the future of pastoral peoples
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the future of pastoral peoples

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a methodology for the inventory and monitoring of pastoral ecosystem processes


Semi-arid rangelands throughout the world share a number of properties. They are characterized by extensive grasslands having:
- Environment-controlling factors, notably soil and rainfall, that are highly discontinuous in space and time;
- High rates of nutrient turnover;
- Large variations in annual production; and, consequently,
- Human and animal populations that are highly mobile.

In the past such areas have been left to independent pastoral peoples, largely because they have been remote and have had low potential for intensive agricultural or husbandry enterprises. Increased attention is now being focused on rangelands. The reasons are complex: the spread of agriculturalists and the attendant government interest and infrastructure; the need to bring outlying border regions under central control; a global protein deficit; and, more recently, a series of dry years that have resulted in considerable loss of life among humans and livestock.

The main objective of governments responsible for rangelands should be to manage production systems in a way that optimizes the welfare of the people in the long term. A system must be understood to be managed properly, and an understanding can be derived from data collected and analyzed in ways that elucidate the dynamics of the ecological, economic, and sociological processes in an area.

Thus, management strategies must be based on knowledge; the more complete the knowledge, the more likely it is that the strategy will produce the desired results. The ecological realities of the pastoralists work at a scale larger than that of any other rural society, one that extends far beyond the immediate group boundaries and incorporates whole ecosystems and biogeographic regions. To gather information needed for management strategies, one may take a ground-based, interrogative approach concerned with details, but this approach does not afford detailed information about the whole of the pastoralists' vast range and may well overlook the dynamics and sweep of the ecological events that mould the pastoralist's lifestyle.

In accounting for the behaviour of groups, we as researchers must be able to account for the range of influences they are subjected to at any one time. For example, if a group is in a particular place when we investigate it, we must have some information about other places to draw conclusions about why it is there. The food, water, and shelter in different areas are
essential environmental features to which pastoralists, and indeed all migratory species, react, through either direct comparison, cultural knowledge, or information built into the genome. The pastoralists' response to their environment and our investigation of it must be based on an appreciation of not only the current but also the long-term factors of their entire range. An extreme example is that of trying to predict the rainfall or forage production in 1 km² of semi-arid northern Kenya — such is the annual perversity of rainfall. However, if we study, say, 1000 km², our prediction of rainfall somewhere in the area would be made with more confidence. It is this sort of ecoclimatological notion that determines the land perception of pastoralists and that ultimately must determine the scale at which we examine the causal factors involved in their lifestyles. We need, therefore, survey and monitoring methods that may be applied regularly and relatively inexpensively over the whole range of ecological influences to the pastoralists.

Although rangeland-use planning and day-to-day land management have the same ultimate objective, operationally they deal with different time scales. Planning activities investigate the various options for land use in an area, i.e., what is currently going on and what is possible over a long term. Management, on the other hand, is concerned with relatively short-term tactics to deal with changes in production (primary and secondary) for a given set of environmental circumstances.

To reduce costs, operational agencies must seek a set of methods that, with a minimum of modification, are useful to both planners and managers of pastoral areas. We, the authors, believe that recently developed ecological monitoring strategies are able to serve both masters, as well as be of considerable use to anthropologists.

an appropriate strategy

Ecological monitoring is a strategy for collecting information on the life-support capacities of large areas of land. It is a combination of techniques; it has been developed and tested, largely in semi-arid regions of East Africa, over the past decade. The techniques are relatively straightforward and inexpensive. What is innovative is the way in which they are combined to produce a multidisciplinary approach to the problems of optimum use of natural resources.

In a nutshell, data on people, animals, plants, and the earth itself (soils, topography, etc.) are collected simultaneously from three levels:

- From the ground, by mobile teams and some fixed stations;
- From the air, by human observers flying at very low altitudes in light aircraft on systematic reconnaissance flights (SRF); and
- From space, by the colour-sensitive scanners in orbiting satellites such as Landsat.

Aerial photographs are also used, where they are available and where budgets allow, for additional interpretation and mapping.

The data are collected according to a systematic sampling strategy, both in space and in time. All of the information is then related to a grid of the area of interest. This spatial system allows easy mapping of distribution as well as analysis of the correlation between, say, the movements of pastoralists and the greenness of the grass. Moreover, data are collected regularly so that
changes in land productivity and use may be measured, studied, and understood.

