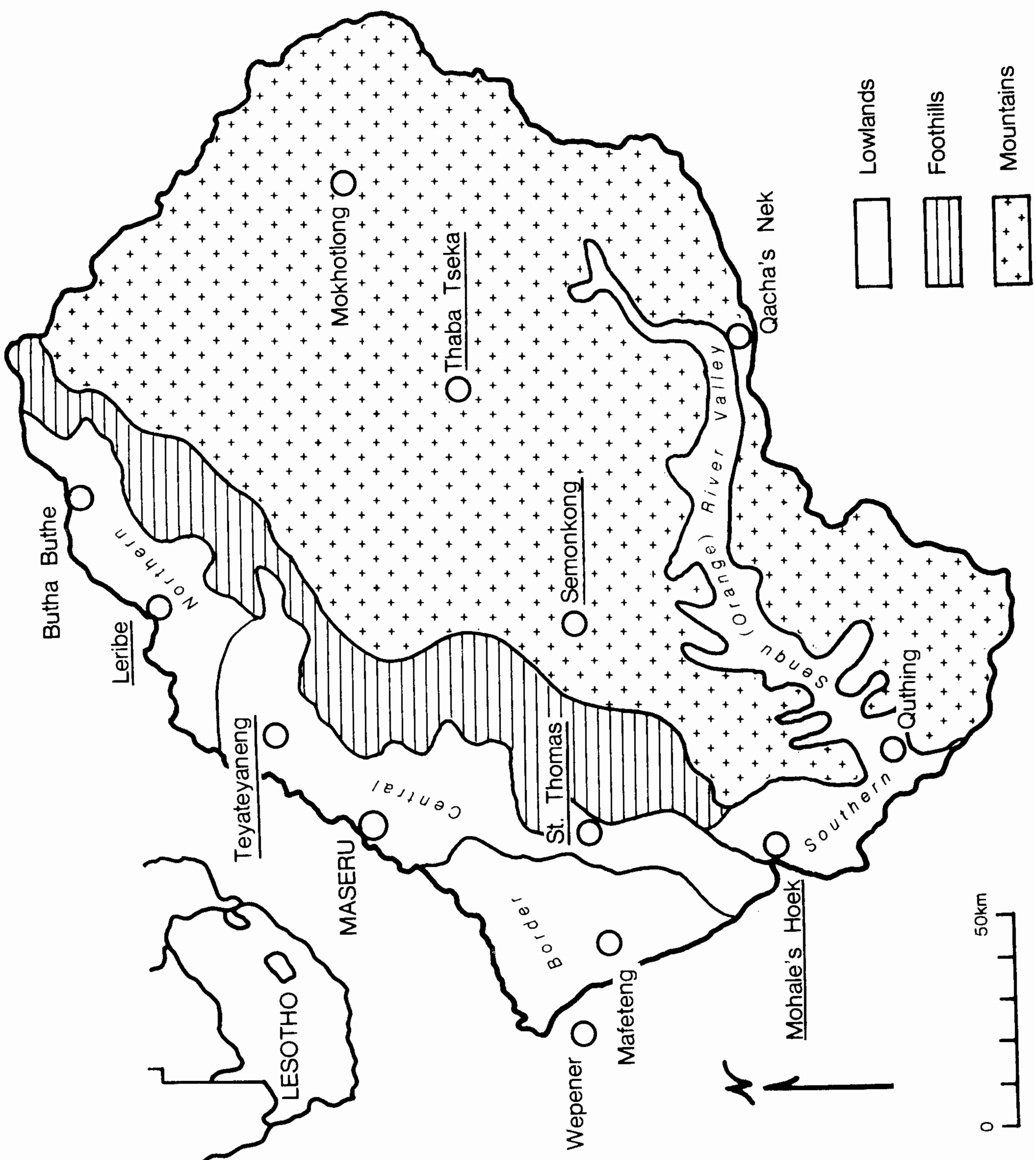
Following the survey and preliminary reviews of results, the individual questions were evaluated with respect to quality of response. The criteria included accuracy, reliability, and general estimation of whether questions elicited appropriate information. For example, did responses to Question 19 indicate that farmers varied amounts of land as an adjustment to environmental circumstances, or merely as ordinary crop rotation? Although admittedly subjective, the evaluation represented the collective wisdom of supervisors and enumerators following the experience of the survey. Based upon this evaluation, questions judged least reliable were dropped from the summaries and analyses.

The main objectives of the study were to identify major hazards and local methods of coping with them. Identifying relative importance of hazards by region required a broad survey; however, although the number of farmers following a particular strategy was of some interest, it was more important to determine whether the practice existed as part of local technology where it was available to all, though not perhaps practiced by all.

In any farming community, a few individuals with special gifts for predicting events and devising defensive strategies are recognized and

FIGURE 1

PHYSIOGRAPHIC REGIONS OF LESOTHO



Precipitation*

Lesotho lies entirely within latitudes 28° and 31° S, and thus is dominated by the subtropical high pressure belt of the Southern Hemisphere. Above a relatively shallow layer of maritime air there is a strong and persistent subsidence inversion that inhibits lifting of air masses and thus precipitation. The most common type of weather is anticyclonic; this prevails in the winter, but also occurs in the summer in weakened form.

In winter, pressures intensify over land and inhibit the entry of marine air. The blocking pattern is disrupted by southern cyclones that shift north in the winter and bring frontal and orographic rains and occasionally snow. In summer the high pressure belt shifts south and separates into two cells, the Atlantic and Indian Ocean highs. Pressure distribution over the differentially heated land mass remains anticyclonic, but weaker than in winter, permitting the influx of moist tropical air. Convective, convergent, and orographic lifting of unstable air produce most of the annual rainfall. For most stations more than 75% of the total precipitation falls during the six months October to March (see Table 2).

Although the Northern Lowlands enjoy more rainfall and somewhat better soil conditions than the other Lowland sub-zones (Youthed, 1963), there are no clear latitudinal trends. Slight differences in seasonal totals, however, may be significant. Thus, northern stations receive only 20% of their annual precipitation during the six winter months, whereas stations farther south, more affected by frontal storms, may receive 25% in winter.

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*Much of this section is taken from Wilken 1978a.

TABLE 2

AVERAGE MONTHLY PRECIPITATION (mm)*

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total	Six Months Winter Amt	Six Months Winter %	Six Months Summer Amt	Six Months Summer %
Lowland																	
Leribe (28° 53' S 28° 03'E 1740m)	13	13	30	76	104	117	132	115	112	60	34	13	819	163	20	656	80
Teyateyaneng (29° 09' S 27° 44' E 1750m)	11	12	22	68	90	93	111	93	99	57	31	11	698	144	21	554	79
Maseru (29° 17' S 27° 30' E 1530m)	12	13	21	61	88	89	108	91	99	60	29	11	682	146	21	536	79
Mafeteng (29° 49' S 27° 15' E 1610m)	12	15	26	59	82	88	104	106	107	66	33	13	711	165	23	546	77
Mohale's Hoek (30° 09' S 27° 28' E 1600m)	14	15	26	62	86	95	113	101	106	61	37	15	731	168	23	563	77
Mountain																	
Semonkong (29° 50' S 28° 06' E 2460m) long-term means not available																	
Thaba Tseka (29° 30' S 28° 37' E 2160m)	11	14	22	59	67	86	96	72	74	39	27	8	575	121	21	454	79

(Lesotho Hydrological Survey, 1971)

*Period of record 50 years, 1920-1970 except Thaba Tseka (approx. 30 years of broken record to 1970).

Longitudinal and altitudinal differences are more pronounced. The Lowlands are progressively drier toward the west, culminating in the the Border Lowlands that are climatically as well as physiographically distinct. Generally, mountain regions receive more precipitation than lowland, with means along the Maluti and Drakensberg escarpments in excess of 1300 mm. However, some mountain stations in sheltered valleys, such as at Mokhotlong and along the lower Senqu (Orange) River, receive as little as 500 mm on the average, or less than the dry Border Lowlands (see Figure 2).

Typically, the rainy season begins in September or October. The five months November, December, January, February, and March are relatively uniformly wet on the average, although never in any one year. A slight secondary precipitation peak in March that appears in the monthly total of several stations (e.g., Mohale's Hoek) is in part a product of the short, 28-day February that precedes it. But less sunshine and stream flood stages also often occur in March, suggesting that an as yet undetermined atmospheric phenomenon may be present. Timing of the rains is the single most important determinant of planting times, and thus cropping seasons.

Rainfall varies from long frontal and orographic drizzles to hard convective downpours. With inadequate observational data available, point rainfall intensities have been estimated for Maseru (Table 3).

Precipitation intensities by themselves can only suggest the likelihood of exceeding soil infiltration rates and storage capacities. In Lesotho, where soils often are thin and underlain by relatively impermeable layers, the threats of flooding and erosion obviously are great. Standing water in fields and silt-laden runoff are common sights following heavy rains.

