ARID LANDS OF SUB-SAHARAN AFRICA

Appendices to the Staff Final Report

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1975

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ARID LANDS OF SUB-SAHARAN AFRICA

Appendices to the

Staff Final Report

on an Advisory Panel

of the

Board on Science and Technology for International Development

Commission on International Relations

National Academy of Sciences - National Research Council

July 1974 - December 1974

NATIONAL ACADEMY OF SCIENCES

Washington, D.C.

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Appendix I

FOURTH MEETING OF THE ADVISORY PANEL ON SUB-SAHARAN AFRICA

Washington, D.C., 23 September 1974

National Academy of Sciences, Joseph Henry Building, Room 400A

Panel

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In his opening remarks Dr. McKelvey welcomed Dr. McLoughlin, who had recently returned from an extended visit to the Sahel to review the situation there on behalf of a consortium of private U.S. interests.

Dr. McKelvey. Discussions have been held since April 1974 within the Rockefeller Foundation and among NAS, AID, and Foundation staff regarding future plans for activities concerning the Sahel. From these discussions has come the concept of an international conference involving scientists and planners from the Sahel and donor agencies. The Foundation is able to make available the Villa Serbelloni Conference Center in Bellagio, Italy, which could accommodate up to twenty participants, however, the only available period before 1975 is in late October. Accordingly, the NAS, AID, and the Foundation have proceeded with planning for the conference and selection of participants and the present meeting was called to discuss the issues which should be dealt with at the Bellagio conference.

The panel's term of office ends 31 December 1974 and activities beyond that date would depend in large measure on the outcome of discussions at the Bellagio conference, which is an opportunity to test NAS panelists' ideas and concepts against those of representatives from other countries and agencies. There will be a further meeting of the panel after the Bellagio conference, and a report will be prepared on the problems of the Sahel, solutions, opportunities for new assistance

programs, which will be of importance not only for the Sahel but other countries faced with similar problems resulting from the conflict between man and resources.

Dr. Talbot. The concept of the conference is useful, but I would like to first explore the relationship of the activities of the NAS panel and AID. I have written raising questions about the effect the panel's deliberations on AID programs and policies and would like to discuss this before the discussion of the Bellagio conference.

Dr. Lyman. Since the spring AID has been planning projects involving food production in the higher rainfall areas and livestock production on a pilot scale since less is known about livestock. As a result of the NAS discussions, projects have not been approved where concerns have been raised. For example, in livestock and range management programs based on western technology there is no role for the subsistence herder, and projects are therefore proceeding on an experimental basis to reconcile increased production without causing unemployment. Thus, the main thrust of AID programs has been in grain production programs--a $9 million project in Niger; in Senegal with SODEVA (Societe pour le Developpement Economique et Vulgarisation Agricole) and in Mauritania; in Chad the principal project is the Lake Chad Basin Commission project for development of polder agriculture, although there is some technical assistance to herders; in Upper Volta there is a range management project in the eastern part of the country; and in Mali there is the livestock development project, about which much is uncertain, and there is presently experimentation in improving communication between government authorities and herders.

Therefore, the timing of the Bellagio conference is very good. AID development assistance programming will take place in the fall and will be looking at education and health programs in the longer range to see what the AID role might be. The advice of NAS will be helpful on a number of issues, such as:

. How can "rational" production and ecological use of resources be reconciled equitably with employment requirements and subsistence agriculture;

. How can farmers and herders be involved in the decision-making process (seminars in the bush, floating academies, etc.);

. How do you provide market opportunities in the stratified zone structure of production?

Dr. Scudder. How does AID distinguish between the "MIT approach" ('rationalized' productivity) and the "Horowitz approach" (development through widespread small-scale assistance to farmers and herders based on their perception of their needs), and how are the host countries involved in developing policies regarding these choices?

Dr. Lyman. AID is torn in both directions as to whether to concentrate on food production first or on creating better long-run systems of agriculture. AID is, therefore, approaching this dilemma by a series of experiments--increasing food production in some places on the one hand, and working with herders to improve range management on the other. Lessons are being learned--many herders have less than ten cattle, and some of the things planned do not make sense on this scale. It has been a disheartening experience, and the feeling is prevalent that nothing can be done, or that now that the rains have come, the problem has disappeared.

In response to further questions, AID representatives assured the panel that increasing emphasis was being given to evaluation of AID experimental approaches. With regard to the projects described at the 14 March panel meeting (about which panelists raised serious objections) the problem of tsetse fly clearance in wetter areas has disappeared; as a result of the drought the flies have moved south. The idea of creating large grazing reserves was not implemented, and the program has concentrated on cereals production and other areas previously outlined by Dr. Lyman.

Dr. McKelvey discussed the prospective participation in the Bellagio conference and indicated, in response to Dr. Kates' question, that it had been impossible to arrange for representation at the conference of participants from all countries, agencies, and organizations concerned with the Sahel. The conference would be to discuss the priority issues concerning what AID and other technical assistance agencies could do in the long run to improve the lot of the conditions of the Sahel and prepare, perhaps, a 20-page document which would be brought back and discussed with the panel.

Dr. Kates. I think the report should deal with three points. It should: (a) challenge conventional wisdom; (b) consider the question of equity; and (c) deal with the question of fragility--the Sahelian system is robust; monocultures are fragile; what does this mean in terms of long-term projects?

Dr. McLoughlin. I have gone through tons of documents in the last three months and a number of points emerged:

. The psycholinguistic difficulties of development discussions in Sahelian countries;

. The set ideas on what should be done and how to do it;

. The problem is developers, not the recipients;

. A qualitative change in reports is necessary--for example, the psychological effects of drought are hardest on farmers, not herders, contrary to conventional wisdom.

Dr. Scudder. The greatest impact of the panel is in questioning the conception of planners--who should be avoiding development from above and involving more people in the decision process.

Dr. McLoughlin then described his recent visit to the Sahel and some conclusions he had reached in the 18-volume report he had just presented and which was not public.

Dr. McLoughlin. There is difficulty in defining the problems, although there are not many unsolvable, partly by leaving people alone and partly by building up the capacity of governments to do things. There is also the problem of defining urgency--what is urgent, or abnormal, or new? Outsiders may feel the urgency more than local officials. There is a policy to "get rid of nomads" so when technical assistance projects are suggested for range management, the officials think this is crazy. So attention must be increased on the definition of projects, on experimentation to take into account cultural parameters--tribal conflicts, and so forth--and on finding out more about the different perceptions of the problem. Many of the problems may be caused by outside technical

assistance, which has resulted in nomad-farmer conflict. This problem of conflict must be taken into consideration at the micro level.

There is also the problem of conceptualization on the part of the developers. The process of identifying projects, working them up, and screening them is a very difficult process. There are pieces of paper which are required to be filled in, the whole bureaucracy of development assistance. Most countries cannot do this, and as a result the projects can take many different directions, depending on available information.

In the Sahel emergency treatment is needed. Field staff technical assistance differs from metropole bureaucracy technical assistance. The economic macrostructures of the countries have been shredded and must be studied as budgets, costs, income distribution, population distribution have all changed, and the base of the macroeconomy must be understood if it is to be helped. For example, in the case of fertilizer pricing using the former price structure would be fatal; the new structure must be understood.

There is absence of sufficient numbers of qualified Africans for the countries' requirements, which is why there is still such dominance of French influence. Long-range education programs will help to change this. Even before the drought there were not enough people to maintain wells and other services; they were unable to cope with the maintenance problem then, even more so now that the level of activity is likely to increase. Therefore, many good ideas for projects simply do not have a chance of being implemented. Quantitatively this is the most important constraint. Thus, the absorptive and implementative capacity should be known and projects geared to this. The fragility of the situation is in

the people, not the physical ecosystem. Productivity is fragile, and the situation is very finely tuned. It could collapse again in a few years independently of what the weather does.

Personnel are also in short supply for intergovernment liaison and involvement in regional projects. In transportation, for example, there are a number of intercountry highway systems which the United Nations Economic Commission for Africa (ECA) has been trying to promote and doing it well. These should be accelerated now--particularly Dakar-N'Djamena, Dakar-Lagos, Lagos-Mombassa and the Transsahara systems. This should be accompanied by integration of the piece-meal developed internal road systems.

The current energy crisis has affected fertilizer prices to the extent that it is inconceivable that the countries can afford to purchase fertilizer from abroad. Yet soil productivity is crucial for the Sudan and Savannah areas. Export crops are at a standstill. There is no fallow. Everything is being turned to grow food crops. Superphosphate is mandatory--yet cannot be obtained. Thus, the organization on a West African basis of phosphate supply is mandatory; there is no alternative. The trade-off between food and export crops is not a problem. There must be improved varieties but those which do not need fertilizer. This is very difficult, but it is essential to achieve self-sufficiency. When the rains return, it will swing back to export crops. The crux lies in increasing the absorptive capacity of the Sudan Zone.