The monitoring method is not a rigid strategy but is, rather, the flexible combination of intensive and extensive techniques to provide useful data for planning and management of large tracts of rangelands. Through correlations between intensive and extensive data bases (ground, air, satellite), useful and cost-effective statements can be made about actual and potential production, although, during correlation, some precision is sacrificed. The manager must carefully design sampling to minimize the loss of information on the one hand and to avoid drowning in detail on the other. Managers who know everything about 1000 km² will not be of much use to planners who must deal with 100,000 km², unless the former have some basis for extrapolating their results.

Thus, a primary management consideration in ecological monitoring is to balance effectively the low cost of extensive data collection techniques with the need for high-quality information from intensive data collection methods. For example, a Landsat image produces low-information data at a cost of approximately $0.01/km². In contrast, a vegetation survey carried out by a ground team produces detailed data at a cost of the order of $100.00/km². Clearly, the information quality of the extensive approach must be improved to be of much use, and the cost of the intensive approach must be lowered to be practical. The former can be done very quickly; the latter can hardly be done at all.

We (Gwynne and Croze 1975a) have argued that the most cost effective first look at an area is provided by the SRF. If repeated later, it provides more precise data on population estimates of animals or patterns of seasonal use by pastoralists. The precision is enhanced if the SRF program is run concurrently with collection of information on the ecological state on the ground. Time-series ground data are improved as well because the patterns of production change are related to controlling factors (e.g., rainfall and soil type) and modifying factors (e.g., animal use, fire, influence of humans).

The third tier of data acquisition, satellite imagery, in the scheme provides spectral reflectance signatures over both the microevents in production recorded on the ground and the mesoevents in transhumant distribution from SRF (Gwynne 1977).

Although the data from SRF rest somewhere between those derived from ground work and satellite imagery analysis in terms of information quality, particularly at the outset of the investigations, its cost effectiveness is considerably higher. This is a difficult point to quantify directly, although it is simple to show that the flying and data acquisition part of an SRF program is relatively inexpensive (Table 1). For example, it costs $13,000 to cover an area of 100,000 km², which is roughly three times the size of the Sahelian zone in Upper Volta. For this outlay, one would get data on permanent attributes (topography, soil, drainage, watering points, static animal features, such as termite mounds), semipermanent attributes (plant physiognomy, plant community composition, zoogenic features, distribution of nonmigratory mammals, human settlements), and seasonal attributes (rainfall; insolation; soil moisture; evotranspiration; plant phenology; plant productivity; distribution, productivity, and population of migratory mammals; fire; surface water) (Gwynne and Croze 1975b). Comparable information collected from the ground, or from aerial photography with ground checks,
would take many hours, whereas, obviously, only the crudest of relationships could be derived from the first set of uncorrelated Landsat images.

The combination of methods allows correlations between them, which eventually should result in the phasing out of the more expensive, intensive techniques. Management and planning decisions may then be made as a matter of course and would be based on the cheapest data collection technique, backed up and checked at a manageable frequency with quality control air and ground samples.

As the monitoring program progresses and the correlations between the various levels of data acquisition increase, the relative cost relationships between the three levels of data acquisition change. The costs per unit of information from SRF are consistently the lowest. Those of ground work are the highest and become only slightly reduced with time. Initially, Landsat information is costly (though less so than ground work), but the costs drop dramatically because after relatively expensive initial ground correlation a remarkable level of detail is eventually possible for very large areas of land. Landsat information never quite reaches the cost effectiveness of SRF, largely because it is unable to cope with secondary production (i.e., domestic livestock and wildlife).

Up to the present, however, no area has yet arrived at the happy state in which a time series of satellite-generated data provides policymakers with the necessary information on which to plan and manage. Workers in this field are still at the stage of tentatively combining the methods and extracting the correlations. The reason for this retarded state of the art lies largely in an inherent conservatism among ground- or aerial-oriented researchers to expand beyond their predisposed data-collection platform. Another, more practical reason, is the lack of easily accessible, easily usable data analysis facilities. The advent of the interactive, user-oriented minicomputer is largely overcoming this practical constraint.