FIGURE 2

AVERAGE ANNUAL PRECIPITATION

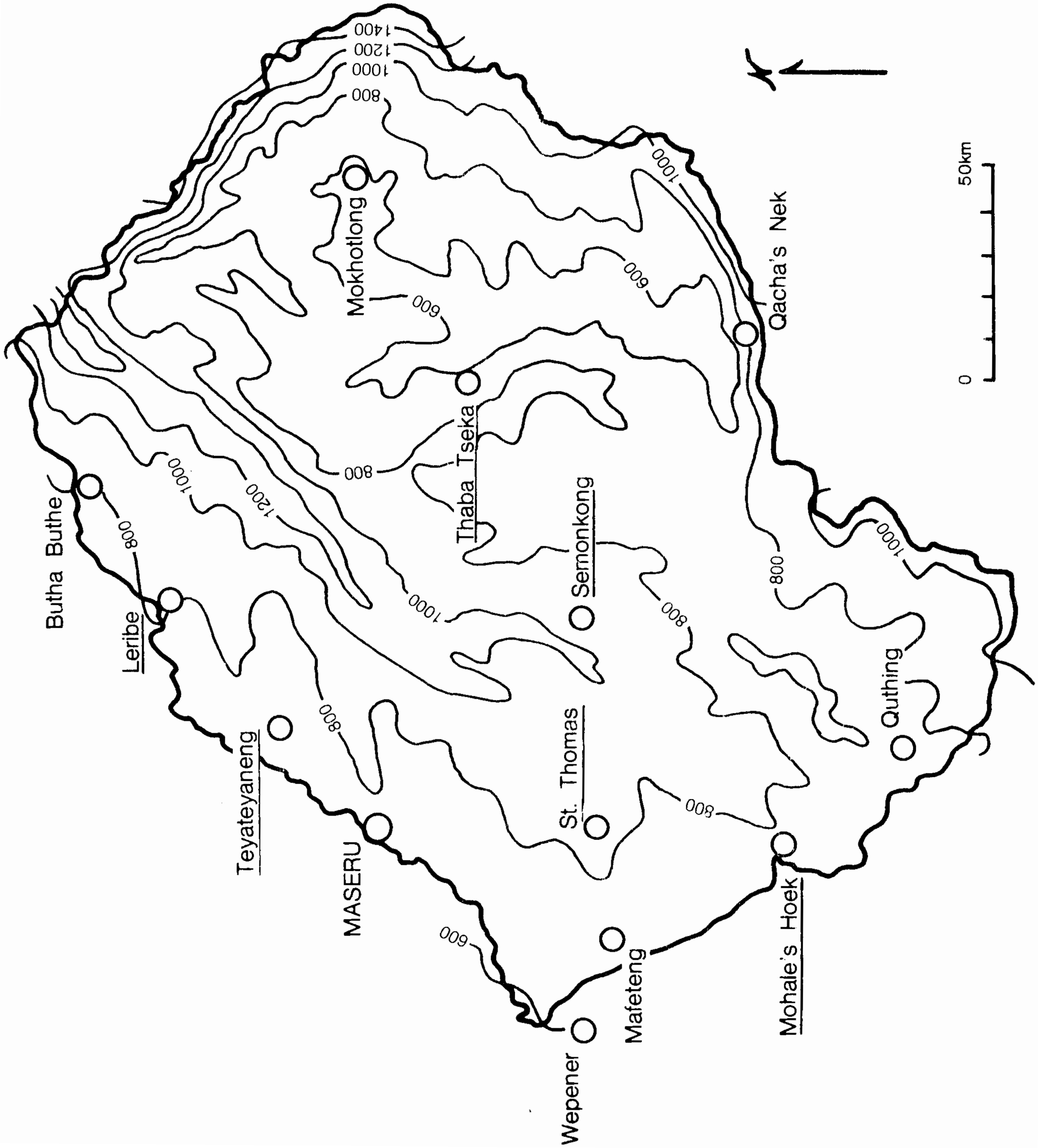

TABLE 3

ESTIMATED MAXIMUM RAINFALL AMOUNTS FOR MASERU
(Elevation 1530 m)

Return Period (years)	15 min.	30 min.	45 min.	60 min.	24 hours
2	17 mm	26 mm	28 mm	33 mm	56 mm
5	24	35	40	45	74
10	27	--	44	52	85
20	31	45	49	58	95
50	36	52	58	68	112
100	39	58	64	74	126

(Adapted from Binnie & Partners, 1972, Vol. 1, pp. 35-36; based upon Reich 1963)

Hail is a recurrent threat, especially the hard hails of summer that can strip fruit from trees and flatten grain fields in seconds. Unfortunately, information on distribution and severity of hailstorms and estimates of crop damage is lacking. Schulze (1972) estimates that most points in Lesotho can expect hail seven to eight times per year. Basotho farmers perceive the frequency, and thus the risk, to be higher.

As is true of most semi-arid regions, severe and prolonged droughts are a persistent threat. A 50-year record (1920-1970) for Maseru indicates that total annual precipitation has varied from 1119 mm to 419 mm, or from 63% above to 39% below the average of 687 mm. In the ten-year period 1960-1970 the critical month of February varied from 274% (1962) to 8% (1968) of normal (Lesotho Hydrological Survey 1971, p. 40).

The intensity, duration and possible cyclical nature (Dyer 1975; Dyer and Tyson 1977) of droughts in Lesotho have not been analyzed. Of particular interest are short-term droughts that may occur during the growing season.

Temperature

All parts of the relatively narrow southern portion of Africa are accessible to cool maritime air, resulting in cooler temperatures than those at comparable latitudes over larger landmasses in the Northern Hemisphere (Schulze 1972). More important, Lesotho is one of the highest countries in the world. From the western border at about 1,500 m elevation the land slopes up across the Lowlands through a narrow band of foothills, and quickly rises into high mountains that along the eastern marches contain substantial areas above 3,000 m. Except for river valleys in the south and east, for which there are few environmental data, most farmland is located in the western lowlands. The cooler hill and lower mountain lands are suited primarily to grazing or, in the case of higher elevations, are nonagricultural.

Highest average monthly temperatures, on the order of 19-20° C at Lowland stations, and 17° C in the Mountains, occur in January. Lowest temperatures in June or July range from 7-8° C in the Lowlands, to 5-6° C in the Mountains. Diurnal temperature ranges are considerable. Minimum ranges occur in mid- to late-summer and are on the order of 12 to 13° C in the Lowlands, and 14 to 15° C at higher elevations. Maximum diurnal ranges occur in mid- to late winter and are about 14 to 15° C in the Lowlands, increasing to 18 to 20° C in the Mountains.

Frost is one of the more threatening climatic hazards in Lesotho. Although most Lowland stations on the average enjoy a seven-to eight-month frost free period, early or late frosts can reduce the growing season by a month or more (see Table 4).*

TABLE 4

FIRST AND LAST FROST DATES

	Years of Record	Elevation	Extreme Last Frost	Average Last Frost	Average First Frost	Extreme First Frost	Frost Free Days Between Average Last & First Frost Dates
Leribe	29	1740	1 Dec	14 Sep	10 May	7 Apr	237
Teyateyaneng	28	1750	2 Oct	24 Aug	2 Jun	5 Apr	281
Maseru	29	1530	4 Oct	6 Sep+	13 May	2 Apr	254
Mafeteng	25	1610	13 Nov	20 Sep	19 May	23 Apr	240
Mohale's Hoek	28	1600	1 Dec	26 Sep	11 May	6 Apr	226
Semonkong - data not available							
Thaba-Tseka	11	2160	25 Dec	21 Oct	3 May	9 Apr	193

+Except average last frost date for Maseru adjusted to 6 Sep vice 6 Aug in concurrence with suggestion of the Climatological Bulletin, 2 (1977).

(Republic of South Africa, 1954)

The data presented in Table 4 are from measurements at standard screen (shelter) height of 120 cm. Of greater interest for agriculture is the likelihood of frost near the surface where most crop plants grow, and where all crop plants pass their early growth stages. Screen (120 cm) and grass minimum (5 cm) frost dates for Maseru based upon nine years of observation are given in Table 5. It is of considerable significance that the average frost-free growing season is more than two months shorter

*A true growing season is that part of a year when environmental conditions permit a specific crop to grow. A more general definition is the time elapsed between the average dates of the last and first killing frosts, which may not coincide with occurrence of freezing temperatures (0°C). For a discussion of this, see Chang (1971) and Wang (1972, pp. 112ff).

if surface, rather than screen temperatures are used, and that January is the only month completely free of the possibility of frost.

TABLE 5

COMPARISON OF FROST DATES AT MASERU
120 cm AND 5 cm ABOVE THE GROUND
(Period 1968-1976)

	Extreme Last	Average Last	Average First	Extreme First	No. of Frost Free Days Between Average First & Average Last Frost Dates
Screen (120 cm)	8 Oct	14 Sep	14 May	2 May	241
Grass (5 cm)	5 Dec	30 Oct	14 Apr	6 Feb	165

(*Climatological Bulletin*, 2 [1977])

Evaporation

Short periods of record, and in some cases questionable quality of data, preclude detailed analysis of evaporation in relation to precipitation and soil moisture storage. Furthermore, evaporation calculated by any of the standard formulae has not yet been adequately reconciled with measured evaporation (Binnie & Partners, 1972, pp. 54ff). However, it appears that evaporation exceeds precipitation in all months and that annual deficits (P - E) are substantial. In the warm Lowlands available moisture normally is not sufficient to satisfy the atmosphere's capacity to absorb water. Therefore, in rainy years losses to evaporation and plant transpiration actually increase (de Baulny, n.d., p. 13).

Wind

Wind usually is considered of secondary importance in agricultural climatology, of significance mainly as it relates to evapotranspiration. However, strong winds, especially those associated with summer storms, can cause considerable damage to standing crops such as maize and wheat and significant soil erosion in some areas (Binnie & Partners, 1972, Vol. 4, p. 411). At Mazenod, near Maseru, the highest hourly windspeed recorded in recent tests was 54 km/hr (in October); the strongest gust (recorded in November) was 116 km/hr. (Clim. Bul. 9/1977; Sweco, 1975, p. 2:11). Comparison with stations in South Africa suggests that over longer periods, even higher windspeeds could be expected (Republic of South Africa, 1974, p. 29).

Erosion

Most government administrators and outside observers rate erosion the number one environmental problem of the country. The following quotation from Lesotho's Second Five-Year Plan (Lesotho, n.d., Vol. 1, pp. 111-112) not only expresses this concern, but also describes the more common erosion forms:

> Topsoil and water are two of Lesotho's most valuable resources. Both are being wasted in a spectacular process of erosion. This erosion has been going on for more than a generation despite the installation of a basic protection system of contour banks on virtually all arable land. The surge of water down inadequately vegetated slopes is obviously destroying topsoil by gully (*donga*) formation, particularly in the Lowlands. But the widespread sheet erosion which accompanies such surge, although much less visible, is far more deleterious because it results in general reduction of fertility on both range land and cultivated land. The conservation of soil and water is particularly difficult in Lesotho because of physical factors which cannot be changed: rugged topography, intense summer rain storms, cold dry winters, and, in the lowland, highly dispersible soils. However, the natural potential for erosion is aggravated by forms of poor land use which can be changed, especially overgrazing, poor cropping, and cultivating of unsuitably steep land or of land without adequate protection.

Despite this eloquent and alarming statement and despite the horribly visible evidence of soil loss in the landscape, erosion is not perceived as a major hazard by most Basotho farmers. Some of their perceptions are revealed in this study, but unfortunately, responses to questions on erosion were too few to permit detailed analysis of farmer attitudes or to resolve the enigma.

FARMER CHARACTERISTICS

In Lesotho a substantial number of young men migrate to off-farm employment, primarily to the mines of south Africa, leaving women and older men to manage the small (average 2 ha) farms. The average age of the 346 farmers interviewed (question 05) was 51 years, and 196 or 56.6% were women (question 09). Landholders* made up the majority (52.9%), followed by wives of landholders (25.7%), widows (13.6%), relatives of landholders (4.9%), and sharecroppers (1.4%).

The Basotho are rightly proud of one of the highest literacy rates in Africa and some 60.4% of the respondents professed at least minimum reading skills. Standard three was the mean educational attainment (question 08).

By far the majority of respondents claimed affiliation with one of the major religions in Lesotho: Catholic 47.1%; Lesotho Evangelical 25.4%; and Anglican 18.2%. Only 9.3% either did not respond or identified with some other group (question 06).