There are several spots where the farmers have been able to maintain the productivity of the soil. In Kano, for example, the experience should be studies in depth. How does it work? What do they do? How can it be

transmitted? (This must be done carefully--the use of fertilizer affected the relationship between farmer and nomad.) There have been small, successful extension efforts. In Upper Volta, for example, there are development efforts not only run by the Ministry of Agriculture but by pre-cooperatives. A half-dozen of these should be examined in detail. Similarly, the experiences of the pastoralists should be gained. What do farmers and nomads want? We must find out how to manage by seduction, not coercion. The Mike Horowitz idea of the bush seminar is excellent. A Sahel institute or pastoralist institute should be looked at. Many pastoralists have stopped herding, mostly voluntarily; it has happened, but no one knows why. This is worth detailed examination, if there is ever to be reliable information available to the decision-making process about change of life-style, forcing settlement of nomads, etc. There are psycholinguistic requirements for improved communication. What does "drought" mean to a nomad, a farmer, or a government official?

There are higher education requirements, training of Africans for management positions. The use of computers may be wise, the sparing effect releasing trained people to do other things may be helpful. Information from and about the area must be collated--a documentation center would really be helpful with fertility trials for example.

Another major problem is that public agencies deal with the things they deal with, and there is no adequate representation of the things the private sector deals with. Mining, manufacture, agricultural equipment, pumping equipment--the whole area of management and servicing of the economy is neglected.

Dr. Kates. Of the least developed countries, seventeen have less than one percent mining products as exports, while the next twenty five countries all have more than one percent. In the Sahel is it known where there are possibilities?

Dr. McLoughlin. It is known by both governments and companies. It is not because it is not there or not economical.

Dr. Van Dyne. What about oil?

Dr. McLoughlin. Nigeria, Togo, and Dahomey are exporting oil because it is worth it, and they can get better prices outside the region.

Dr. Scudder. What about communication between Upper Volta and Ghana or Niger and Nigeria?

Dr. McLoughlin. The Ghanaians and the Voltaiques got together on the development of the Black Volta, and Niger and Nigeria have been talking about water resource development. These committees are not working well.

Dr. Scudder. What about settlement?

Dr. McLoughlin. Disastrous--Bornu (in northern Nigeria) went from three million people to nine million. But there is no assessment of the effects of these movements on people. Food relief brings people to the cities for relief grain. Meanwhile, the productive fields are left in charge of the children and are full of weeds. This simply engenders dependency. The people who moved north about 10 years ago are the worst off.

The following are suggested questions to be addressed by the Bellagio conference?

. How is the capacity of governments to cope assessed/increased?

. How does this affect or tailor technical assistance projects?

Dr. Kates. I would like to report on the Sahelian work at Clark University. This has focused on long-term problems with a 20-year perspective and problems which extend well beyond the Sahel. It focuses on the special qualities of least-developed nations, including four from the Sahel--Mauritania, Chad, Niger, and Upper Volta--bringing together people around the nation that they are a subset of common problems of environmental constraints. What is distinctive about Sahel countries? Their isolation, eco-fragility, long-cycle low productive system, drought, impact of technology and absence of foreign exchange resource, capability and absorptive capacity.

We already know a great deal which can be done about these problems, rural water supply, health care, disaster prevention, modernization of pastoralism (compared with division of labor). How do you learn from the people, mix this with scientific and technological inputs and hidden information in technicians' minds and the minds of the people (which Peter McLoughlin addressed)? There are some fresh approaches to these "problems which will not go away", and the Bellagio conference should address itself to identifying these.

Agenda for the Bellagio Conference

The afternoon session was devoted to discussion of the agenda for the Bellagio conference. It was decided to discard the draft which had been circulated and to concentrate rather on a series of questions aimed at clarifying the main issues and what should be done about them.

After much discussion the following list of questions was compiled, and it was agreed these should be circulated along with the information for participants in the Bellagio conference.

Climate/Weather

1. What are the realistic prospects for the climate of the Sahel over the next 20-30 years? What are the implications of this for large- or small-scale project development planning?

2. What research is required?

The Ecosystem

1. What is the capacity of the Sahel to support people and animals? How can the limits of this be determined? What are the development implications for the next 20-30 years?

2. What changes are taking place? Are they inevitable? What are the major facets of interrelations of change in climate, population, agricultural production, land use, and environmental quality? Specifically, where is the energy to come from for development, for fertilizer, for transportation, etc.?

The Peoples and Institutions

1. What are the psychological impacts of the drought? Are they more profound and permanent among agricultural or pastoral peoples?

2. How can the process of identifying local wants, needs, and priorities be assisted and related to donor objectives? How can governments be assisted to increase absorptive capacity for projects? How can maintenance, monitoring, and evaluation of projects be assured?

3. How are the most favorable conditions for rural development created?

4. How can rationalizing productivity and ecological use of resources be reconciled? What would be the effect of this on employment and subsistence? For example, are there realistic ways of continuing to encourage and modernize pastoralism as an ecologically adaptive system for the low productivity environment, without eliminating the overall life and livelihood system?

5. How do the heretofore rather neglected sectors (e.g., manufacturing and mining) become incorporated into efforts to develop these economies?

Appendix II

CONFERENCE ON INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Bellagio, Italy, 24 - 29 October 1974

Rockefeller Foundation Conference and Study Center, Villa Serbelloni

Participants

JOHN J. MCKELVEY, JR., Associate Director, Agricultural Sciences, Rockefeller Foundation, New York, New York, Chairman

SAMUEL C. ADAMS, JR., Assistant Administrator, Bureau for Africa, Agency for International Development, Department of State, Washington, D.C.

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THOMAS F. MALONE, Director, Holcomb Research Institute, Butler University, Indianapolis, Indiana

MOISE C. MENSAH, Assistant Director-General, Regional Representative for Africa, Food and Agricultural Organization of the United Nations (FAO), Accra, Ghana

L. K. OPEKE, Administrative Secretary, Association for the Advancement of Agricultural Sciences in Africa (AAASA), Addis Ababa, Ethiopia

JEAN R. PAGOT, Director, International Livestock Center for Africa, Addis Ababa, Ethiopia

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GEORGE M. VAN DYNE, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Opening Session - Thursday, October 24, 1974

I. Welcome to the Villa Serbelloni

Mrs. William Olson welcomed the participants to the 267th international conference at the Villa Serbelloni by giving a brief history of the center and its purpose. Announcements were made to indicate how the participants can best make use of the facilities and thereby achieve their goals in the short time available.

II. Introductory Remarks by Dr. John J. McKelvey, Jr.

On behalf of the National Academy of Sciences Dr. McKelvey welcomed the participants to the conference. He stated that the objectives are twofold and may be expressed in the form of questio

a. What needs to be done in the long term to help achieve deve ment in the Sahelian region? This question presupposes a knowledge of what has been done, and a realistic appraisal of what can be don

b. How can that which needs to be done actually be accomplish This question is directed to the institutional arrangements wherebj the countries of the region and the donor agencies can jointly foc their talents on long term solutions.

In order to arrive at a concensus of these two questions the conference is intended to be as open to all points of view as possi Some papers have already been distributed to the participants. Eve one's views are invited--both in written form and in the discussion Only by free exchange of ideas among the participants, each of who was invited because of his individual knowledge and experience, is the objective to be achieved.

Dr. McKelvey stated that the meeting has no rigid agenda for the four days of sessions. For Friday, October 25th an outline or schedule was suggested (Attachment I). Subsequent to the first day plans are flexible, dependent upon discussions to that point, and wishes of the participants.

For the reference of the participants a number of documents were noted as available (Attachment II). Copies of two discussion papers were also distributed:

1. "The Sudano-Sahelian Zone" by Dr. L. K. Opeke
2. "Long-Term Development Strategies in Relation to Environmental Management in the Sahel" by Dr. George M. Van Dyne.

A paper by Dr. Robert Kates, and possibly others, would be available on October 25th.

In summary, the work of the conference is to produce recommendations on priorities and means to achieve priorities in Sahelian development. The recommendations, if carefully and realistically constructed, will serve as tools for the countries and for donor agencies to help solve the long-term development needs in a more coordinated fashion.

The session was then opened to general discussion.

III. Discussion and Questions

a. Dr. Malone suggested that the problems of the Sahelian region represent a class of development situations concerned with human, animal and plant balances in a fragile ecosystem and that this problem has common elements for analysis, and possibly solutions, in other geographic areas of the world. Therefore, the group assembled at this conference should be concerned both with the particular problems of Sahelian development and with more general problems in the methodology of ecosystem management.

b. Dr. Doo Kingue was concerned that the group present did not include sufficient representation from the six Sahelian countries that are most directly affected (with the exception of Senegal). In reply Dr. McKelvey stated that more persons had been invited but could not be present; nevertheless, the group assembled did represent a cross section of knowledge and wide experience in the region. Furthermore, the Bellagio meeting would naturally be followed by other consultative discussions in the region and elsewhere, to present conclusions and recommendations and seek the views of a far larger group than could be present at the Villa Serbelloni.