Results are what managers and planners require, and they are based on the organization of the flow of information (Fig. 1). To organize data collection and dissemination of analyzed information to managers and planners, one plans the approach, executes the initial stratification from a low intensity survey flight, fixes preliminary operational boundaries over the study area, initiates data collection from the three levels (ground, air, and space), analyzes the data, produces preliminary results, reviews the depth and scope of the information obtained (revises data collection, if necessary),

<table>
<thead>
<tr>
<th>Intensity (distance between flight lines) (km)</th>
<th>Optimum area (km²)</th>
<th>Maximum daily coverage (km²)</th>
<th>Proportion coverage</th>
<th>Cost (U.S. $/1000 km²)</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>500 - 10000</td>
<td>5000</td>
<td>10</td>
<td>40</td>
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<tr>
<td>10</td>
<td>1000 - 500000</td>
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<td>5</td>
<td>20</td>
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<tr>
<td>20</td>
<td>&gt; 10000</td>
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<td>10</td>
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<tr>
<td>50</td>
<td>&gt; 100000</td>
<td>50000</td>
<td>1</td>
<td>5</td>
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</table>

* The figures give order of magnitude estimates only and will be modified by as much as 25%, depending on local conditions. They include the cost of pilot, crew, and data analysis.
Fig. 1 Indicates the flow of information through an ecological monitoring unit (EMU), together with the organization of the EMU work plan and some of the results that an EMU can be expected to produce (adapted from a project document for rangeland monitoring in Senegal, which is typical for the network of the Global Environment Monitoring System, UNEP).
Plan study logistics:
- Maps, aerial photos, Landsat images:
- Equipment:
- Aircraft supplies:
- Aircraft:
- Sampling strategies:
- Arrange data analysis: etc.

Do preliminary low-intensity survey flight

Locate boundaries of pilot areas on maps, images, etc. and determine area limits on the ground

Order aerial photographs

Collect climatic data

Locate sample flight strips

Evaluate land system/vegetation/soil complex

Preliminary soils, vegetation/land system maps

Preliminary desertification maps

Locate ground sample sites

Initiate GW monitoring program

Initiate SRF program (2 SRF/year)

Initiate Landsat Program

Analyze data

Are data adequate?

Yes

Prepare reports, etc.

Start follow-up program

No

Modify design plan, etc.

Yes

Reports

Suggested management plan alternatives

Methods manual

Follow-up proposals

Desertification maps

Estimates of animal population sizes

Distribution maps of animals

Distribution maps of habitat feature

Animal/habitat correlations

Primary productivity, etc., estimates

Climatic maps, etc.

Rainfall probabilities, etc.
prepares reports for operational units (management and planning), and initiates follow up programs (Table 2).

With careful organization in the initial planning and a degree of bureaucratic autonomy (to minimize time-consuming delays, such as interministerial squabbles over territorial rights), there is no reason that the review state ("Are the data adequate?") cannot be attained within 18 months from the inception of the monitoring project. This suggests that managers and planners can have relevant reports in hand less than 2 years after the starting date. Moreover, because of the flexibility of the strategy, the full program can be short-circuited in cases of urgent need for rapid policy decision and bear fruit after the first half year.

Information, beginning at the determination of the existing state of knowledge of an area through the acquisition of further data and its evaluation to its distribution for management and planning, moves from the particulate in the initial stages to the general and is structured by the evaluation (analysis and synthesis) stage into forms suitable for short-term operation by managers and for long-term land-use allocation by the planners. Throughout, data are drawn from a number of disciplines —

<table>
<thead>
<tr>
<th>Activity groupa</th>
<th>Personnel-months</th>
<th>Cumulative personnel-months</th>
<th>Elapsed time (months)</th>
<th>Relative project cost</th>
<th>Costs (%) of components cumulative</th>
<th>Special equipment</th>
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<tr>
<td>1</td>
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<td>Library, maps</td>
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<td>3</td>
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<td>0.3</td>
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<td>High-wing, 4-seat aircraft</td>
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<td>1.0</td>
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<td>1.0</td>
<td>6</td>
<td>2</td>
<td>0.3</td>
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<td>14</td>
<td>3.5</td>
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<td>15</td>
<td>5</td>
<td>0.1</td>
<td>26.7</td>
<td>Mapping facilities</td>
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<tr>
<td>16a</td>
<td>14.5b</td>
<td></td>
<td>8b</td>
<td>13.5</td>
<td>100.0</td>
<td>Aircraft as for (6), small format camera, 4 x 4 vehicles, camping gear, neutron probes Image viewing or digital analysis equipment Desktop or mini-computer</td>
</tr>
<tr>
<td>16b</td>
<td>30.0b</td>
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<tr>
<td>16c</td>
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<td>3.3</td>
<td>100.0</td>
<td>—</td>
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</tbody>
</table>