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*Landholder as opposed to land owner. Lands in Lesotho are held in trust by the paramount chief (king) and are administered through a hierarchy of regional and local chiefs. The right to use but not to own land is allocated by village chiefs or headmen (Sheddick, 1954; Williams, 1972). The new land law of 1979 will change many traditional land relationships.

Farmers were asked how long they had lived in their particular place as an indication of their experience with local conditions (question 07). The average of almost 41 years seems high and may reflect the fact that even though men are away in the mines for years, they still feel that they "live" in their native village. However, movement within Lesotho is not common, except perhaps to urban centers, since it involves disruption of family relationships, loyalties to local chiefs, and loss of rights to land allocations. Thus, although the respondents may or may not have spent an average of more than 40 years of continuous residence in their place, their experience is likely to have been ample.

In material terms the Basotho are by no means affluent. Presumably respondents do not overstate possessions to enumerators who happen by, but even discounting understandably cautious answers (questions 10-11), the capital equipment and tools of agriculture seem meagre (Tables 6 and 7).

TABLE 6

ANIMALS OWNED

Type of Animal	Average	Range
Oxen/cows (draft & milk)	4.1	0- 47
Sheep	8.0	0-250
Goats (Angora, for wool)	3.2	0- 52
Horses (mostly for riding)	0.8	0- 10
Donkeys	0.6	0- 6
Pigs	0.6	0- 15
Fowls, all kinds	5.8	0- 50

TABLE 7

EQUIPMENT OWNED

Type of Equipment	Average	Range
Yokes	0.9	0-8
Plows	0.6	0-2
Planters	0.2	0-2
Cultivators	0.2	0-2
Harrows	0.2	0-2
Carts	0.1	0-3

(Only one farmer claimed to own a tractor)

Adequate traction power and tools are of more than passing interest. In a country where variable rains can reduce optimum periods for plowing and planting to a few days, access to equipment may be a major factor in farmer decision-making. This concern will appear again in the section on strategies to avoid environmental risks.

As is common in many parts of the traditional farming world, land holdings in Lesotho are counted more by number than by size. Traditionally, a newly married man applies to the village leader for his first field; a second and later a third are granted as the family grows. Ideally, fields are of different characteristics. Quality differences, especially in moisture storage, and spatial dispersal facilitate diversification and reduce risks of complete crop loss. Population growth has long since prohibited such reasonable arrangements, and although the tradition persists, field sizes in fact have gradually decreased, and the average holding is now two fields (Lesotho Agricultural Sector Analysis [LASA], 1978, Chapter V).

The respondents in this survey (question 12) held an average of 2.1 fields, almost exactly the national figure, with a range of 0 to 9 fields.* Respondents also were asked field sizes (question 13), but since replies included both "English" acres (43,560 $ft.^2$) and "Sesotho" acres which are of determinable width but variable length,** actual size of holdings could not be calculated.

DEFINITION, PERCEPTION, AND EVALUATION OF HAZARDS

Defining Hazards

Before environmental hazards can be evaluated, they must be recognized. More to the point, before investigators begin to study hazard perception, they must first determine how hazards are locally identified. Discrete events such as hailstorms pose few problems, but other hazards such as drought and frost are less subject to precise definition, even within a culture (e.g., Gibbs, 1975).

Farmers were asked what signs indicated drought, frost, and too much rain (questions 25-27), hazards that had been identified in earlier studies (Gay, 1977; Wilken, 1978b). Field tests of the questionnaire had suggested three or four common responses which were entered on the revised form to facilitate recording. Enumerators were specifically instructed not to suggest these or any other answers, and farmers were encouraged to give as many responses as they wished.

Drought. Ultimately, 343 farmers out of the total of 346 interviewed provided more than a dozen indicators of drought. Of these, 135 mentioned two or more indicators for a total of 522 responses.

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*Rural residents without fields are still considered farmers if they own a minimum number of animals, or if they sharecrop or contract to farm others' fields.

**"A Sesotho acre is most exactly defined as a piece of land twelve paces by X - where the value of X is not relevant," (Wallman, 1965).

Farmers describe event indicators in a wide variety of ways; the responses were listed as recorded, then successively assigned to like clusters and finally identified with major indicator groups (Table 8). Clusters of the most common responses paraphrased in representative terms appear as sub-entries.

TABLE 8

INDICATORS OF DROUGHT

Indicator Group	No. of Responses		Percent of Total Responses
Meteorological Indicators	70		13.4
period without rain		70	
Soil Moisture Indicators	190		36.4
soil dries out		183	
soil makes clods		7	
Hydrological Indicators	11		2.1
springs dry up		5	
wells dry up		6	
Plant Indicators	202		38.7
crops turn yellow		57	
crops/grass dies		137	
crops won't grow		7	
seeds don't germinate		1	
Animal Indicators	5		1.0
animals die		5	
Others	44		8.4
TOTAL	522		100.0%

Probably all farmers would agree with the meteorological indicators of drought ("a period without rain"), but the indicators they volunteered that stress soil and plant responses make much more sense. As Gibbs (1975) points out, drought is a supply _and_ demand phenomenon, and using agricultural requirements rather than supply as a criterion more correctly reflects the farmers' perspectives.

Soil and plant indicators together account for 75% of total responses, which is not surprising since these are of first concern to farmers. Animal indicators are low, perhaps because income-producing sheep and goats are relatively drought-resistant. Although drought effects on the more sensitive cows reduce their performance as draft animals, they do not lower their value as savings institutions or status symbols--unless, of course, the drought is so severe that they die.

Frost. Frost indicators are summarized in the same fashion as those for drought with comparable results. Objective criteria (e.g., white frost on the fields) were much less frequently mentioned than crop responses (e.g., plants turn black). Some 75% of the 474 responses clustered around various plant response indicators (Table 9).

TABLE 9

INDICATORS OF FROST

Indicator Group	No. of Responses		Percent of Total Responses
Objective Indicator	74		15.6
white frost on fields		74	
Plant Indicator	355		74.9
plants turn black/yellow		149	
plants lose leaves/ don/t grow		4	
crops die		182	
crops dry up		20	
Other	45		9.5
TOTAL	474		100.0%

It is reasonable for farmers to identify frost with crop response rather than some temperature (e.g., 0° C) or other arbitrary quality (e.g., visible frost). Plants register the damaging or killing temperatures peculiar to their species. These vary from crop to crop and are much more significant to farmers than frost as measured by thermometers or as manifested by visible frost formation.

Too Much Rain. In a land characterized by scanty annual rainfall and plagued with seasonal and intervestrial droughts, a hazard captioned "too much rain" seems contradictory. However, the problem surfaced in earlier surveys (e.g., Gay, 1977) and, in fact, provided one of the first indications that it would be absolutely essential to identify local standards and definitions of hazards. It was first thought that perhaps farmers recognized the connection between the destructive power of moving water and the serious and widespread erosion, ranked the number one problem in the country by many non-farmers (e.g., Deutshe GTZ, 1977; Lesotho n.d., Vol. 1. p. 111-112). The responses (Table 10), however, quickly disabuse us of that notion. Erosion is low on the list--well below plant and soil/field indicators.

Farmers recognize that too much rain has fallen when fields become unworkable with oxen and plows and planting is delayed, and when exuberant weed growth associated with abundant rains impedes cultivation (weeds could have as easily been included in the plant- rather than the soil/field-indicator group). Again, crop plants emerge as prime indicators. More than 40% of the respondents mentioned general plant damage and phenological indicators of water-logging. Whether there has been "too much rain" depends in large part on the nature of fields and soils. If plots are well situated with good drainage, too much rain

TABLE 10

INDICATORS OF TOO MUCH RAIN

Indicator Group	No. of Responses		Percent of Total Responses
Soil/Field Indicator	206		40.7
fields unworkable		200	
weeds grow		6	
Erosion Indicators	61		12.1
causes erosion		54	
floods		7	
Plant Indicator	207		40.9
damages plants		175	
crops turn yellow		4	
crops don't set seed/ maize tassels early		28	
Animal Indicators	3		0.6
animals die		3	
Other	29		5.7
TOTAL	506		100.0%

may never be a problem, but if plots are low and soils are poorly drained, there may be "too much rain" almost every year.

Although few in number, animal indicators were an unexpected addition to the list. Respondents clarified the association: long wet spells, especially if accompanied by winds, chill susceptible animals such as sheep and cause pneumonia and death.

Summary. Basotho farmer definitions of drought, frost and too much rain overwhelmingly rest upon environmental indicators, as opposed to arbitrary standards or measurements. Although soil characteristics are widely used as guides to potential moisture stress, for the most part hazards are recognized after events have caused noticeable damage to crops. Thus, farmers actually are defining a loss situation, and not the environmental event itself. In this respect the Mosotho farmer agrees with modern definitions of environmental hazards that include economic rather than exclusively objective or measured criteria (Gibbs, 1975).

Perceiving and Evaluating Hazards

Rather than checking against prepared lists of hazards, farmers were asked to identify voluntarily the environmental problems in their regions (question 23). Enumerators occasionally clarified the question with examples, but otherwise were instructed not to suggest possibilities. The 346 farmers interviewed were encouraged to mention as many hazards as they felt were significant in their region. Each named an average of 2.6 major hazards. Response frequencies are presented in Table 11.

TABLE 11

IDENTIFICATION OF HAZARDS: RESPONSE FREQUENCIES

Hazard	Frequency	Percent Frequency	Percent Farmers Mentioning Hazard
Drought	257	28.4	74.3
Hail	135	14.9	39.0
Worms	241	26.7	69.7
Frost	95	10.6	27.5
Too Much Rain	145	16.0	41.9
Wind	11	1.2	3.2
Erosion	20	2.2	5.8
TOTAL	904	100.0	261.4*

*Greater than 100% since each farmer could mention more than one hazard.

A number of non-environmental problems (rats; straying cattle) were identified, as were some environmentally associated hazards such as weeds which are especially luxuriant in wet years. These were mentioned by only a few farmers and not included in this report. The one exception is worms, usually cutworms, which are high on the list of recognized hazards and are closely related to the weather, proliferating especially during drought periods.*

After identifying the major hazards of their place, farmers were asked (question 24) to rank them in order of importance. Results are presented in Table 12. Drought is an easy winner of first-place choices, followed by worms, too much rain, hail and frost. In addition, a clear division appears between these major hazards and those of little consequence in the farmers' opinions, such as wind and erosion.