As a further suggestion, meetings in which both the French and English languages would be used was recommended.

c. Dr. Pagot suggested that documents from other meetings dealing with the Sahel should also be referenced. Further more, if the Bellagio group could produce a succinct document (about 5 pages) which had real quality as its final report, it would be read by everyone concerned with the Sahelian region and would have a very wide impact.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Friday Morning, October 25, 1974

The morning session was given to a presentation by each of the participants of his views on the conference topic and his dreams for the Sahelian region. These presentations are summarized below:

A. Dr. Michel Doo Kingue, Assistant Administrator and Regional Director for Africa, UNDP.

Dr. Doo Kingue first asked the participants to recall the vast size which comprises the Sahelian zone. It extends over a geograph area equivalent to that of India, Pakistan, Bangladesh, and Indones Fortunately, the population density is by far less in the Sahel, and this makes the problem more manageable.

Secondly, Dr. Doo Kingue is convinced that the Sahelian area can feed many more people; the problem is one of appropriate organization of the geographic area for its development. One need only recall that several hundred years ago a large proportion of the Sah was green and supported a flourishing economy. Reclamation of dese lands is a dream, but a realizable dream if human solidarity and technological ingenuity can be effectively mobilized. This implies full utilization and development of water resources in the Niger and Senegal river basins and area of Lake Chad. The investment is great but not so great as emergency schemes to finance recovery fro periodic drought. Even though the political climate within traditi donor countries is not currently strong to support vast development projects, the cost/benefit economic studies for development plans are favorable when viewed against emergency aid criteria as has bee necessary in the region for the past two or three years. Thus, one should not be deterred from development planning even though the schemes do require capital from outside the 7 countries.

In a further development of his theme Dr. Doo Kingue stated

1. There is no basic conflict in purpose between river basin development plans and the desire of the people in the region. The

basin development plans are not schemes of the UN organization but supportive of local ideas, plans, and aspirations.

2. The CILSS Program (Comite Inter-Etats de Lutte Contre la Secheresse au Sahel) is one which the UN endorses. It comprises: (a) water management (including river basin development), (b) transport and communications, (c) improvement of genetic stock (seeds), (d) reforestation, and (e) a special development fund for the Sahel.

Within the CILSS Program are subregional activities including a Sahelian R & D institute, an applied climatological center, training programs, animal health and sanitation. The CILSS Program is one endorsed by the heads of state from the Sahelian region.

3. The phenomenon of desertification is one which is debatable (personal opinion of Doo Kingue is that overgrazing and lack of management of underground water resources has had the major effect upon man and animals in his micro-environment).

4. There needs to be a clearer understanding of what is a drought. (Is it merely an aggravation of a permanent situation of water imbalance?)

5. Finally, the perception of the Sahelian situation needs to be constantly updated. What was considered unacceptable by individual states in the Sahel a few years ago is now being considered. The drought has forced a reassessment of development options and methods both by those in the area and by donor organizations.

B. Dr. Cheikh Hamidou Kane, Vice President, IDRC, Ottawa.

There are perhaps 3 or 4 points which I hope may be discussed at this conference:

1. In the past the Sahel was an area of extremely high civilization both in economic and human-cultural terms. This can be true again if we address ourselves to the sociological and psychological problems as well as to more strictly economic problems.

2. The plight of the nomadic and subsistence level agricultural peoples should be our first concern, recognizing their normal way of living on the land and not imposing sophisticated and complicated solutions. They are a resiliant people and given an incremental assistance, will be able to help themselves greatly.

3. This leads to the fundamental point that development schemes, useful as they may be, will succeed only as the local population participates in all steps of the process. (Specific example given was river basin development.)

4. There has been immigration from the region to Europe and the flow continues. Ways must be found to harness and hold this talent in the Sahel both for the benefit of the region and the individuals themselves.

C. Dr. Moise C. Mensah, Assistant Director-General, Regional FAO Representative for Africa.

The main issue is the confrontation between an increasing population in the Sahelian region and the availability of resources to support that increasing population. The degradation of the envir ment, the drought and other effects are evidence of a continuing situation which are derivatives of the main issue. Thus we must look into the population dynamics from now until the year 2000, always seeing the population as a productive force as well as a consumer of resources.

Then I think we must look into the resources, both renewable and nonrenewable. I am not certain we have a clear picture at this time for the Sahelian region. We have to discuss the possibility of discussing renewable resources from the technical standpoint and from social, psychological and political realities as well as financial possibilities and institutional capabilities.

My dream for the Sahel is not one that is apart from that of the countries themselves. They have identified about 30 regional programs and some 100 national programs. Some of these may now have a cost/benefit relation that will be more attractive to donor natio than was true a few years ago. I, therefore, feel we must give care ful consideration to the CILSS Program to see that it is better formulated, if that is needed, and then implemented. I think in this way we will learn more and raise the limits of growth in that part of the world. In depth inventories, surveys, research and training, etc. are needed and are emphasized in a coordinated way. We have to strengthen the ability of the CILSS committee to formula projects and programs and absorb assistance from the donor communit This illustrates the importance of the institutional questions, and is priority number 1.

My next point is that we need to develop the Sahelian zone as such and then see how we can integrate that zone into the Sudanian zone. We should not count upon the Guinean zone absorbing people from the other two zones. From a purely geopolitical point of view the Sahelian zone requires habitation for stability in the region.

D. Dr. A. Hugh Bunting, University of Reading, England.

I have five general points to suggest:

1. The history of the Sahelian region over long periods of time shows cyclical variations of wet and dry periods. Since 1900

we have data and I have a paper to give to the participants of this conference (Bunting et. al. "Weather and Climate in the Sahel: An Initial Study," University of Reading, 1974). Thus climatic change of the Sahel should not be something that surprises the world community or causes undue alarm.

2. It is important to know that fluctuations (wet and dry) are coming, to make predictions when they are coming (which we believe we can do), and to take actions within seasons (which we are certain we can do).

3. Peoples of Africa have lived with these problems and have coped with them for centuries. We cannot, however, expect the people of the Sahel to cope with the problems within their (limited) ecological boundaries. Any planning must take into account the complentarity of the Sahel with other regions.

4. Changes are coming; minerals are being found and trade with the south is a fact. Any proposed actions must look forward and not backward because the changes are already a factor and fact with which everyone in the Sahel and outside must live.

5. We around this table can make a contribution to a worldwide effort, but we shouldn't try to go it alone. It's important to see the process in perspective.

E. Dr. Michael Horowitz, State University of New York, Binghamton.

I see both an emerging consensus and a fundamental opposition arising in this discussion; I would like, if I may, to suggest a way out.

First, there is the tension between programs which would have a basic change in the life of the peoples and the more localized kinds of programs built on the strengths and existing capacities of the region. I think we must ask ourselves what are the implications of these different thrusts and priorities on relevant levels of funding which may become available.

Secondly, a useful function of this group is to challenge what may be called the conventional wisdom on Sahelian development programs, projects, and facts that are under consideration. For example, we heard one challenge to the desertification argument. If we look at history, we see that the desert both advances and recedes over time. I pose the question, do we need to challenge the advocates of range management. It may be that free ranging is a more responsive, direct response to climatic change in the Sahel. Also, let us look at the social, economic and political consequences of irrigation plans.

In making our challenges I think we need to recognize the

beneficiaries of any type of intervention we may make. Broadly defined they are: (a) the people, (b) the land, and (c) the political states. Ideally the intervention suggested should support all three, but this is, of course, not always possible.

F. Dr. Robert Kates, Clark University, Massachusetts.

I have a paper from the research group looking at problems of least developed nations that I want to share with you. I will not speak to that paper but will make two remarks about an opportunity and a danger that I see, both very real, in dealing with the long-term development problem of the Sahel.

The opportunity arises within the international community to respond imaginatively and on a new scale to the problems of the Sahelian region. I have the hope that this might be done in a truly cooperative and noncompetitive spirit.

But there is also a danger, even a nightmare. No matter what projects are done or on what scale they are done there is the need to strengthen the capacity of people within the Sahel at every level (governments to the individual farmers and nomads) to deal with their own situation. Drought is basically a human phenomenon; a response as it were to the absence of rainfall which is a natural phenomenon. Whatever is done by the world community in the Sahel, it must not leave the area more vulnerable to future interventions of man and nature than in the past.

G. Dr. Louis Sauger, National Center for Agricultural Research, Senegal.

I speak from the point of view of an agricultural technician with association in the Sahel.

First, I must say that the development of the Sahelian region is not one which may be disassociated from the whole region, particularly those bordering areas having a higher level of rainfall.

Secondly, the problem is not only a technological one. We know, on a technological basis, the answers to many problems, particularly agricultural ones. The area also has organizational and structural problems and the involvement of local people themselves. Without that involvement and commitment, solutions will not be forthcoming.

Speaking from an agricultural point of view I feel the following are needed:

1. Better utilization and management of water resources, fully realizing many areas must be managed not through river basin development but only with the natural rainfall available.

2. Land use planning at the "catchment area level" (river basin or regional). This implies equilibrium studies between human and animal population densities and the interactions with other agricultural use development (crops and forests).

3. Development of greater educational opportunities at all levels from the university to the pastoral people living in the Sahel.

4. Studies of energy resources and use. For example, we cannot expect sustained possibilities for hydropower and irrigation reservoirs in the same dams. The balance or complementarity of use is very difficult to plan for under sustained drought stresses as exist in the Sahelian region.