a The activity group is indicated in Fig. 1.
b Activities that are repeated throughout the project.
c Time of first useful output from SRF data.
agriculture, ecology, anthropology, sociology, and economics — and management and planning cannot take place without information from all of them.

The close relationship between monitoring, research, and evaluation indicates the need for a single body to be responsible for the collection, processing, and dissemination of information for this activity cluster. At the national level, the task can best be done through a national government ecological monitoring unit such as that established in Kenya (Kenya Rangeland Ecological Monitoring Unit).

results: appropriate information

In the meantime, while the correlative data base is being built up both locally and globally through the Global Environment Monitoring System, national planning and management agencies are receiving usable, relevant information from ecological monitoring units. The units can provide such data largely because of the flexibility of the monitoring strategy. Given an explanation of the nature of the problems, they can provide useful information from any one or nearly any combination of the three tiers of data collection.

Ecological monitoring provides quickly and inexpensively a wide range of information relevant to productivity over large areas of agricultural, pastoral, or natural land. The information is of two sorts: state and process.

Information on the state of the land tells what the situation is like at a certain time. There are many types of questions that can be answered with inventory data from one single monitoring operation. A few examples are:

- How many cattle—dwellings—camps are in the area, and where are they?
- What proportion of the land is covered by different crop types?
- What is the current land-use pattern?
- What is the woodland cover?
- What is the state of the wildlife resource?
- What is the distribution of soils suited to irrigation?

Similarly, data analysis from a single ecological monitoring program in an area can tell about process, that is, what is happening in the area and what is likely to happen. For example:

- Is desertification increasing? If so, why?
- How will a proposed dam affect agricultural activity downstream?
- Are woodlands receding? If so, why?
- What are/will be the sociological, economic, and ecological effects of an irrigation scheme?
- What are the best locations for water schemes?
- What has been the effect of a drought on livestock numbers and species mix?

Results obtainable from SRF and from visual analysis of Landsat data at differing intensities of application (Table 3 and 4) are of use both to managers, who must make day-to-day decisions on how to run a particular part of the production system, and to planners, who have to account for the optimum use of large areas of land over long periods.

The continually updated information from monitoring has the additional advantage that it provides a check and measure of the effectiveness of
### Table 3. Some results from systematic reconnaissance flights.

<table>
<thead>
<tr>
<th>Type of flight</th>
<th>Distance between flight lines (km)</th>
<th>Periodicity</th>
<th>Type of result</th>
</tr>
</thead>
</table>
| **Inventory**  | 5–10                              | Once only, or once every few years | • Estimation of size of domestic or wild animal populations;  
|                |                                   |             | • Permanent data base from which to draft maps of soils, vegetation, or topography;  
|                |                                   |             | • Distribution of infrastructure (roads, villages, water points);  
|                |                                   |             | • Verification of ecozone boundaries determined from aerial photos or Landsat imagery;  
|                |                                   |             | • Determination of stock routes. |
| **Specific objective** | 20–50                              | Annual, beginning of rains  
|                |                                   | At peak of rains  
|                |                                   | End of dry season  
|                |                                   | Seasonal | • Advanced information on beginning of "green wave";  
|                |                                   |             | • Estimation of annual production;  
|                |                                   |             | • Distribution and type of burns.  
|                |                                   |             | • Estimations of animal population sizes of increasing precision;  
|                |                                   |             | • Distribution and phenology of vegetative cover;  
|                |                                   |             | • Seasonal animal distribution;  
|                |                                   |             | • Distribution of biomass of primary and secondary production;  
|                |                                   |             | • Correlations between biotic and abiotic factory;  
|                |                                   |             | • Establishment of boundaries of ecological management units;  
|                |                                   |             | • Correlations between animal distribution and spectral signatures from Landsat imagery. |
| **Monitoring**  | 5–30                              | Seasonal | |

* The operations are not mutually exclusive; for example, an SRF for a specific objective could produce results obtained from monitoring.

management itself: the same methods that provide information on which to make decisions for action are suitable for monitoring the effects of the actions.