TABLE 12

RANK ORDER OF HAZARDS

	1st	(Percent of 1st)	2nd	3rd	4th	5th	Total	Percent of Total
Drought	155	45.1%	67	21	13	---	256	26.5%
Hail	36	10.5	44	42	9	3	134	14.9
Worms	83	24.1	95	49	9	4	240	26.7
Frost	20	5.8	37	30	5	1	93	10.4
Too Much Rain	45	13.1	53	24	19	4	145	16.1
Wind	1	0.3	1	4	2	3	11	1.2
Erosion	4	1.2	3	3	4	5	19	2.1
TOTAL	344	100.0%	300	173	61	20	898	99.9%

*The exact relationship of weather and cutworms is not clear. Some farmers maintain that saturating the soil drives cutworms to the surface where they are eaten by birds, whereas dry weather allows the worms to remain safely below. Although ecologically appealing, the explanation is as yet unverified.

Hazard Perception by Region

Lesotho contains several distinct regions, each with different agro-climates and hazards, reflected in farmers' perceptions. Thus, although drought is perceived as a major hazard throughout the country, Lowland farmers in St. Thomas, Leribe, Mohale's Hoek, and Teyeteyeneng are much more aware of the threat than are the Mountain farmers of Semonkong and Thaba Tseka (Table 13). Since the Mountains do not necessarily receive more reliable or even more abundant rains than the Lowlands, the perceptual differences probably are due to the greater dependence on drought-sensitive crops in the Lowlands, compared to the Mountain emphasis upon animal husbandry, especially at Thaba-Tseka.

Less understandable are the responses within the Lowlands. Although the southern Lowlands are slightly drier than those farther north, differences in annual and seasonal precipitation do not seem great enough to account for the markedly different perceptions at Leribe and Teyateyaneng in the north, and those at St. Thomas and Mohale's Hoek in the south-central and south. Possibly the averaged data mask differences in drought frequencies to which the farmers are sensitive. Similarly, it is not clear why worms, which are usually closely associated with dry weather, rank so low in drought-fearing St. Thomas and so high in Thaba Tseka.

Frost is almost exclusively a Mountain concern, which is not surprising considering the late cessation of last frosts and early onslaught of first frosts there (Table 4). On the other hand, too much rain is a worry mostly of the Lowlands. Hail is perceived as a major problem in the Lowlands mostly around Leribe. In Lesotho it is widely

TABLE 13

IDENTIFICATION OF WORST HAZARD, BY REGION

Hazard	St. Thomas	Leribe	Mohale's Heok	Teyateya-neng	Semon-kong	Thaba Tseka	Total/ Average
No. of Respondents	54	61	57	43	66	65	346
Drought							
No. of first ranked	43	20	38	19	15	20	155
Percent of those ranked first	79.6	32.3	64.4	45.2	23.8	31.2	45.1%
Hail							
No. of first ranked	4	14	0	0	14	4	36
Percent of those ranked first	7.4	22.6	0.0	0.0	22.2	6.3	10.5
Worms							
No. of first ranked	5	9	11	10	15	33	83
Percent of those ranked first	9.3	14.5	18.6	23.8	23.8	51.6	24.1
Frost							
No. of first ranked	0	0	0	0	13	7	20
Percent of those ranked first	0.0	0.0	0.0	0.0	20.6	10.9	5.8
Too Much Rain							
No. of first ranked	1	18	10	13	3	0	45
Percent of those ranked first	1.9	29.0	16.9	31.0	4.8	0.0	13.1
Wind							
No. of first ranked	0	0	0	0	1	0	1
Percent of those ranked first	0.0	0.0	0.0	0.0	1.6	0.0	0.3
Erosion							
No. of first ranked	1	1	0	0	2	0	4
Percent of those ranked first	1.9	1.6	0.0	0.0	3.2	0.0	1.2
Total	54	62*	59*	42	63	64	344
	100.1	100.0	99.9	100.0	100.0	100.0	100.1

*Respondents insisted on assigning first order to more than one hazard.

held that hail is highly localized, occurring with particular intensity or frequency at elevated locations in hail-prone belts. Unfortunately, data to support this contention and to verify suspected "hail belts" are not available. A study of hail concentrations and frequencies is badly needed for general planning purposes and to support hail insurance programs.

FORMER AND FUTURE ENVIRONMENTAL EVENTS

Last Event

After the farmers had identified the major environmental hazards in their areas, they were asked (question 23) the last time each had occurred, the worst it had been, and when they expected the next event to occur. The questions attempted to elicit impressions of past events which could then be checked against weather records and against expectations or perceptions of event frequency and periodicity.

The responses were not completely satisfactory. Considerable difficulty was encountered in establishing standards for comparison (Was last year's dry spell really a drought? How did it compare with the one three years ago?); in making distinctions between events and expectations; in clarifying confusion with time in a culture that does not lay undue emphasis upon precise recording of events; and in distinguishing between individual recall and village oral history. Unfortunately, questions posed by an enumerator often elicit responses even from those with no clear impressions simply because it is easier to offer an answer than to admit to no definite recollections or anticipations.

Despite these caveats, the responses do offer some insights into farmers' perceptions. Answers to the question (number 23) "When was the last time there was an (event)?" are presented by frequency and percentage in Table 14. The pattern of recalled last occurrence is similar for all hazards. A scattering of years prior to 1973 are mentioned, but these account for less than 10% of the responses and probably represent an effort to identify years of especially severe events, rather than last events. For example, of the eight farmers that assigned the last drought to the pre-1967 period, half specified the 1932-33 season when many stations in Lesotho recorded the lowest precipitation in history. In these cases "last event" was confused with the next question regarding "worst event."

For the most part, last occurrences are identified with the five years immediately preceding the survey and, in fact, more than half the responses fall in the last three years, with the survey year (1978-79) and the one immediately preceding it being particularly hazard-filled.

Considering the recency of the seasons listed as those when events last occurred, it might be of interest to examine records of measured climate elements for the past five years. Unfortunately no records exist for many perils (hail, worms, erosion), and temperature-related hazards such as frost escape the crude monthly reporting period. Precipitation data, however, are available for comparison with farmers' responses. The period October to March was selected as best indicative of moisture conditions during the agricultural season. However, the season falls in two calendar years and since farmers usually indicated only a single year when last or worst events occurred, it was necessary to examine weather records for best fit with farmers' responses. Considering the general uncertainty of dates, such a procedure should not unduly influence comparisons.

TABLE 14

WHEN WAS LAST EVENT

Period*	Drought	Hail	Worms	Frost	Too Much Rain	Wind	Erosion	Total
Before 1966	8	2	1	-	1	-	-	12
1966-67	-	-	2	-	1	2	-	5
1967-68	1	1	-	-	-	1	-	3
1968-69	-	-	1	-	-	-	1	2
1969-70	3	1	3	1	-	1	-	9
1970-71	1	3	5	1	-	-	1	11
1971-72	4	3	4	1	1	-	1	14
1972-73	8	1	5	4	1	-	-	19
1973-74	8	3	1	1	4	1	1	19
1974-75	12	9	11	3	7	2	2	46
1975-76	31	6	11	7	15	1	2	73
1976-77	50	23	28	7	19	-	4	131
1977-78 1978-79	47	65	108	54	73	1	4	352
Subtotal	173	117	180	79	122	9	16	696
Comes every year	(9)	(2)	(7)	(12)	(5)	(2)	(3)	(40)
Can't remember	49	5	37	-	11	-	1	103
Don't know	7	4	3	-	1	-	-	15
Can't tell	(19)	(7)	(14)	(4)	(6)	(-)	(-)	(50)
Subtotal	56	9	40	0	12	2	4	118
Total	229	126	220	79	134	9	17	814

*The "period" is the Southern Hemisphere agricultural season extending from September to March or April.

Several anomalies immediately were apparent. With the exception of 1978-79, precipitation during the last five years has been relatively abundant; so why did farmers note drought problems in these years?

Examination of monthly records affords few clues. Although several stations had one or more dry months during the 1976-77 season that might have constituted a drought in farmers' minds, the remaining years--1974-75, 1975-76, and 1977-78--enjoyed timely and plentiful rains. Perhaps some weeks-long dry spells escaped the reported data, but not farmers' recollections. The season of 1978-79 was indeed dry, with some months falling well below plant requirements; it justified the farmers' designation as a drought year.

The response table also contains what appear to be contradictions, as when the same year is listed both for drought and too much rain. No doubt some respondents confused years and events, and it may seem in retrospect as if everything went wrong in a particularly bad year. It should be noted, however, that hazardous events are not mutually exclusive, as any farmer can verify. An overall dry year may experience frosts and hailstorms, and even days or weeks when torrential rains flood fields and inhibit farming activities.*

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*Environmental hazards show a fine disregard for level of technology. The carefully monitored field trials of the huge Thaba Bosiu Rural Development Project (near Maseru) repeatedly were plagued by drought, hail, and too much rain. Prolonged rains delayed plot preparation and planting of maize, beans, and sorghum; damaged crops; caused disease and rotting in potatoes; encouraged weed growth and inhibited weeding; and created difficulties in threshing and drying wheat. Drought and associated cutworms reduced yields. In some cases, entire trial plots were abandoned.

Quite a few respondents (almost 15%) did not specify particular years, but answered that they could not remember or did not know. The responses indicating that the respondent could not tell seem inappropriate for this question and suggest confusion as to the meaning of the question. Answers are listed for information, but are not included in the calculations. Similarly, expressed expectations that hazardous events come every year are excluded, though they could have been combined with those stipulating the current cropping season.

Worst Event

Farmers next were asked when the worst example of a particular event had occurred (question 23). The pattern of responses is similar to those of the "last event" question, suggesting a certain amount of confusion on the part of respondents. There are, however, more events noted for years past; for example, the disastrous 1932-33 season apparently lingers in memory or oral history as an outstanding drought period.

Nevertheless, recent events again are dominant irrespective of severity. Two causes for this may be cited. The sample is skewed by age structure--most farmers have lived through recent events, whereas only a few old farmers actually experienced events several decades in the past. Beyond this, it seems that recent events loom disproportionately large in farmers' memories. Excluding absolutely catastrophic events, the drought or hail storm of ten years back fades in comparison to the one that struck last year or the year before.

To test farmers' recollections, "worst drought" responses were compared to seasonal precipitation, as was done for "last drought." Clearly the 1932-33 season in Lesotho was harsh. Precipitation at the four Lowland stations was deficient by 30-50%. The 1969-70 season also was memorable, with the Lowlands suffering perhaps even more than in 1932-33, and the Mountains sharing in the drought. Thereafter, the pattern resembles that of "last drought"--perception of recent years fails to correlate with recorded events.

Perhaps the last year is always the "worst year" for many farmers, or the absolute connotation of "worst" was missed in the interviews and the farmers simply were expressing the idea that drought can come any year. Whatever the reasons, it seems that recalled events are well correlated with measured events if they happened more than five years ago, whereas such is not the case for recent events.