5. We must continually strive to reduce the feelings of insecurity in the human population due to climatic reasons. Our goal needs to be development models adapted to the human population.

H. Dr. L. K. Opeke, Association for the Advancement of Agricultural Sciences in Africa, Addis Ababa, Ethiopia.

My short paper ("The Sudano-Sahelian Zone") states my major thesis and supporting points, but what I wish particularly to underline here is the notion that the problems of today have accumulated over a long period of time (and therefore are not easily resolved) and need to be approached from the standpoint of the interactions between the Sahelian and Sudano zones. We must also take note of the fact that the human and animal population loads on the Sahel are much greater today than in the past. But tradition persists and the wealth of the pastoral peoples is measured in terms of cattle on the hoof. The fundamental change to a more modern system of measuring wealth is very difficult to accomplish, but the change must come. We need greater knowledge to solve the problems and my paper suggests some ways, institutionally based, in which this may be done.

I. Dr. Jean Pagot, International Livestock Center for Africa, Addis Ababa.

Basically my view is one of interaction between energy and water founded on the fundamental knowledge that there is an energy-water relationship to produce the quantity of food required for the animals and man in the Sahel that exist in a sort of symbiosis one with another.

To help alleviate the long-term or perhaps medium-term problems I would suggest:

1. Road building - where transport is not only possible but

good, then alternatives to starvation exist when a severe drought occurs. In Central Australia, for example, a drought approaching the proportions of that in the Sahel did not cause the same problems because cattle could be trucked quickly to the south where possibilities for survival existed. The greatest devastation in the Sahel occurred in the most inaccessible areas.

2. Research - integrated,interdisciplinary research of the kinds that focus on the problems and not on the desire to produce good reports for the literature.

In summary I feel we must work for men and their cattle for therein lies the problem and promise of development of the Sahel.

J. Dr. George M. Van Dyne, Colorado State University, Ft. Collins, Colorado.

We were challenged to dream and I would like to state my dreams for the Sahel as follows:

1. One dream is that there may be a nerve center in the Sahel to deal with its own problems.

2. A second dream is one of programs for countries and for the region and not of disassociated projects.

3. A third dream is to see a "comfortable compromise" between ecological-cultural considerations on the one hand and massive technological interventions on the other.

4. Finally I dream of the Sahelian nations and their peoples developing their capabilities and resources to such an extent that they may help other nations in the years to come.

K. Dr. Samuel Adams, Assistant Administrator, Bureau for Africa, U.S. Agency for International Development.

My paper will be distributed but I would like to highlight some of my main points.

First, my hope for this conference is not to discover something new (technically) that no one else has articulated. My hope is that the needs of the Sahel will be nearer in time to becoming fulfilled because we met at Bellagio. By nearer I do not mean 5 years from now but within the next few months or year. I am looking for ideas on organizational arrangements, institutional preparations, and the kinds of commitments and understandings of what are involved in long-term development.

I am impressed with the fact that the situation today is quite

different today (October 1974) from what it was when the crisis in the Sahel was recognized. If one talks about long-term development, he must recognize the dynamics of the Sahelian situation and the local perception of that situation. This also needs to be related to donor country realities in making commitments sequentially for long-term development.

The countries themselves have what they believe is a strategy, a range of problems. They become impatient with the donor countries' inability to make specific pledges of funding and aid. I think we need a discussion of how one institutionalizes donor interests. Donor countries, for example, understand the situation of mass famine and how to deal with that but less clearly the relationship between risk of mass famine and problems such as lack of roads or extending the capacities of native peoples to deal with their own problems. I would hope that there might be a discussion of the processes of institutionalization of donor interests. These, of course, must be convincing to the people themselves and to the international community of donors. There must be an increasing ability to implement programs in the Sahel over the years so that sustained international help may be made available.

Another important point to me would seem to be that in the long term there must be a different pattern of interaction between the economies of the Sahelian region and the major economies of the world. Should the Sahelian economies be primarily those of providing primary resources for the developed world. Is this appropriate to Sahelian development. Options to persons within the region need to be extended and to do this investment probably will need to be sustained at a higher level and for a longer time than donor groups have anticipated.

I would also presume that longer term development is a process which will only occur by extending the capacities of local people in managing their own affairs and seeing their economies meet costs to a greater extent than in the past.

L. Dr. Roger Fauck, ORSTOM, Paris.

I have two papers in French addressing themselves to ecological problems. Two or three points are very important:

1. The Sahel is not (within itself) one homogenous region but contains 3 or 4 ecosystems based upon differences of soil, rainfall patterns and water resources.

2. A second point is that although development of the Sahel is possible, it must be carefully organized by giving account to resources and population. A good equilibrium must be maintained.

3. Finally, droughts will occur in the future; thus, we must

always think solutions in these terms. Some Sahelian countries have more water than others but drought is a possibility always to be kept in mind.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24-29, 1974

Notes: Friday afternoon, October 25, 1974

A. Comments by Malone

Malone noted that the Sahel is an example of a problem in front of many countries. The problem is basically matching food production with human needs. He indicated there were perhaps 32 nations with more than 700 million people on the borderline of malnutrition. The world food reserves had decreased in ten years from a 90-day to a 30-day supply. He noted that climate is a constraint as an input to a larger problem of water management. A brief review of what is happening to the climate, in historical perspectives, gives the following information. For approximately the last billion years the climate has been good. Every 300,000 years we tend to have an ice age. There are various interglacial fluctuations. About 10,000 B.P. was the end of an ice age. The greatest ecological impact is in the transition periods. There was a mini-cold period about 1500-1850. In the last century from 1880 to 1940 there was warming of about 1°C. Since then the temperature has dropped on the average of 0.3°C.

Specifically related to the climate of the Sahel, there are conflicting views. It was noted there was a gradient of about one millimeter annual precipitation per kilometer from north to south, i.e., a decrease. He indicated there is probably no permanent climatic change, only fluctuations; but it is not a unanimous view. Most individuals feel that we cannot predict the weather well enough at present. Reference was made to WMO analyses and to the University of Arizona analyses for a summary of droughts, the number of years in each, and the length of each, and the use of historical and "proxy" data.

Malone sees a research need regarding estimating the probability of drought of various lengths.

B. General discussion

Adams raised the question of whether man has caused drought through land use practices. Malone's reply was no and even lake influences only have a downwind effect of only 40 miles.

Doo Kingue suggested that in Tanzania tree removal had led to swamps. Further discussion noted the effect that reduced transpiration

had yielded more runoff or less water loss or both. Further discussion focused more on the Sahel, and the conclusion was there was a need for management on a catchment basis.

Bunting referred to figure 3 of his paper and the irregular fluctuations in rainfall. The consequence was that if you are in the lower than average periods, be prepared to evacuate animals. A second consequence was that if the season begins badly, it is likely to end badly. Reference is made to table 9 and particularly to the diagonal elements of the table of his paper.

Further general and mixed discussion considered the problems of technology having reduced present storage capacity for foods and potentially increased variability in weather in the next several decades (reference was made to an article in Nature about 17-20 October). With respect to weather predictions, it was indicated that it would be useful to be able to predict the second period of rainfall in the Sahel. Further questions ranged to the topic of abandonment of small irrigation systems in Northern Upper Volta. This led to discussions of impermeability of water catchment devices to infiltration, the use of tanks to store water, the use of small areas to get some surface runoff and then plant crops, and other techniques of irrigation. This included a general discussion of catchments and food production.

Malone spoke of the problem of the food resource--demand balance. He thought we were moving into a period of greater climatic stress and a greater stochastic nature of climate. This led to discussion of weather modification and it was noted that the return per unit of cost invested would not warrant it at present. There is probably a maximum of a 10% change possible due to the weather modification during the average to better years of precipitation and less than that during drought periods. Weather modification is not a solution, more research is needed, but it eventually may enter into the long run.

Malone specified several research needs including the following: future global research leading to physically based schema for describing weather; future modelling activites, particularly to speed up the development of predicitve models, determination of the global interactions and correlations of weather patterns; determination of joint probabilities, e.g., as based on real data or proxy data.

C. Bunting on research topics

Bunting presented a proposal which specified research such as the following: systematic weather watch; development of a unit to study climate; study of the effect of drought and temperature on the growth of plants, particularly in terms of yield; examination of the reasons for climatic variations, suggesting a study of the circulation of the atmosphere with satellite imagery to examine the intertropical conversion zone; study of water balance in the Sahel on different crops and soils and storage capacities; determination of global climate; interspatial correlations examining the drought in Africa relationship to the drought in the Rajastan, i.e., a cause and effect analysis.

Further general discussion by several participants referred to the Stockholm symposium draft report, to WMO analyses indicating no real indications of one-way trend in weather, and to discussions regarding trees and crops with respect to shading, water competition, wind reduction, and evaporation decrease.

Bunting continued with discussion of several points including the following: the biological environment of the Sahel is almost completely man-made and influenced; erosion has been excessive in the past due to geological causes and now is excessive due to localized overgrazing; there is no water table or permanent water table in the Sahel but there is need to know the recharge rate of underground aquifers; with respect to degradation of the biota, he stated he though the vegetation cover would come back under proper management; there is a paradox or problem in that the nomads own the livestock but the government owns the land; and, there is increased population or migration.