**postscript**

It is with some humility that we offer the above approach for the consideration of anthropologists. We are sure that there can be no real understanding of the problems of nomads without full comprehension of the dynamics of the ecosystems in which they live and move. Gaining this
information for the range of habitats exploited by any given nomadic peoples must be a number one research priority for the 1980s. We are also certain that the approach we have outlined here is one of the best and most cost-effective ways of obtaining this information. The arrogance of our certainty that it is the best way to assess problems in semi-arid ecosystems is tempered with the realization that anthropologists are one group that is in a position to take monitored information, synthesize it, and turn it into sensible planning options for decision-makers — options that will lead to actions that will benefit both the state and, most importantly, the nomads themselves.

The rate at which the pastoralists are coming under both political and ecological pressures is increasing exponentially. Their future rests with proper land-use decisions. The perceptions and insights gained from just one family group or a settlement in one area may be locally true but generally misleading. We have argued that the optimum decisions cannot be made with local-scale information because the pastoralists in time depend on extensive areas for their well-being. Although intensive anthropological (and social, economic, and political) studies are being set up in key areas, we believe it is imperative that “quick-look” inventories be initiated over large (if not all) pastoral areas to help guide decisions that are taken precipitously, no matter what we do, and to provide a long-term basis for other decisions that are taken more thoughtfully, on a basis of an understanding of both the people and their ecosystems.

More research effort should be put into examining the details of pastoral ecology so that the minimum amount of land necessary for a sustainable living for any particular group and their progeny is set aside and managed.

It seems to us that there is a need for anthropologists to know more about the workings and maintenance of the animals that their peoples manage. Feeding mechanisms, diet requirements, metabolic tolerance, water turnover, and behavioural adaptations, such as progression rates, degree of scattering, herd social structure, are subject areas on which the very lives of pastoralists depend. Much of the information is already in the literature, awaiting the anthropologists’ attention. The anthropologist from his or her

<table>
<thead>
<tr>
<th>Type of image</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>1 : 1 000 000 mosaic of colour composites</td>
<td>• Preliminary definition of ecological zones</td>
</tr>
<tr>
<td>1 : 1 000 000 colour composite transparencies (in a seasonal series)</td>
<td>• Identification of ephemerally green areas;</td>
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<td>• Identification of zones with a high production potential;</td>
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<tr>
<td></td>
<td>• Estimation of occupancy by pastoral peoples, domestic stock, and wildlife (given correlations with a data base of distributions from SRFs);</td>
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<td>• Soil humidity (given correlations with a data base from ground studies);</td>
</tr>
<tr>
<td>1 : 500 000 and 1 : 250 000 colour composites, paper positives, or transparencies</td>
<td>• Preliminary topography, soils, or vegetation maps</td>
</tr>
</tbody>
</table>
stance of intimacy with the pastoralist should be able to point out to ecological colleagues the data that are lacking.

**discussion**

*Marx:* At what stage do you bring in assumptions about pastoralists, such as the type of economy?

*Croze:* We are not sure it is necessary to bring in any assumption. Ecological monitoring allows planners and managers (and even the pastoralists) to understand more fully the systems with which they are dealing. Obviously other data are brought in as well, data best supplied by the pastoralists and their interpreters, sociologists and economists.

*Schneider:* I am shocked no one here has challenged Dr Croze's assertion that pastoralists don't choose to be pastoralists. People in arid zones have the highest ratios of cattle to people. It is also true that pastoralists consider cattle to be wealth. Hence it makes sense to suspect that some people choose to move into the arid zone simply to become wealthier.

*Croze:* Whether or not they choose to live in arid areas is indeed a social and political issue. Once they are there, the choice of how to make a living is very narrow. There will be variations, but the main theme will be chasing ephemeral protein and water around the ecosystem. That is a fact backed with data.

*Schneider:* How can you deduce desertification from only three production cycles?