Next Event

To obtain some idea of farmers' anticipations and attitudes toward future events, they were asked when they thought the events they had identified would happen again (question 23). With few exceptions, specific responses fell within three years of the survey period (Table 15). By far the majority of these indicated the current (1978) or next (1979) cropping season. In fact, if these are added to the 252 (28%) "comes every year" responses, it would appear that the average Mosotho farmer expects some if not all adverse events every year.

Within this generally gloomy outlook there is considerable variation. Slightly less than half the farmers expect any particular event during the present or next season. Hail, which can strike suddenly and devastatingly, and worms, which are always lurking in the soil, are viewed as even more likely than the others.

Perhaps a better interpretation is that the farmers think any of the hazardous events could happen in the near future; this is supported

TABLE 15

WHEN WILL EVENT OCCUR NEXT

Period	Drought	Hail	Worms	Frost	Too Much Rain	Wind	Erosion	Total
1977-78	8	5	7	2	1	-	-	23
1978-79	42	42	70	42	25	5	3	229
1979-80	17	3	8	6	6	-	1	41
1980-81 & beyond	4	-	-	1	-	-	1	6
Totals	71	50	85	51	32	5	5	299
Comes every year	73	30	80	22	39	2	6	252
Can't remember	(4)	(2)	(4)	(-)	(-)	(-)	(-)	10
Don't know	59	29	34	8	41	-	1	172
Can't tell	50	24	37	14	33	4	8	170
Totals	182	83	151	44	113	6	15	594
Grand Totals	253	133	236	95	145	11	20	893

by the remaining non-specific responses. Disregarding less-threatening wind and erosion, for which responses are too few to be useful, some 30% of the farmers stated that they did not know or could not tell when a particular event would occur. Presumably, there is a difference between those who don't know (the knowable) and those who can't tell (the unpredictable). Exploration of such subtle differences and their effect upon risk-avoidance strategies must await analysis of internal correlations.

Story Event

To further investigate attitudes toward randomness or periodicity in event occurrence and to check previous responses to direct questions (when was last event, when will event come again), enumerators read a story and asked farmers to identify with one of the expressed opinions (question 41).

Results are presented in Table 16. At first glance, the responses seem to contradict previous findings that more than half the farmers expect hazardous environmental events year after year. However, as has been suggested, annual expectations probably are best expressed in answer number two (event can happen anytime) despite the disclaimer of uncertainty (did not know when because event can happen in any year). Basotho farmers do not expect all hazardous events, or even any particular event to recur every year, but apparently the probabilities loom so large that they do expect one or more in any year. Furthermore, a recent event does not change the odds--it neither guarantees nor eliminates the possibility of recurrence. The effects of this wary attitude will be explored in the following section on risk avoidance strategies.

TABLE 16

BEST IDEA OF WHAT TO EXPECT

Idea	Frequency	Percent
No. 1 Come again soon	26	7.6
No. 2 Happen anytime	208	60.6
No. 3 Comes regularly	94	27.4
No. 4 Won't come again	15	4.4
Totals	343	100.0

Conclusions

The preceding survey results suggest some general attitudes toward environmental hazards on the part of Basotho farmers:

1) Drought is the most widely recognized hazard, followed closely by the worms associated with drought. Too much rain, hail, and frost follow, in that order. Other environmental hazards such as wind and erosion are of little concern.

2) There appear to be marked regional differences in hazard perception. Although fairly universally recognized, drought is more often mentioned in the Lowlands and frost is much more a Mountain concern. Significant north-south differences in the Lowlands in drought and hail perception suggest that these events may be more location-specific than is indicated by presently available climatic statistics.

3) Hazardous events are characterized by random and frequent, rather than periodic occurrence. About half the farmers identified the present or previous season as year of last occurrence, and accept the likelihood of recurrence the next year. There is little evidence of belief in cycles or periodicity, or even that occurrence of a particular event in one year will reduce probabilities for recurrence the next year.

4) Recent events loom much larger in the memories of farmers than events in the past.

RISK-AVOIDANCE STRATEGIES

Perception and evaluation of hazards, no matter how realistic, are of little use by themselves. Unless there are specific actions to be taken, such knowledge only leads to a sense of impotence and anxiety, as perhaps comforting but ineffective ceremony.* Such feelings are common among farmers everywhere, which is not surprising considering the awesome power of most natural events compared to the weak counter-forces available. Every agricultural society, however, has certain strategies for avoiding or mitigating the effects of some natural events.

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*For a short summary of the role of magico-religious ceremony in relieving anxieties over uncontrollable events, see Souldner and Peterson (1962, pp. 34-35).

The most fundamental strategy is the basic crop/livestock mix itself--the traditional economic plants and animals that have proven successful within a particular set of environmental constraints (Gould, 1963). Usually there is considerable variation in characteristics and tolerances within the basic mix; although all plants and animals may flourish under average conditions, some are better able than others to withstand marginal or extreme conditions. Such diversity also offers the second basic risk-avoidance strategy in that farmers can shift toward those crops that have the best chances for success if they anticipate adverse conditions.

In addition to these basic strategies, farmers have a number of operational strategies that can be instituted as the situation demands. Such practices as plowing and planting dates, plant densities, fertilizers, insecticides, and weeding may vary depending upon environmental conditions.* Crop insurance could be added to this group, except that it is available only to a limited extent in certain project areas in Lesotho.

Next are what might be called specific strategies aimed directly at shielding crops from adverse events. These include mulches, arbors, and windbreaks.** However, except for light straw mulches in house-yard gardens and a few techniques for altering surface geometry (maize mounds and contours), the Basotho seem unacquainted with these practices.

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*Irrigation is one of the most effective operational strategies. But Lesotho agriculture is overwhelmingly dryland (rainfed) and none of the farmers surveyed had access to irrigation water. Nevertheless, several suggested it as a strategy against drought.

**For a review of such techniques see Wilken, 1972.

Finally, there are a number of ceremonial activities, some involving action or avoidance on the part of farmers, others requiring the services of traditional or native doctors who, in addition to treating the ill, also perform certain acts to ward off impending events. For the most part these are restricted to hazards against which Basotho farmers have no effective measures, most notably hail.

Farmers were not asked about the basic crop mix of maize, sorghum, wheat, beans, peas, and houseyard vegetables, which perhaps was a mistake since almost nothing is known about farmers' perceptions of alternative crops. Instead, the survey concentrated upon shifts in crop emphasis, and upon operational and specific strategies.

Crop Mixes and Crop Areas

To establish basic patterns, farmers were asked which crops they planted and, of these, which the most (questions 15 and 16). Despite a fairly good range of available crops, actual cropping efforts are concentrated on a very few. Maize, the basic food crop, is a clear favorite, followed by sorghum, how used mostly for making the local grain beer (*joala*).* Production of wheat is encouraged by the government. Although beans, peas, and potatoes are considered important cash crops, few of the farmers devote much space to them.

Within the basic grains--maize, wheat, and sorghum--there is considerable variation in environmental limits and tolerances. Wheat is planted as a winter and summer crop and thus fits a separate niche.

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*Although sorghum was the original Basotho subsistence crop, most of the old sorghum-based dishes have fallen out of favor since maize became dominant.

Sorghum is considered much more tolerant to drought than maize. Although sorghum and maize are only partially interchangeable as food, sorghum enjoys a steady demand and can be converted into food through local market systems.*

On a regional basis, somewhat more detail is apparent. Lowland farmers in Leribe, Mohale's Hoek, and Teyateyaneng favor maize strongly, as do the Mountain farmers of Thaba Tseka. Sorghum commands first place in Lowland St. Thomas and wheat in mountainous Semonkong. However, rather than showing great regional differences, local crop mixes are better characterized as variations on the same basic mix (Table 17).

TABLE 17

CROP MIXES BY REGION

Area	Main Crops	Other Crops
St. Thomas	Sorghum, maize	Beans, wheat, peas
Hlotse (Leribe)	Maize, sorghum	Beans, wheat, peas
Mohale's Hoek	Maize, sorghum	Beans, wheat, peas
Teyateyaneng	Maize	Sorghum, beans, wheat, peas
Semonkong	Wheat	Maize, peas, barley, beans, wheat
Thaba Tseka	Maize	Beans, sorghum, peas, wheat, barley

The list of other crops grown brings out the meagre range of alternatives available to Basotho farmers. The respondents did not list the individual crops grown in houseyard gardens and, indeed, only a few thought to include even the general category "vegetables" in their lists

*For an analysis of local village exchange systems, see Gay 1980; Guma, Gay, and Kumar, 1978.

of other crops. These occupy only tiny plots near houses and, in reality, the main farming options are restricted to the short list of field grains and a few crops such as beans, peas, and lentils. A few people also plant potatoes, cabbage, and pumpkins for local markets.*

With such a small number of crop alternatives and these further limited by subsistence needs, farmers have few options for adjusting to environmental conditions. Nevertheless, about one-third claimed to practice some shift in crop mix. To simplify procedures, only the possibility of dry weather was suggested in the questionnaire. To the questions of adjustment (questions 31 and 32), farmers said that they planted special crops or varieties that were drought-resistant (63), had special but otherwise unidentified characteristics (35), or were fast-growing (7), the last presumably to allow harvest before the effects of drought became severe. A very few (6) were more specific, and mentioned that they planted less maize and more wheat, sorghum, or beans when they expected dry weather. It should be noted that no completely different crops are planted in anticipation of drought--all those mentioned are drawn from the basic mix.

Another possible adjustment to adverse environmental events is to vary the amount of land planted. In Lesotho this option is limited by general scarcity of farm land and the need to plant for subsistence regardless of expectations. Farmers are able to adjust the amount of land planted to any particular crop, and a few (27) noted that they

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*Tree crops such as peaches and apples are not included since these do not figure in short-term responses to environmental events.

planted more land to maize when it was wet and more to sorghum when it was dry or when there were worms.

Field allocation by soil quality and moisture characteristics (maize lands, sorghum lands) and by location (valley bottom, hillslope) permits crop dispersion and reduces chances of complete loss from drought or highly localized events such as hail. Population pressure and reduction of average holdings from three to two fields has diminished the effectiveness of this traditional strategy. Since field allocation is not a short-term response to perceived hazards, it was not examined in this study.

Operational Strategies

A much wider range of alternatives is offered by various operational strategies. For example, plowing and planting dates can be adjusted in response to environmental indicators or other controls (question 14). Preferences for plowing times are shown in Table 18, where late winter and early spring appear as clear favorites.

Farmers were allowed to volunteer reasons for planting time preferences. Not all farmers volunteered reasons, but of those who did, 38 gave more than one. The complete list subsequently was grouped into major categories (Table 19). The groupings are somewhat arbitrary; for example, those farmers who plow "right after harvest" actually may do so to maximize infiltration of winter precipitation ("preserve soil moisture"). The groupings do emphasize a most important point--timing of Basotho planting is based upon rational grounds, mostly related to environmental signals and purposeful soil management, and not upon

TABLE 18

WHEN DO YOU PLOW?