Bunting made the statement, which was not unanimous, that there is not excessive degradation in the Sahel.

D. General discussion

Kates indicated that growth rates of population are relatively low. He indicated there was a 3-4% increase in the nomads in Tanzania and Nigeria in the only census data that are available (time period not specified). The utility of census data was questioned. This is because census records are often related to taxation listings.

Horowitz indicated that many of the present pastoral groups have a historical culture derived from agriculture. He indicated the pastoralization was a response to commericalization. Both of these problems have led to increase in livestock numbers. There has been a change in the camel-cattle ratio, with camels decreasing.

Bunting noted that shifting cultivation has given way to sedentary cultivation.

E. Discussion by Mensah

A clarification was made about the Sahelian countries vs. the Sahel itself with respect to the percent of the land and the percent of the population in each. Estimates were made of the size of the human and animal populations in the Sahel and the change in the human population. Emphasis was placed on the need to develop the economies to improve health and education in contrast to simply sustaining subsistance levels of agriculture. Questions were raised as to the limits of improvement, the potential impact of discovery of unknown resources, the limits of the people to make or accept changes, and so forth. Discussion was introduced as to what institutions are needed at the country and regional levels and how these might supplement CILSS.

F. Discussion

McKelvey introduced the discussion by stating the assumption that

each of the Sahelian countries is in economic trouble. The question is how can they get out of it?

Mensah noted that Senegal needs more food crops. They have excess manpower and thus need industrialization.

Doo Kingue noted that we have to consider both the before-drought and the after-drought situations. In Upper Volta 55% of the financial income is from cattle. They had projected they would be a net importer within 7 years. Now after the drought they would like to recover, then improve policies and change the whole economy. They have a 10 to 15 year "contingency problem" in development due to the drought. The health problem will have a longer term impact than the drought itself. Drought shifts the priorities.

Bunting noted that the Sahelian governments must seek solution in part outside their own boundaries. Commentary by Mensah indicated that the Sahelian countries will be forced into trade agreements with their neighbors they would not have accepted prior to the drought. For example, the sale to countries to the South of cattle vs. the sale of carcassess. He hopes that some infrastructure (roads were an example) will be produced to allow resources to be exploited more efficiently. The idea of multiple use of development projects such as roads was indicated--transportation, mineral extraction, and localized water control (and to this could be added the problem of fencing along roads in some instances).

General discussion led to the necessity not to rely on agriculture but to focus also on industrialization. Within the industrialization sphere, it was noted that damns being built may allow exploitation of other resources such as minerals.

Fauck noted that the Sahel can support more population than at present for humans, but not for cattle. It would be possible to double the yields of cultivated crops in the southern zones at the Sahel-Sudan region boundary because of better climate there. Some areas of good soils should be selected first. There must be realization of complimentary development of the Sahel and the lands to the South.

G. Discussion by Pagot

This discussion centered on livestock production problems. He proposed usage of a "UBT", a Unite Betail Tropicale, i.e., instead of a 500 kilogram animal that can grow 500 grams per day use a 250 kilogram animal with a daily growth capacity of 250 grams.

General discussion was held about need to reimport cattle into some areas of the Sahel where 60-70% loss has already occured.

The role of goats and sheep were discussed. Special breeds resistent to diseases were identified. The discrimination against goats is in essence a lack of knowledge of livestock management by the people. Sheep are economcal where there are roads for trucking and give good revenues in the Sahel. A major advantage of the smaller livestock is that they can be consumed by family units in relatively short periods of time.

Disease incidence in small livestocks was related to behavioral habits. For the breeds that are non-gregarious, the impacts of disease are less intense. Sheep and goat diseases are difficult to control.

Goats, sheep, cattle, and camels and donkeys are useful to provide "ecological complimentarity" but management of these multiple herds requires training more people in animal husbandry and management practices.

Pagot spoke of the need to use deep wells for truck crops and also to raise forage for insurance against drought. There is a need to develop stored feeds such as silages which are much less expensive than air drops in emergency periods.

H. Discussion

Opeke opened the discussion by indicating that no one area of economy can be developed alone--developments must be integrated.

Mensah indicated that 3 years are needed for institutions to become effective. Instead of developing new institutions, he indicated the present ones should be used and reinforced. With respect to the Institute of the Sahel idea, he indicated it probably would have more of a coordinating function than an individual research management function. He indicated the need for the Institute of the Sahel, but also the need for developing present centers. Regarding a livestock center, he indicated they are using existing centers to carry out much of the work.

General questions were raised by several participants regarding the need to commercialize some of the production processes, the question of whether or not new management procedures are possible, and the question of whether or not grazing regulations (for example) can be imposed.

With respect to controls, Pagot indicated control was easy with respect to intensive grazing around the wells. The point is "who brings the oil for the pump"; such an agency or person can control the movement of livestock in effect by controlling the pumping of water, presuming the people are agreeable. Mensah noted that the chiefs did the coordination of the rotation of grazing in the old days. There is a need to replace this with massive education and a need to use a planned rotation.

Adams noted that the least developed countries faced problems of survival around the world. They must be able to extend their options or else their carrying capacity has been reached. Survival will require higher levels of inputs into these economies than at present. They need an integrated way of increasing the capacities of people in terms of production, health, etc. Adams further emphasized a need to examine problems on a regional and programmatic basis rather than on a project basis.

McKelvey acknowledged that an impressive amount of knowledge had been put forward in the conference thus far, but he was not impressed by the sifting of that knowledge. Priorities must be reached. There must be a "systems basis" for development. If the development plan is too broad and costly, than no one will pay attention.

Doo Kingee questioned the extent of our knowledge regarding increasing productivity of the area. He questioned how much could be done in one season, one year? He questioned the losses of the animals that have occured to date. How much is the grazing now in balance?

Discussion shifted to the role of satellites and the use of satellite imagery. It was indicated that the definition of resolution was inadequate for many purposes. Although 50% increase in agricultural producation may be possible, only 1/10th of this increase may be accounted for by use of satellite imagery.

Saugier noted we have enough knowledge now to greatly increase production. He gave examples of high crop production with low rainfall. Such production required the spacing of water, good soil management, procedures to get soil water infiltration and storage, and usage of short" lived varieties of plants that don't use all of the water. The techniques he described require animal power, cultivation equipment, fertilizers, and some seed dressing. The problem of implementing these techniques is an extension problem. It was noted that AAASA is having a conference on extension in March. Examples were noted of projects in Senegal regarding development. An area of approximately 5000 hectares was being utilized along with the people from the village who were suggesting adoption of new technology and systems. This involved a literacy campaign, also.

The role of animal power was again stressed, illustrating the need of oxen for an economy of scale, to plow, cultivate, and do other cultural practices rapidly.

Some of the points of the discussion were summarized by Mensah indicating the following: the Sahel can be made to support many more people; there must be intensification of food production and varieties of plants for this area but more extension services and mass education are needed regarding their use; the Sahel can increase cattle production if it is kept in mind there is an upper limit to carring capacity and forage production must be increased greatly; there was disagreement on the fact whether or not new institutions were needed or whether it was only necessary to improve the existing ones; there was a need to improve the North-South connections for movements of goods and supplies and products; it was indicated that in order to sustain the population that the production after drought must be about at least 50% greater than that before drought.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Saturday, October 26, 1974 - Morning Session

I. Remarks by Dr. John J. McKelvey, Jr.

In order to focus our attention upon a report and recommendations, Dr. McKelvey suggested that participants jointly prepare a broad strategy statement on the development of the Sahel. There can be, of course, a number of alternative strategies but this Conference could not be expected to explore the range of possible strategies; however, a well reasoned, long term strategy statement based upon the knowledge and experience of the group would fill a definite need in the development community.

As a first approximation, Dr. McKelvey suggested the following outline:

A. Introduction

A section defining "development" in terms relevant to the current Sahelian situation; that is, survival for man and his animals and recognition that recovery from the drought also means improvement in the quality of life for the pastoral and agricultural people who have lived, even in good times, a marginal existence.

B. Climate/Weather

1. Basic premise: Uncontrollable climatic fluctuations in the Sahel will produce future droughts as severe, or more severe than those experienced in the past.

2. Need: To be written by the participants with Drs. Bunting/Malone asked to lead off in its preparation.

C. Soils and Water

1. Basic Premise: There are at least three or four major soil types in the Sahel and two water systems which interact with the soils.

2. Need: To be written by the participants with Dr. Fauck taking principal responsibility.

D. River Basins

1. Basic Premise: There are at least four river basin systems in the Sahel (Senegal, Gambia, Niger and Volta) and one extensive lake (Chad) which, if better utilized and developed, could help reduce reliance upon uncertainties of the climatic cycles.

2. Need: To be written by the participants with Dr. Doo Kingue taking principal responsibility.

E. Farming/Pastoral Systems of Land Use

1. Basic Premise: There is an integrated and overlapping set of human activities sensitively adjusted to the ecosystem of the Sahel which must be better managed in order to support a doubled population by the year 2000.