*Croze:* In only three production cycles, one gets an indication of what is going on, although long-term monitoring can confirm whether a deficit in production is cumulative or merely cyclical. It is important to look at both plants and animals — one reason the method was developed. Over a decade in a semi-arid region of Kenya, the grass cover changed from perennial-dominant to annual-dominant and back. Secondary production — cattle — remained constant or even increased. The ecological monitoring method gives a clear picture of livestock trends over three cycles.

*Hopcraft:* How does your analysis assess vegetation changes?

*Croze:* In the Kaputei region of Kenya in the 1960s, vegetation was predominantly perennial. Then, from the late 1960s through the 1970s, there was an increase in annuals, probably due to less rain and lower stocking. Now the species composition has changed back to a predominance of perennials, with an increase in rain but with the same stocking level.

*R. Dyson-Hudson:* Can your program study individual and group behaviour? Perhaps the cost effectiveness of research ground work can be improved, through the use of anthropological data.

*Sandford:* We have thousands of monitors in the pastoralists themselves and could use the environmental information supplied by them. Your system is very centralized and so may be inappropriate for day-to-day processes. It could be dangerous to make decisions on information that is not that useful in microdecision-making.

*Croze:* The distribution of soil and vegetation types, people, and animals, the greenness of the grass, and the number of huts and gates in a settlement
exist pretty well independently of planners and academics. We agree that there is a wealth of ecological data to be supplied by the herders, who are, after all, practicing ecologists. Centralized systems may be inappropriate in rural areas but we have centralized systems to deal with; it was the government of Kenya through FAO (Food and Agriculture Organization) that asked us to think about management of wildlife and livestock in Kajiado some years ago; it is the UN General Assembly and the governing council of UNEP that asked us to consider arid lands today.

Hjort: We need demographic data on age and sex distribution of livestock. Does your monitoring provide it at a reasonable cost?

Croze: Such herd details are best collected by ground work.

Aronson: The figure you quote for one flight is about the cost of a year’s fieldwork by an anthropologist, who might cover less ground but would get far more information about the society. Also, you have said these data go to the planners. Why not to the pastoralists themselves? Otherwise, don’t we concentrate power in central hands?

Croze: Your worker on the ground would get good information but only about a fraction of the land and of the plant, animal, and human influences. Both intensive and extensive data are necessary. Projects are formulated with national governments, and we have to hope they reflect the wishes of their people. Few of us are able to bypass the central machinery.

Gwynne: The information does get back. In the early Landsat project, which examined northern Kenya, information was returned to pastoralists in 2 weeks, and they were diverted from certain areas.

Goldschmidt: Your research program can exacerbate the very problems development personnel seek to alleviate. I come from California where growth of farm technology has served the large-scale corporate farm, at the expense of the family farmer. I understand aerial reconnaissance has helped larger fishing operations. Your methods can have the same kind of effect on the pastoralists.

Conant: Do your observers have anthropological knowledge? Why do you not use photography more?

Croze: Photography is expensive and only picks up visible static features. Our system picks up movements.

Bourgeot: The presentation reduces an ecosystem to the primary producers alone. The ecosystem is like an equation of three elements, with animals between humans and nature.

Rigby: Your methodology seems to lead you to ecological determinism. The argument that pastoralists are what they are because they have no choice distorts the nature of the pastoral social formation. They choose to be pastoralists and may choose to go into semi-arid regions that can be exploited by agriculture.

Croze: Their choice of what to do for a living is limited in arid and semi-arid ecosystems. Movements of pastoralists over their range are determined by ecological factors, such as rainfall and availability of grazing and water. If you live in a region with less than 500 mm average annual rainfall, you cannot be a farmer unless you can afford to irrigate or have some special claim to the one river running through the area. We do not presume to explain the social
formation, but we are able to predict the distributions of pastoralists and account for why they herd rather than farm.

Siham: We development personnel are in a period of doubt about the way we have been proceeding. These doubts represent some of the reasons that the monitoring system UNEP has just presented is coming increasingly into demand. Anthropology is the most difficult of the disciplines to integrate into our research program, but without it we shall never understand, in Croze's words, "how the system works."

Croze: This methodology makes a positive contribution to development of pastoral areas, one that complements the work of ILCA (International Livestock Centre for Africa). It is up to anthropologists now to contribute also to the job of surveying and monitoring for development.