	Responses		Responses
Spring	24	Fall	12
September	84	March	18
October	90	April	5
November	20	May	5
	218 (66.9%)		40 (12.3%)
Summer	3	Winter	
December	2	June	8
January	1	July	12
February	0	August	28
	6 (1.8%)		62 (19.0%)
Total		326 (100.0%)	
No response		20	
		346	

TABLE 19

REASONS FOR PLOWING

	Responses		Responses
Environmental Signals		Social	
soil wet and loose	75	when neighbors plow	4
warm temperatures	7	told by husband	1
plants green or in flower	21	equipment available	10
	103 (33%)		15 (5%)
Purposeful		Sequential	
avoid frost	27	at planting time	41
avoid worms	29	right after harvest	15
kill weeds; plow under dead plants	22		
increase soil fertility	7		
preserve soil moisture	19		
prepare for planting	20		
loosen soil	15		
	139 (44%)		
Total		313 (100%)	

capricious or non-environmental factors such as calendar dates or phases of the moon.

Timing of planting is the next great decision farmers make. Spring is naturally the favorite period, followed by fall (for winter wheat). Again, a full list of volunteered responses to the question "Why plant at [the indicated] time?" (question 14) is presented. Some of these are identical to those given for plowing ("When the soil is wet "), whereas others are exclusive to planting. Table 20 contains the responses grouped into the same major categories that were used for planting.

TABLE 20

REASONS FOR PLANTING

	Responses
Environmental Signals	
soil wet and loose	72
plants green or in flower	12
weather is favorable, temperatures are warmer and/or rains have come	17
	101 (32.1%)
Purposeful	
hail is past	5
avoid frost	95
avoid worms	41
avoid drought	5
so plants have time to grow	35
that is the time to plant	10
	191 (60.6%)
Social	
when neighbors plant	6
equipment available	14
told by husband/government advisor	3
Total	315 (100.0%)

Contrary to popular opinion, social reasons remain a minor factor.* Positive environmental signals ("soil is wet") account for almost one-third of the reasons given for planting at a particular time, or about the same proportion as for plowing. However, environmental hazards account for a much larger segment of responses--nearly one-half the farmers mentioned hail, frost, worm, or drought-avoidance as a key to determining planting time. If the answer "So plants have time to grow" is interpreted as suggesting a rain- or frost-defined growing season, and "favorable weather" also indicates diminished hazard probabilities, then the figure approaches 60%. Clearly environmental hazards are foremost in the minds of farmers, and one of their principal risk-avoidance strategies is to vary planting dates.

Another strategy common elsewhere is to vary plant densities; the reasoning is that in wet years close plantings maximize yields, whereas in dry years more open spacing will reduce competition for scarce soil moisture. Basotho farmers were asked directly whether they ever used more or less seed, and indirectly by the queries on planter plates (questions 17 and 18).

The results of these questions were not completely satisfactory. As noted earlier, Basotho fields are often of indeterminate size. Furthermore, seeds are measured out in "tins" which also are not necessarily standard. And finally, planting is not always done meticulously. In a land where some farmers still broadcast maize seed, it is not easy to determine planting rates nor to ascertain the amount of reduction or increase.

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*Equipment availability is included as a social factor since those farmers who do not own their own teams and tools must wait until they can borrow or rent equipment, or secure the services of a contractor.

Nevertheless, 84 farmers (24%) noted eight reasons for varying the amount of seed applied in any given year. Contrary to the expectations, however, Basotho farmers increase seed when they anticipate difficult growing conditions! According to the farmers, seeding rates are increased to replace seed lost to worms, rodents, birds, drought, and too much rain (78), and to compensate for bad seed (4). Only two farmers mentioned decreasing seeding rates to insure that plants would have adequate nutrients or moisture.*

The typical Basotho ox-drawn planter has several interchangeable plates coupled to the 36-inch main wheels. These measure out seeds of different sizes at different spacings. For example, a number 4 plate has four holes and therefore applies seed at 9-inch (36 ÷ 4) intervals; a number 5 plate at about 7-inch intervals, and a number 6 plate at 6-inch intervals. Row spacing is fairly uniform at 36 inches (0.9 m) to accommodate the ox-teams. Thus, the three plates mentioned will produce stand densities of about 48,000, 60,000 and 72,000 plants per hectare, a somewhat theoretical figure since few fields in Lesotho are as large as a hectare and seed germination and plant survival rates are poor. Nevertheless, the ratios remain constant--changing from plate 4 to plate 5 should increase stand density by about 25%, and from plate 4 to plate 6 by about 50%. It was hoped that determining plate changes would allow more precise estimation of seeding rates, but although 74 farmers in the survey said they owned planters, responses to questions 17 and 18 were inadequate for analysis.

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*One farmer saw it as a Hobson's choice: he planted extra sorghum seed in dry years to compensate for worm losses, and extra in wet years too, because seeds stick to plow and planter blades and are left on the surface.

Although only indirectly related to environmental conditions, fertilizer and manure use was sampled (questions 21 and 22) for possible later internal correlations. Some 103 farmers (30%) claimed to use fertilizers and 94 (27%) to use manure, amazingly high percentages for Lesotho.* Application times are indicated in Table 21.

TABLE 21

APPLICATION TIMES FOR FERTILIZER AND MANURE

	Fertilizer		Manure	
	Number	Percent	Number	Percent
At plowing time	1	1.0%	25	26.6%
At planting time	102	99.0	49	52.1
At harvest time	-	-	9	9.6
During winter fallow	-	-	10	10.6
Other	-	-	1	1.1
Total	103	100.0%	94	100.0%

Possible Actions

After basic and operational strategies had been sampled with specific questions, farmers were asked what they could do as individuals, and what others could do about environmental hazards (questions 28 and 28a). Farmers volunteered an average of 1.8 answers to each of the two questions. Results were combined (Table 22) for two reasons: it was not

*For years, various projects and programs have advocated increased fertilizer use, but Basotho farmers remain hesitant, and perhaps for good reason. Since plant response to chemical fertilizers is closely related to the weather, especially precipitation, it would seem wise to first ascertain the probabilities and financial risks associated with fertilizer use, which has not yet been done.

TABLE 22

PRACTICES AVAILABLE (Combined)

Practices	Drought	Hail	Worms	Frost	Too Much Rain	Wind	Erosion	Total
Active								
Environmental Modifications								
Dig drainage furrows					30		3	33
Contour					1		1	2
Mound	4							4
Plant trees				1		2		3
Field Practices								
Traditional								
Winter fallow	55	7						62
Plow in winter	10	7			2	1	1	21
Cultivate	6				1			7
Apply manure	12				2			14
Burn old plants		1			-			1
Adjust planting dates	1				5			6
Modern								
Irrigate	64			1				65
Apply fertilizer/lime	21	1			2			24
Buy selected seed	2							2
Apply insecticides			250					250
Ceremonial								
Native doctors	1	75	17					93
Traditional medicine	1	68	26					95
Pray	6							6
Shoot cannon		8			1			9
Government schemes	4				1	2		7
Subtotal	187	152	308	2	45	5	5	704
Passive								
Don't know	6	1	4	2	1		1	15
Nothing	185	50	56	95	116	3	4	509
Subtotal	191	51	60	97	117	3	5	524
Grand Total	378	203	368	99	162	8	10	1,228

always clear whether a respondent was speaking only for himself ("What can you do?"), or for the village or even larger community ("What can others do?"); and additionally, the 1200+ responses combined with answers to earlier specific questions offer unique insights into the collection of Basotho farming strategies, and perceptions of measures that can be taken against environmental hazards.

Responses have been listed as "active," or those suggesting specific measures, and "passive" ("don't know" or "nothing"). Suggested measures were then grouped into several major categories. Those that involve restructuring of surface geometry were placed under "Environmental Modifications." "Field Practices" are divided between "Traditional", or those that can be accomplished with local resources, and "Modern", or those that require purchased inputs. Irrigation was assigned to "Modern" field practices since, as far as could be determined, none of the farmers interviewed had irrigated lands or access to irrigation water, thus, irrigation as a solution to drought is not an actual practice, but something suggested, perhaps by exposure to project or extension field workers or by acquaintance with farmers from irrigation project areas.

It was tempting to place fertilizer/lime applications under "Ceremonial" practices since fertilizing during droughts, the main suggested use, is hardly to be recommended in Lesotho. It seems likely that under strong, mainly project-related programs, Basotho farmers have been so propagandized that fertilizer has taken on something of a cure-all aura in their minds. Government schemes were assigned to "Ceremonial" practices since, as far as I know, the government is as impotent as the farmers when it comes to counteracting drought, frost, or too much rain.

The suspicion is that in this case government simply represents another, distant, unknown force that might, somehow, do something against these feared hazards.*

Several features stand out in the combined Table 22. In the first place more than 40% of the responses indicate that nothing can be done about environmental hazards. After the preceding review of basic and operational strategies, such expressions of impotence seem contradictory. We have seen that there are many things farmers can do, and that in fact their defensive strategies are fundamental to decision-making and farming operations. When asked, farmers readily describe what for them are common field practices; yet, if the question is couched in terms of defying the elements--"What can you or others do about drought, hail"--they apparently are overwhelmed by their perceived lack of resources and ignore the stock of techniques that have assured the survival of their crops, and thus of their society.**

Secondly, farmers seem to feel most confident against worms (308 active responses), but this is based primarily upon faith in chemical insecticides (250 responses, or 81%). Again, it is uncertain whether such confidence is based upon experience or instead represents acceptance of extension and project workers' claims. Control of hail, third highest in number of responses, almost completely depends upon native doctors

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*The disorganized view of government held by many farmers is explored in Gay (1979).

**For example, only six respondents mention the possibility of adjusting planting dates as defense against drought or too much rain, whereas 186 farmers earlier had indicated that hazard avoidance was a principal determinant of planting time.

or traditional medicine* (99% of all active responses).** Of the hazards that received a significant number of suggestions, only drought and too much rain have a number of seemingly effective traditional remedies.

Missing measures are of almost as much interest as those mentioned. For example, mulches, arbors, windbreaks, heating wells, and other climate-modifying methods apparently do not occupy a prominent place in Sesotho farming technology. No respondent mentioned crop insurance even though there have been efforts to offer coverage in Lesotho, especially in the Leribe District (Leribe, 1973). As noted earlier, neither wind nor erosion loom large as hazards to Basotho farmers, and suggested defensive measures are correspondingly meagre, accounting for less than 1.5% of all responses.

Measures available to individual farmers differ from those available to others only in minor ways. Irrigation is viewed as beyond individual efforts, which reinforces the suspicion that information on irrigation comes from development projects. Otherwise, either the Basotho do not perceive opportunities for external assistance or group action, or the questions failed to elicit distinct responses.