2. Need: To be prepared under the leadership of Drs. Pagot, Sauger, Van Dyne, and Bunting.

F. Crop Production

1. Basic Premise: There exists a network of crop research experiment stations in the countries of the Sahel and a backlog of research results that will enable local farmers to increase yields of food and other crops if modern inputs and management are utilized.

2. Need: To be prepared by Dr. Sauger.

G. Animal Production

1. Basic Premise: There is a nomadic population, moving across national frontiers in managing its livestock in order to take the best advantage of rainfall and grassland resources; this population incorporates livestock husbandry integrally into its social, cultural and economic life.

2. Need: To be prepared by Dr. Pagot.

H. Infrastructure for Development (Note: This section is to deal with human resources rather than physical resources)

1. Education: Sub-section to be prepared by Drs. Kane and Mensah.

2. Research and Development

a. Basic Premise: In the Sahelian region there are a number of institutions covering crop and animal improvement, a program for the development of the Senegal River basin and an intergovernmental committee for the fight against the drought.

b. Needs: The concept of a Sahelian multidisciplinary institute serving as a nerve center for a systems study and development of agricultural livestock and water management resources to be prepared by Drs. Doo Kingue and McKelvey.

II. Conceptualization of Dr. Robert Kates

Perhaps another manner of conceptualizing a report would be in the following manner:

Major Objectives	Major Opportunities	Immediate Action Activities
1. Prevention of future drought disasters and food shortage.	a. better understanding of climatic variables.	
	b. Food storage distribution network.	
	c. Increased productivity of pasture and crop lands.	
2. New resource development.	a. River basin development	
	b. Building a road and communications network.	
	c. Utilization of minerals	
3. Increased capacity for development activity.	a. Strengthening education systems at all levels.	
	b. Better links between agricultural extension and farm problems.	
	c. Establishment of a multi-disciplinary Sahelian R & D institute.	

III. Discussion of Dr. McKelvey and Dr. Kates Conceptualization

A. Dr. Adams

First we want our recommendations to be "actionable" in the best sense, and by a number of potential donors. In that context then, a strategy should be thought of from a systems approach and should include our ideas about consultations between donors and recepients as well as the timing within which implementation could begin.

B. Dr. McKelvey

Very good point and it could be that our document would be a lead up to that point.

C. Dr. Doo Kingue

I have some difficulties with the second formulation (Kates outline). I do agree with the first point, prevention of future drought disasters and food shortages, but I would think our next priority would be rehabilitation of the economies which were so devastated. Third would be the enhancement (creation) of opportunities so that the people will not just survive and be rehabilitated but also have a better quality of life as a result of development efforts.

IV. Problems of Integration of Agricultural and Livestock Production

A. Dr. George Van Dyne

I would like to direct your attention to pages 24-35 of the background document "Long-Term Development Strategies in Relation to Environmental Management in the Sahel." It is here that I have reviewed: (a) livestock and range production, (b) animal husbandry practices, (c) range management in the Sahel, (d) watering points and water resources management, (e) stocking rate, (f) grazing control, (g) and the general concept of cattle moving from north to south in the marketing process.

The problem as I see it is one of improving the efficiency of livestock production in a manner which is compatible with the social-cultural practices of the pastoral people and with the limitations imposed by the environment. Animals-on-the-hoof represent the food source of the people and their savings. The people do not participate in the money-credit economy nor do they use banking institutions. When money is needed an animal is sold. This is a system of survival that is fraught with the greatest difficulties because the surplus of good years is directly at risk in poor years.

On page 49 of the report I have sketched a system of more efficient livestock production related to crop production. In general it involves rearing livestock in the semi-arid rangelands (giving the animals mineral and other supplements), growing and finishing cattle in an area of more controlled ranges where regular dry land farming also exists, and finally fattening livestock in still more regulated pasteurland areas. This is, in general, a north to south movement of cattle.

B. Dr. Horowitz

The broad outlines of what Dr. Van Dyne proposes do, in fact, exist. It is not a very efficient or productive system as it now operates. Dr. Pagot can correct me but I believe that the average off-take of cattle for marketing

is around 10% and the maximum off-take is only 14-15%.

C. Dr. Pagot

I believe the overall average is only 7% but in some places it is 10% and a few even up to 15% off-take. A very modern, efficient figure of exploitation is 20%.

Dr. Van Dyne's proposed system is not new; it has been talked about since the 1930's. It is an idealized system. It has been tried in a modified form in a few places. One of these is in a small area of Niger where it arose unexpectedly and apparently spontaneously. One of the studies of the ILCA (International Livestock Center for Africa) is to study various existing systems of rangeland/pastureland raising of cattle and determine why they have not evolved into more efficient production schemes.

I want to suggest to Dr. Van Dyne that a very good bibliography on feedlot cattle raising was prepared for the National Academy of Sciences about 2 years ago. This bibliography, which has over 300 entries of which nearly half refer to the Sahel, would help up-date his bibliography. Data show that Sahelian cattle raised under feed lot conditions can have a growth of 1 kg/day and when slaughtered are very good quality, in fact are export standard. Under good conditions the small "white" bull of the Senegal can attain 270 kilos in 7 months, which is the same weight of the mother under bush (rangeland) conditions.

D. Dr. Van Dyne

I agree with the other speakers; this scheme is not unique or new; it is based on a tried-and-true system in localized places. The components suggested in the diagram (page 49) exist. It is rather a matter of organization; rough calculations indicate that with the scheme something between double or triple the present livestock production in the Sahelian region could be attained.

E. Dr. Mensah

Your goal to increase production is a good one because export markets for the meat exist within the West African region.

The fact I wish to emphasize is that there is good complementarity between the Sahelian and coastal areas in terms of meat supply. FAO has compared three surplus production areas--Mali, Niger and Upper Volta--with three defficiency areas--Ghana, Ivory Coast and Nigeria. We found that in 1965 the potential export was 63,000 tons from the surplus areas and the potential import demand was 76,000 tons. At that time there was already a deficiency and the projection to 1980 indicates 130,000 tons potential production with 200,000 tons demand. The coastal states make up the deficit with imports from Argentina, Australia, etc. But these studies were made under non-drought conditions, the so called "normal" conditions. It did assume that the coastal areas would not increase their own production.

Now because of the drought, the coastal countries have increased their own capacities to produce meat for market. This trend will probably continue and the coastal countries will go a long way to meet their own needs. Thus the Sahelian countries face the prospect of uncertain markets as the coastal states increase their own production. If there is to be inter-regional trade, some political decisions and marketing arrangements need to be worked out between the coastal states (consumers) and Sahelian countries (exporters).

My second observation is on the question of enforcing grazing rights. As you know the pastoral people move long distances southward and then northward with their cattle. It is a practise in which grazing rights are collective. There were beginning to be changes in grazing practices in some geographic areas prior to the drought because sedentary farming was gradually increasing. Thus confrontations between sedentary farmers and pastoral peoples were beginning to occur. There is, I believe, going to be an increasing movement toward sedentary patterns of agriculture where that is possible, and a consequently increasing problem of land for free pasturing. Thus the idea of supplemental forage for pastoral animals needs to be worked out. (Grazing reserves)

My third point is the integration of work animals into sedentary agriculture. This is a very interesting phenomenon. It is being done and the sedentary peoples are beginning to raise cattle both for working the land and for production of meat. This trend should be encouraged because of the increased efficiency which it brings to the small farmer.

F. Dr. Sauger

I think we also need to look at the questions of calf production and survival. It is my experience that there is a very low rate of fecundity among the females and a high rate of mortality of the young. Is not this one of the main problems to solve?

G. Dr. Van Dyne

The estimates seem to be 50% calf crops or less; in similar areas in Australia, Argentina and America it is possible to achieve about 80% calf crops with minimum technical inputs.

H. Dr. Pagot

Taking into account actual cattle disease conditions in the Sahel 70% is possible under the best conditions. Also 30-35% mortality (overall average) during the first year. If we could decrease mortality to 20% during the first year we would increase the revenue to the pastoral people by 15.6%; furthermore, if the mortality could be reduced to 10% the corresponding increase (in revenue or off-take) could be 21%. I also agree with Dr. Sauger about the low fecundity. Studies in the Senegal show that supplemental phosphorus in the correct amount will increase the fecundity by 50% over the present figure.

I. Dr. Doo Kingue

I have a series of questions.

1. In my own country, particularly in the northern Cameroon, one's wealth is measured in terms of cattle. Furthermore, cattle are very important in terms of social customs. My question is this--have we any reason to assume that the herdsman of the Sahel will accept a system of marketing young cattle--this is a fundamental change to a more market oriented system. My point is the psychology of the herdsman. In the Cameroon the cattle men are largely Fulani and they are of the same tribal group as those in the Niger. When the drought came the Fulani came across the border into the Cameroon. It is possible or even reasonable to assume that one will (or should) change the fundamental patterns of nomadism?