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*There are two aspects of traditional ceremonial hazard control: active ceremony by native doctors and passive or avoidance behavior by individuals. Thus, firewood should not be brought home at midday nor should a corpse be carried through the fields during the day, on pain of suffering crop loss from hail or frost (Ashton, 1967, p. 133). Elaborate rainmaking ceremonies to break drought were practiced in times past (Sechefo n.d.; Sheddick, 1954, p. 113), but now are rare.

**The surprising thing is not the number of answers in this category, but that there are so many pragmatic answers in the others. Many traditional agricultural societies lean heavily upon ceremonial responses to environmental threats.

Specific Strategies

Most traditional farmers have some highly specific techniques for preventing crop damage or loss from environmental events. The general question "What can you/others do?" revealed farmer familiarity with such techniques as furrows to hasten runoff and contouring to check erosion.

One of the most universal protective measures, especially in maize cultures, is hilling or mounding. To check the extent of this practice, farmers were asked whether they mounded maize or sorghum (question 33). Of the 346 farmers interviewed, 85 said that they mounded maize only, 12 sorghum only, and a surprising 178 said that they mounded both. Lowland farmers in St. Thomas, Leribe, Mohale's Hoek, and Teyateyaneng said that, for the most part, they mounded both maize and sorghum, whereas the Mountain farmers of Semonkong and Thaba Tseka restricted mounding to maize.

The total of 275 out of 346 (79.5%) is an extraordinarily high figure not supported by field observations. It seems likely that any post-planting rearrangement of the surface elicited a positive response whether it involved formal mounding around individual plants, or simply incidental ridging during cultivation.

Since there is some divergence of opinion, farmers also were asked just what mounding achieves. Responses were fairly evenly split between moisture and nutrient retention, root protection, and plant support. This last purpose, presumably against lodging (wind throw), is surprising since these same farmers had not previously indicated any great concern about wind hazards. Only one respondent offered the response so familiar in many parts of the traditional farming world: "It is the custom here."

HAZARD PREDICTION

From years of experience in a place farmers develop expectations about inevitable hazards, and the measures to offset their effect. A sense of expected frequencies also is helpful. Although Basotho farmers generally seem pessimistic about hazard probabilities ("Can come every year"), in fact, they experience as many good years as bad, if not more.* Simply being ultraconservative or defensive is not enough. Unless farmers employ strategies to take advantage of good seasons, they will not produce the surplus necessary to tide them over bad years.**

A feeling for probabilities still does not provide the information needed for farm planning. The grail of traditional farmers, no less than for modern scientists, is prediction! Farmers were asked (questions 29 and 30) if there were any signs or ways to know if the hazards they had identified were coming. Expectedly, there were many diverse answers. Table 23 indicates the general pattern of response for each of the seven hazards now joined by the more general "wet year" and "dry year." These last two were added to cover responses that emerged from presurvey testing, and to reinforce questions on drought.

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*Emphasis upon hazards may have distorted the image presented by the survey. In retrospect it would seem advisable to have asked more questions about farmers' perceptions of favorable conditions.

**Subsistence surplus may be held directly as stored food, or indirectly as social credits that entail reciprocity, such as loans, gifts, or feasts, and thus that provide a measure of security in lean years. Basotho cattle herds also represent a form of liquid capital that can be increased or diminished. Savings and loans in banks perform these functions for commercialized farmers.

TABLE 23

ARE THERE SIGNS OR WAYS TO KNOW

Event	No; Don't Know; No Response	Yes	Total
Drought	125	99	224
Hail	32	87	119
Worms	102	119	221
Frost	46	48	94
Too Much Rain	46	68	114
Wind	2	2	4
Erosion	0	5	5
Wet year	5	86	91
Dry year	3	57	60
	361	571	932
	38.7%	61.3%	100.0%

Out of a total of 932 answers volunteered by farmers, 571 (more than 60%) were positive, i.e., indicated that there were ways to anticipate events. Not surprisingly, much-feared drought leads the list, followed by the now familiar sequence of worms, hail, and too much rain. Apparently the greater the concern with a particular hazard, the more strategies are developed against it, and the more ways there are for predicting it.

Even with the initial grouping of responses, some 34 predictive signs were identified. To these were appended another 20 monthly, seasonal, or directional modifiers (e.g., June, fall, west), for a theoretical total of 680 possible indicators. Actually only 157 separate signs were listed, and among these there was considerable overlap. Nevertheless, it was necessary to eliminate some detail in order to see patterns. Groupings and categories resemble those developed for the definitions of hazards (Tables 8, 9, 10) and, in fact, many of the responses are similar.

Individual Hazards

Although many farmers (125, or 56%) did not believe that drought could be anticipated, 99 (44%) did. The largest single group felt that certain winds, primarily those from the south, presaged droughty weather. A dry winter or spring also indicated a dry summer to follow. The state of groundwater, as indicated by contracting springs and wells, is followed closely by some farmers. Finally, animal activity, especially swarms of butterflies (of which cutworms probably are the larval stage) could indicate a coming dry season.

Hail. Hail prediction is much more immediate than drought. For example, the responses "thick black clouds" no doubt refer to towering cumulus with the vertical development necessary for hail formation. In addition, local atmospheric conditions that enhance sound transmission and produce echos from nearby mountains are considered signs that hail is imminent.

Worms. Worms are strongly associated with drought, and with the winds that portend drought. Again, flights of butterflies are good indications that worms (larvae) are on the way.

Frost. Frost, like hail, is predictable only a short time in advance, by winds, especially from the south, and by lowering temperatures (e.g., "previous day cold "). Animals also sense pending cold weather and leave higher pastures for warmer valleys.

Too much rain. Too much rain is indicated directly by gathering storm clouds, and indirectly by rain-bearing winds, especially those from the north. Groundwater fluctuations around springs and wells really is more an indication of generally wet conditions than of a pending onslaught of heavy rains. Lunar signs, so common in Europe and Asia, appear here for the first time in familiar form--the tipped half or quarter (crescent) moon pouring rain, and the more meteorologically explicable "ring around the moon" (caused by high cirrus clouds that often appear as forward outliers of frontal systems).

Wind and erosion indicators were associated with rain and clouds but were too few to justify discussion. Apparently these hazards are of so little concern to Basotho farmers that they practically escape recognition.

Wet year. Wet year signs are similar to those for too much rain--north winds, rising groundwater tables, and lunar positions. In addition, winter precipitation, either rain or snow, augers well for a wet year. Soaring, crying (migratory?) birds also are good omens.

Dry year. Dry year signs are the opposite of wet years--scant winter precipitation, lowering groundwater tables, and adverse winds.

Nature of Indicators

The predictive signs themselves can be grouped into distinct categories (Table 24). Winds are the most commonly used indicators of future events, especially for drought and drought-related worms, frost, and rain. Precipitation itself, particularly winter rains and snow, presages wet years. Clouds are indicators of immediately pending hail and rain. Groundwater levels and movements confirm seasonal trends and serve as indicators of drought severity or rainfall abundance.

TABLE 24

SUMMARY OF PREDICTIVE SIGNS BY CATEGORY AND HAZARD

	Drought	Hail	Worms	Frost	Too Much Rain	Wind	Erosion	Wet Year	Dry Year	Totals
Climatic										
Winds	38	7	18	30	21			14	17	145
Rain/No rain	27		68			1	3	13	11	123
Snow/No snow	10							18	18	46
Clouds		73			12	1	2	4		92
Other	13		2	16	10			2		43
Total	88	80	88	46	43	2	5	51	46	449
Hydrologic										
Springs/wells	6				9			9	5	29
Animal Behavior	3		24	2	4			14		47
Atmospheric/Celestial										
Moon					6			4		10
Acoustical		6						2		8
Other					2			1		3
Total		6			8			7		21
Other	2	1	7		4			5	6	25
Totals	99	87	119	48	68	2	5	86	57	571

Although less frequently mentioned, animal behavior includes some colorful indicators. Behavior indicators fall into two sub-groups--those which forecast events well in advance (e.g., swarms of butterflies), and the more immediate animal responses to temperature, humidity, and pressure changes that signal events soon to occur.

There were surprisingly few responses involving sun, moon, and stars. Elsewhere, celestial bodies have for centuries been considered good indicators of future events, but Basotho farmers apparently have neither developed nor adopted an extensive lore of celestial forecasting. Similarly, there were only a few plant signs and these were mostly responsive rather than predictive (e.g., failure of plants to grow indicates drought). Perhaps familiarity with the phenological changes associated with various weather conditions, especially in perennials, has been denied the farmers of essentially treeless Lesotho.

A more regular predictive system is available and in use. More than half the respondents said that they listen to weather news on the radio (questions 35, 36, 37) (Table 25), and of these, some 75% listen to Radio Lesotho (assuming that all radio users listen to weather broadcasts proportionately). Since Lesotho cooperates with South Africa in data gathering and reporting, weather analysis and forecasting benefit from a sub-continent-wide system.

This raises the possibility of even greater service to farmers if Radio Lesotho also offered medium- and long-range forecasting, perhaps as special features. Granted, such extended forecasting is less than precise, but farmers already are making their own forecasts as much as

TABLE 25

LISTEN TO RADIO

Station	Listen to Radio		Radio Station		Listen to Weather Broadcast	
	Yes	No	Lesotho	South Africa	Yes	No
Semonkong	41	25	36	5	33	33
St. Thomas	33	21	25	8	32	22
Hlotse (Leribe)	40	21	31	9	39	22
Mohale's Hoek	37	20	24	13	35	22
Teyateyaneng	24	19	14	10	24	19
Thaba-Tseka	27	38	23	4	17	48
Totals	202 (58.4%)	144 (41.6%)	153 (75.7%)	49 (24.3%)	180 (52.0%)	166 (48.0%)

six months in advance and the educated estimates of professional planners might serve as welcome comparisons to local predictions.

SUMMARY AND CONCLUSIONS

Past and Present

Rather than arbitrary criteria such as a fixed temperature or minimum precipitation, Basotho farmers recognize adverse events primarily on the basis of immediate crop damage. In this, Basotho farmers concur with modern definitions of climatic hazards that include economic as well as meteorologic elements.

Drought is rated the most important, or worst hazard throughout Lesotho, although its apparent significance varies from region to region. Worms, which farmers strongly associate with drought, are a close second. Hail and too much rain complete the list of major hazards. Wind is not considered a major threat, nor do Basotho farmers share widespread official concern for accelerated sheet and gully erosion. Possible explanations are that 1) erosion does not meet the standard of immediate crop damage, 2) erosion forms are part of the familiar and accepted landscape and therefore escape notice, or 3) except for catastrophic years,* erosion processes are gradual and thus are of less concern than more immediate events such as hail or drought.