2. My second question relates to the problem of pastoral lands. I think that this has to be looked at on a case-by-case basis. For example, in the Mauritanian area of the Senegal River basin development scheme there is the possibility of making Mauritania self sufficient (self contained) in the scheme Van Dyne suggests for rangeland/pastureland management. But if you take other cases (countries) it would be quite different.

3. My third question is addressed specifically to Dr. Pagot and relates to the transport of cattle. On the assumption that we want to be able to transport cattle in case of a future drought condition what is your advice (as to how to do it?)

4. My last question is as follows. Will not the economies of the cattle surplus countries (Upper Volta, Niger and Mali) be in jeopardy because of the tendency of the coastal countries to become self-sufficient in meat production?

J. Dr. Van Dyne

I have been told by other people, although I have no experience myself, that many of the tribal people will adapt, within fairly wide limits, to new systems of production as long as they have a strong hand in the planning and decision for the new systems.

Secondly, with regard to rapid transport of animals in times of drought. Road networks do need to be greatly improved and vehicles need to be available to move the cattle. This has been done very successfully in the arid zones of Australia. I think this can also be true in the Sahel.

Thirdly, most of the Sahelian countries would seem to offer opportunities for north-south shifts as in the scheme we have been talking about. Obviously, there are some exceptions. There also should be some possibilities of east-west shift; alternate markets for the meat also need to be worked upon as part of the overall plan.

K. Dr. McKelvey

Do these answers make you, Dr. Doo Kingue, feel comfortable or do you have reservations.

L. Dr. Doo Kingue

No, actually the answers seem quite alright.

M. Dr. Opeke

Is nomadism going to become obsolete? How is nomadism going to be stopped because this seems to be the trend of the scheme we are discussing.

N. Dr. Horowitz

I would put it in the frame work of a related question--how does one get the herdsman to shift to a beef production activity? It is a basic shift.

I would submit that we really do not have tribes with a "chief" or "director." We do not have a "natural leader system" in the sense that if one gets that person to act, everyone else tends to follow. There is a tremendous autonomy within the herdsmen groups, they generally go within a certain pattern but this is not rigid by any means.

I might add that the Earth Resources Satellite (ERTS) offers us a possibility to help in some ways. The ERTS can spot over wide areas where the grasslands are overgrazed, or non-existent, and where the best areas remain. If there were reliable, systematic ways to get the data to the herdsmen, it could have tremendous impact. I throw this in as an aside, but it is potentially important.

The basic questions are (a) what is the advantage for the herdsmen, and (b) how do you regulate access or movement within range/pasturelands.

O. Dr. Van Dyne

I could suggest four short answers: (a) Participation in the planning; (b) initial phases must involve incentives to the herdsman in terms of animal health and supplimentary cattle feeds and, for his family, in terms of education and human health; (c) provision of information to the herdsman with known security of access to grazing rights when the herdsmen are asked to move; and (d) involvement of the pastoral peoples in the regulation (policing) of the range/pasture/water rights.

V. Development of Education and Training at Various Levels Within the Sahelian

A. Dr. Hamidou Kane

As a general introduction to my remarks I would say that insufficient

attention has been paid both by our own governments and by international agencies to popular participation in development. There is a truly deep need to correct this situation. The kinds of education and training I shall emphasize are really non-formal in character. Of course more formal, traditional educational opportunities through schools must also be extended but for quick results and impact the non-formal techniques should take priority.

1. To help increase participation in decision making we should use techniques such as that of animation rural in Senegal. This is primarily an oral technique; the use of what in traditional societies has been called palaver between the people and their leaders. It is an open discussion about problems within the community and has been less widely practiced in recent years. In my opinion, we should reinstate palaver so that people and their leaders meet one another more often.

2. Cooperatives, in the broadest sense, are a maravelous technique to improve functional literacy along the lines of business education--bringing of nomadic and farming people into the marketing, credit, commerce system.

3. Agricultural extension needs to be greatly expanded both to bring new techniques to the farmer/herdsman and also to bring his problems to the agricultural researcher. Both are very important. The researcher must not isolate himself from the felt problems of the people on the land. Here again animation rural could be a good means to help accomplish the goal.

4. Training of youth (14-20 years) needs to emphasize rural life rather than continue to prepare persons for limited urban work opportunities (particularly in government service and other white collar employment).

5. The primary school system also needs fundamental change along several lines:

(a) Emphasis, particularly in the first 1-3 years, on instruction in the local languages.

(b) Curricula dealing with life about the village with practical emphasis on agriculture, health, and nutrition rather than classical educational topics.

(c) Consideration to shortening of primary schooling by entering the child at 8 or 9 years of age rather than 6 or 7 and accelerating the pace of instruction for earlier school leaving times.

B. Dr. Samuel Adams

I commend you, sir, for the clarity and profoundity of these suggestions. External donors have been too enamored of western educational models and I believe your suggestions show many new insights into a more practical way of education in Africa.

I also have a question. Are there not already some trained people who are underutilized in Africa?

C. Dr. Mensah

I support Dr. Kane fully but I also feel the need for many more people at the highest level of the educational process--agricultural scientists, engineers, economists, etc.

My other comments are (a) that I want international donors to appreciate more fully that agricultural extension is both time consuming and expensive, and (b) that rural opportunities for youth mean that incomes in rural areas must not be so undervalued; the educated person who elects to work in rural areas should obtain a salary roughly equivalent, all things considered, to one he would obtain in the city.

D. Dr. Kane

Dr. Mensah is correct. In the Sahel, as in most of Africa, we desperately need more high-level people.

Turning to Dr. Adams, I also know that many educated persons in Africa are underutilized. To help absorb these persons into the economy we need support from international lending agencies. I realize this is a difficult subject, and a highly important one.

E. Dr. Doo Kingue

It is correct to state that as a general problem there is a lack of people in our countries who want to work in rural areas; the economic factors certainly are important deterrents to rural life. I would even go so far as to say it is unfortunate that so much of the Sahelian rural relief activities had to be left to foreigners.

F. Dr. Bunting

I see, however, that mass media of radio is invading all over Africa. The transistor radio is hanging round the donkey's neck.

Secondly, there is the question of appropriate technology for development of the Sahel. It must be pursued and encouraged as it offers one hope for improvement between the rural-urban imbalances within countries.

G. Dr. Kates

I believe Dr. Hamidou Kane has suggested a very profound change when he asks for early primary education in vernacular languages. As a start widespread radio broadcasting in vernacular languages would be a great help.

Secondly I think we need a system to synthesize effectively and systematically: (a) scientific-technical knowledge of Western societies, (b) the institutional experience of groups like AID, World Bank and UNDP on problems of development, and (c) the popular, or grass-roots knowledge of the people on the land. A synthesis of these three kinds of knowledge would, in my opinion, go a long way toward improving the development process.

H. Dr. Adams

I feel we should look at the CILSS programs to make certain our activities and discussions here fit into their overall pattern. The CILSS program, as we all know, has been approved by the Sahelian governments.

I. Dr. Malone

I am uneasy about the depth to which we have gone. We haven't taken into consideration exogenous variables (those on which Sahelian region and governments have no control). For example, the world food situation has radically altered in the last 3 years. We no longer have an "ever-normal granery." The world food supply may be about 30 days as compared to a 90 day supply a few years ago. This says nothing of quality of diet with respect to nutrition. I therefore ask, can the Sahelian zone be expected to feed itself?

Secondly, my feeling is that the proposed system we discussed earlier for rangeland/pastureland management will remove people from the land, and that they will migrate to cities and exacerbate problems there.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Saturday, October 26, 1974 - Afternoon Session

I. Larger Scale Technological Potentialities for Sahelian Development

A. Dr. Michel Doo Kingue

Mr. Chairman, previously I have spoken about river basin development, particularly as it relates to the Senegal. Let me say I am a supporter of these efforts but we must also recognize that water bourne diseases of some types may therefore be made more serious. I am particularly referring to river blindness and schistosomiasis. We need to take these into account but the health aspects must not control whether or not we go ahead with a river basin development scheme. Although I am not a specialist, I am told that these adverse side effects on man and the environment are controllable.

Another type of problem involves human settlements. When a river basin is developed the kind of habitation along the shore, or at least some portion of the shore is likely to be very different from what it was previously. We need to plan as carefully as we know how for such changes.

I also want to mention energy. There are no known oil or gas reserves in the Sahel although we have exploration going on and great hope that petroleum resources may be found. A dream of the Sahelian people, however, is to use the clean, non poluting sunlight which we have in such abundance. Even if solar energy were limited in use, such as a substitute for wood as fuel, that would be a big asset.

Finally, there is the problem of modern, rapid communication both within the countries themselves and between countries. If a good communication network had existed prior to the present drought, relief efforts would have been greatly assisted.

B. Dr. John McKelvey

I can speak briefly to the problem of solar energy because the Rockefeller Foundation has looked into the matter. The crux of the problem is the economics of storing solar energy. When the sun is shinning one can

heat water but one cannot store this for very long periods nor can one convert sunlight directly into electricity and store the electrical energy efficiently. I just do not have any confidence that the Sahel can count on solar power as an economic energy source in the next 10-20 years.