Generally, farmers tend to identify most recent years with "last" and "worst" events. Perceptions of conditions more than five years in the past correlate well with measurements, whereas those of recent years are not well supported by official records. Similarly, expectations of future events tend to concentrate in the next year or two, suggesting that either farmers are generally pessimistic, or that they interpreted the question as one of possibility (event could happen) rather than as probability (event will likely happen). In any case, there is little evidence of belief in periodicity (regular or cyclical event occurrence) or association (event occurrence precludes or assures repetition).

Basotho farmers have a substantial collection of practices for coping with adverse environmental events. Within the basic crop mix, itself an adaptation to local conditions, there is some flexibility for shifting to more tolerant species or varieties. Field operations offer an even wider range of strategies including adjustment of plowing and planting dates, plant densities, fallowing and application of amendments. Finally, specific strategies such as rearrangement of surface geometry

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*The worst erosion occurs when a year of heavy rains follows several years of drought during which the vegetative cover has diminished or disappeared.

and insecticides protect crops against particular hazards. When all else fails, a ceremonial system includes avoidance ritual for individuals and active procedures for native or traditional doctors.

Prediction of future conditions ranges from immediate forecasting of hail or heavy rains in the presence of towering cumulus clouds, to long-range forecasting based primarily upon winds but also upon winter precipitation and animal activity. Curiously, plants which figure so strongly in hazard definition seem to play little role in traditional hazard prediction.

The familiar maxim that "Everyone talks about the weather but no one does anything about it" is almost universally untrue. Environmental events, especially climatic events, play a dominant and much respected role in the daily lives and fortunes of farmers everywhere. "Doing something about the weather" is a principal characteristic of farming, ranging from adoption of a basic crop mix adapted to the conditions of a region, to the scheduling of farm activities, to minor field adjustments and plant protection, and, as a last resort, to ritual.*

Farming in Lesotho is chancy at best, and possible only because of adaptations and strategies developed over the years.

Future Possibilities

The foregoing review of hazard perception and response in Lesotho has revealed a well-adapted, well-defended farming system that is able to

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*Ritual persists in farming systems everywhere, whether as medicine-tipped sticks in Basotho fields to ward off hail, or as mass prayers in an Iowa farm town to end a drought.

respond to environmental signals. Thus, it should be possible to anticipate individual farmer responses or even farm sector responses to given stimuli. Perhaps more important, it should be possible to anticipate farmer reaction to proposed changes, whether they be new crops or new practices. For example, scheduling of plowing and planting emerge as one of the most important operational strategies; yet farmers are short of draft power and equipment (Tables 6 and 7) and thus lack the means to adjust to favorable or unfavorable conditions. It is not surprising that farmers are suspicious of proposals to reduce the number of animals as a range and soil conservancy measure since such reductions also would threaten the already short supply of draft power.* On the other hand, they are generally enthusiastic about tractor-hire schemes which would allow them to act on their perceptions of timely field preparation (Jenness, 1973; Lesotho, 1975; Wallman, 1969).

It seems likely that other measures to increase farmer flexibility and response capability would be equally well-received. For example, the value of drought-resistant crops should be quickly recognized.** Similarly, insurance against such hazards as hail or frost (Leribe, 1973) might prove effective in attracting farmers away from basically defensive subsistence farming toward more market-oriented operations.

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*In addition, cattle are a form of capital and a source of prestige, which also makes reduction of numbers objectionable.

**I suspect that farmer acceptance of government-introduced asparagus rests largely upon the attractive characteristics of the plant in relation to hazards common to Lesotho. The earth covering (to produce white spears) shields the plant against hail. And the required deep, well-drained soil is not made unworkable by heavy ("too much") rain.

Better climate statistics and weather reporting would be worthwhile. Descriptions of weather must be quantitative in order to calculate probabilities of occurrence and farmers' risk (Harwood, 1979, pp. 45-46). Reports and predictions specific to Lesotho's regions would supplement local efforts to anticipate events and plan defensive strategies. Thus, a more comprehensive weather program would be helpful to planners and farmers alike.

Basotho farmers have developed a reasonably well-adjusted, flexible farming system that is responsive to signals from the physical environment, and the capabilities and limitations of this system are much a part of farmers' thinking and decision-making. Unless proposed changes are perceived as compatible with this system, they will be received with suspicion, itself a defensive strategy that has served traditional farmers well the world over.

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APPENDIX I

RISK PERCEPTION QUESTIONNAIRE

01. Location:____ /__________
    (Leribe, TY, Maseru, St. Thomas, Mohale's Hoek, Other (state)

02. Study site (village name):______________________________ /__________

03. Name of interviewer (print):____________________________ /__________

04. Name of respondent (print)_____________________________ /__________

05. Age of respondent (years; estimate if necessary)________ /__________

06. Religion: Catholic___Anglician___LEC___Other(state)______ /__________

07. How many years have you lived in this place?_____________ /__________

08. Cannot read...Can read___Highest standard completed?______ /__________

09. Status of respondent /__________

	Male	Female
Land holder	_______	_______
Wife of absentee landholder	_______	_______
Relative of landholder (state which)	_______	_______
Widow or other woman alone	_______	_______

Other (describe)____

10. How many cows/oxen do you own?____sheep_____goats______ /__________
    Horses____donkeys_____pigs_____fowl_______

11. What equipment do you own? tractor_____plow________ /__________
    planter____cultivator____harrow____cart_____yoke_____
    other(state)____

12. How many fields do you have?_____________________________ /__________

13. How big is your farm (all fields together; state units e.g., acres, hectares, Sesotho acres, etc.)_______________________ /__________

14. How do you decide when to plow and plant
    (circumstances and usual month /__________

	Summer	Winter
plow		
plant		

15. What crops do you plant? /__________

Maize______________ Wheat____________ Sorghum___________________

Beans______________ Other_______________.

16. Which crop do you plant the most of? /__________

Maize____________ Wheat____________ Sorghum______________________

Beans__________ ___Other_______________

17. Do you ever vary the amount of seed you plant per acre of a particular crop? Yes_____ No_______ If use a planter, do you ever change setting on plates? Yes______ No________ /__________

18. If yes, how much more_____ or less_____ and under what circumstances? (be sure to mention which crop). /__________

____

____

19. Do you ever vary the amount of land you plant to Maize___________ Wheat___________ Sorghum_______________ /__________

20. If yes, how much more_________ or less__________ and under what circumstances? (be sure to mention which crop) /__________

____

____

21. Do you use fertilizer? Yes___ No___ Manure? Yes___ No___ /__________

22. If yes (to either fertilizer or manure) when do you apply it? /__________

Fertilizer____

Manure____

23. What climate environment problems do you have here? /__________
(Note: respondent should be allowed to volunteer information. Interviewer should suggest specific events or hazards only after a respondent has failed to mention any. Mark only those mentioned specifically by respondent.) /__________ /__________

Event	Yes	No	When was the last time when there was (event) (month/year)	When was the worst time for this (event) (month/year)	When will this (event) come again (month/year)
Drought	___	___	__________	__________	__________
Hail	___	___	__________	__________	__________
Worms	___	___	__________	__________	__________
Frost	___	___	__________	__________	__________
Too much Rain	___	___	__________	__________	__________
Wind	___	___	__________	__________	__________
Erosion	___	___	__________	__________	__________
Other (state)	___	___	__________	__________	__________

24. Which of these problems (listed in No. 23) are most important? Which is next? Next? (List in order of importance: drought, hail, worms, too much rain, wind, eorsion, other(state)__________ /__________

Most important ______________________________

2nd most ______________________________

3rd most ______________________________

4th most ______________________________

Least important ______________________________

25. When do you say a drought has occurred or is occurring? /__________

a) After _____ days without rain (how many?)

b) When the grain turns yellow ______________________________

c) When the soil dries out ______________________________

d) When the crops die ______________________________

e) Other (state) ______________________________

_6. When do you say a frost has occurred or is occurring? /__________

a) When you see white frost on the fields ______________________________

b) When the plants turn black ______________________________

c) When the crops die ______________________________

d) Other(state) ______________________________

27. Do you ever get too much rain? If so what happens? (Let respondent volunteer information) /__________

a) Fields become unworkable ______________________________

b) Damages the plants ______________________________

c) Causes erosion ______________________________

d) Other (state) ______________________________

28. Is there anything you can do about any of these problems? If so, what? /__________

Event	What can you do?
__________	______________________________
__________	______________________________
__________	______________________________

28a. Is there anything others can do about any of these problems? If so, what? /__________

Event	What can they do?
__________	______________________________
__________	______________________________
__________	______________________________

29. Are there any signs or ways of knowing when (drought, hail, frost, worms, rain, other is coming) /__________ /__________

Event	Signs or ways to know
__________	______________________________
__________	______________________________

30. Is there any way to tell if a year is going to be wet or dry? /________

Yes________ No________

If yes, how do you tell?____

____

____

31. If you think a drought is coming do you plant special varieties /________

(yes____ no____) or crops (yes____ no____).

32. If yes, what sorts of crops or varieities do you plant? /________

____

____

33. Do you heap the soil around your maize plants (yes____ no____) or /________

sorghum plants (yes____ no____) when you cultivate?

34. If yes, what does mounding do?________________________________ /________

____

35. Do you listen to the radio? Yes____ No____ /________

36. What station do you usually listen to?____________________ /________

37. Do you listen to weather broadcasts on the radio? /________

Yes__________ No__________

38. How much maize/sorghum do you usually get?____________________ /________

39. How much maize/sorghum do you carry over in a good year________ /________

40. How much in a bad year?________________________________ /________

41. Here is a story on which (I/We) would like your comments:

Once, after a (drought, hail, frost, etc.) (Interviewer should use climatic event mentioned as "most important in question no. 24), four men/women spoke about (the event) coming again.

The first said that (event) would come again soon because when (event) happens, more are soon to come.

The second thought that (event) would come again but did not know when because (event) can happen in any year.

The third said that he/she knew when (event) would come again because there is a regular time and that time must pass before it comes again.

The fourth thought that (event) would not come again.

Which man/woman had the best idea about the coming of (event)? /________

First_____ Second_____ Third_____ Fourth_____

Thank you very much. I/we appreciate the time you have taken to help us with this survey.

Interviewer's comments (to be completed after the interview).

42. Interview situation: Respondent was alone____________ /__________

with _______other people. Other (state)__________________ /__________

43. Respondent was: cooperative____________hostire___________ /__________

unreliable_____________uncertain about answers_____________

Neutral_________________ other(state)____________________

44. Time (am/pm)_________Date (day/month/year) ____ ____ ____ /__________

Notes:____

____

____

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Signature of Interviewer_____________________________