C. Dr. Bunting

There is one exception to what you are saying, John. In areas where water is plentiful it is possible to run solar powered pumps to lift water to higher level reservoirs for future use. This is actually being done to some extent in Scotland.

D. Dr. Adams

Can solar energy provide refrigeration and thus become important in food preservation?

E. Dr. McKelvey

Yes, but again you have the energy storage problem and the economics of storage cells defeats one at this time.

A better prospect for the Sahel is the storage of grain at low humidities in silos. This is promising for storage of carry-over grain surpluses from good years to bad but a good road network is essential to make it easily transported and distributed where and when it is needed.

F. Dr. Kates

One suggestion I have is to look again at some of the CILSS projects first suggested one or two years ago. Because of changing energy costs some projects may be much more favorable; others will be less favorable because of higher fertilizer costs.

G. Dr. Mensah

The CILSS projects are not fully elaborated in a feasibility study sense and certainly what Dr. Kates says is true.

H. Dr. Adams

In AID our programs in the Sahel have been proscribed by the Congress to include: (a) responses to immediate humanitarian needs, and (b) proposals for the medium term. We cannot, therefore, build roads but we could provide trucks for transport, training for persons in the distribution of the food aid, etc.

I. Dr. Bunting

We should really look at roads. In many ways road transport is the key to the development of the region.

J. Dr. Van Dyne

I agree. Roads provide: (a) communication; (b) transport of goods, including cattle, food and people; (c) access to health control for men and animals; (d) development paths along which immigration and human settlement occurs spontaneously.

Roads, if planned in an integrated manner, need not be built all at once but in sections as one has the money and the requirement to do so. Roads also open up the countryside to mining, manufacturing and other industrial development potentials.

K. Dr. Horowitz

It is also important to recognize short term negative effects of roads. Truckers in the Sahel are generally small entrepreneurs and do not like to risk their vehicles unnecessarily. When there were no roads, or very poor roads truckers would go anywhere. In those places where there are better, particularly all weather roads, the truckers tend to travel on the road and expect farmers to bring cattle and goods to certain junction and/or settlements. They do not want to put their vehicles "at risk" as in the past.

L. Dr. Mensah

I remain concerned at the insistence of international lending agencies to require very detailed economic cost/benefit studies for roads. We need criteria for both economic and social cost/benefits.

M. Dr. Adams

I agree. I wonder if Dr. Van Dyne's ideas that roads are part of watershead management and may serve as firebreaks may not be one imaginative way to help in justifying road networks.

We might also point to the cost of air shipment of good to illustrate how emergency distribution was enormously expensive. I recall costs of US $3 million to fly food into Mali over a period of 45 days and US $2 million to Mauritania over 30 days. The air distribution costs were enormous. Because droughts will occur again there would seem to be ample justification to build roads.

N. Dr. Van Dyne

We should recall, also, that roads require constant maintenance and this could be a drain on meager resources of the individual countries.

O. Dr. Kates

Turning back to river basin development I want to suggest that there are problems of equity which need consideration. Who is to have access to the irrigated land, at what price and under what circumstances. The

allocation of irrigation rights must be thought of very carefully and in advance because the persons who enjoy those benefits have tremendous long term advantages over the dry land farmers and the pastoral people.

P. Dr. Opeke

What about railways? They certainly offer advantages for cattle transport.

Q. Dr. Bunting

True, but railways often require an access road first so you are really making an extra investment. Also, the average man has independent access to the road but railways are under bureaucratic control (scheduling, rate fixing, shipping regulations, etc.).

R. Dr. Doo Kingue

Mr. Chairman, I should like to turn briefly to industrialization. The prospects improve as river basins are developed because electrical energy becomes available. Likewise river development and roads open up transportation pathways for moving minerals, etc. By chance a mining venture in Senegal will become possible (iron ore) because of the river development. Also we must remember that water, certainly a scarce resource in the Sahel, is an essential raw material in nearly all industrial processes.

S. Dr. Malone

Industrialization is a key element in any development scheme. In the Sahel it would seem that food processing and food technology should be one area to study. And by that I mean food for export purposes. Subsistence farming doesn't help the pace of development; farming in the real worldwide market economy can be enormously important. From the moment you enter world markets, however, you must pay attention to product design, quality and response to market mechanisms. These are rather sophisticated concepts for a developing country to master, particularly when it is trying to break into the world market for the first time.

Another factor that is a plus for the Sahelian countries is that labor prices are low when compared to Western Europe and America. One should not exploit labor and I would never advocate that, but general cost levels for labor in West Africa will help in the process of breaking into the world markets with goods procuded there.

III. An Institutional Framework that Will Aid in Research and Development

A. Dr. McKelvey

In considering what institutional arrangements may be appropriate to aid in research and development in the Sahel we have a model sketched by

Dr. Van Dyne. Dr. Dpecke has also suggested the kind of services AAASA might perform. I would like to ask Dr. Pagot a direct question. "Do you feel there is any need for a centralized Sahelian institute doing research programs in animal sciences?"

B. Dr. Pagot

I would think not. In addition to the ILCA there are six other laboratories doing some research in animal production, health, etc. In the Sahelian region there are examples of laboratories that are under utilized; there is a general lack of people and of management. A Sahelian institute, however, could be a strong force as a center of information linked to research centers in Africa and elsewhere.

C. Dr. Doo Kingue

Mr. Chairman, as you know the CILSS program is one approved by the heads of state of seven Sahelian countries in November 1973. One major feature of the program calls for the creation of an institute for development on livestock, agronomy, forestry, water resources and coordination of research in the area.

We in the UNDP have been asked to help CILSS by doing a feasibility study for the proposed Sahelian institute. Within UNDP we have discussed the terms of reference for the institute among ourselves but not yet with the secretariat of CILSS nor with the member governments. I am going to share our thoughts with you very openly and request guidance and criticism.

We see the role of the Sahelian institute in the following way:

1. It must not duplicate research going on in other institutions either in those countries or in existing international research centers. (This means that the research role may be a small one, but it does not mean that the institute cannot have some research functions)

2. One special activity for the institute would be to facilitate and adapt the transfer of appropriate technology. We see this as happening in workshops, seminars, short courses, etc.

3. The institute would be a center for information which it would distribute through its own publications.

4. The staff of the institute would be available as technical consultants in subjects of their own expertise.

5. The staff would help other R & D institutes in planning and organizing the training of persons according to needs of the countries and of the region.

As to the procedure for consultation with CILSS and the member governments, we in UNDP see it in the following manner:

1. UNDP will form a team of experts to go out to the seven countries and talk with CILSS and other people concerned. The team will be charged with (a) feasibility study for an institute, and (b) suggesting a program for the first 5 years.

2. I do not see this as a UNDP institution but rather an international Sahelian institute, formed by the seven countries and in which the national governments plus international donors contribute. I believe that other West African countries may be associated in the institute, but not as founding members.

3. Personally I do not see the institute as a big, headquarters institution with a huge physical plant. Perhaps the size might be in the range of 50 professionals, surely not 100, and particularly not large in the beginning. It would be in the Sahel and have links with every other appropriate R & D institution in the region.

4. As to a time table, I would hope the UNDP team could go out to Africa early in 1975 and write a report which we would have available by June 1, 1975.

5. I think it is important to emphasize that the UNDP is responding to a direct request of the seven governments in conducting the feasibility study. The governments are convinced that they need a regional (Sahelian) R & D institute.

D. Dr. Mensah

Mr. Chairman, I endorse the basic ideas outlined by Dr. Doo Kingue. I think also that a Sahelian institute would be able to bring to bare in the Sahel results from other programs in various parts of the world which are related to our problems. I think of the ERTS program, for example.

E. Dr. Horowitz

Part of the appeal of these terms of reference is that they are not wedded to conventional ideas. What about linkages to social sciences?

F. Dr. Doo Kingue

I believe the UNDP team should have at least one social scientist, a human geographer as an example.

G. Dr. Kates

I agree, of course!

H. Dr. Bunting

I, too, am attracted to the scheme outlined by Dr. Doo Kingue. You can build regional "self-confidence" in the sciences which would, in time, spread to the individual countries. You might locate institute research teams for long periods of time in various national research centers, thereby specializing on particular problems at particular places and strengthening the existing national centers.

I. Dr. Kates

Another function of the institute from the very beginning should be evaluation of its own work and that of other groups. This is difficult but highly important so the focus doesn't drift off to some "ivory tower" approach unrelated to real development problems in the Sahel.

J. Dr. McKelvey

I share the concern of others that the Sahelian Institute have a small but well planned R & D program of its own. This is a vital function. It could, for example, fill in research gaps, doing well thought out R & D that is not being done by others.

Gentlemen, on this very exciting note I suggest we adjourn for the day.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Sunday, October 27, 1974

I. Introductory remarks on the draft document "A Broad Strategy for Development of the Sahel"

A. Dr. McKelvey

The chairman reviewed the draft document stressing its preliminary nature both as to content and form and urging all participants to suggest freely where changes ought to be made.

B. Dr. Doo Kingue

Mr. Chairman, we need in our outline a statement on how to mobilize all over the world the good will and willingness to assist the Sahelian people in recovering from the drought and proceeding in a well planned, structured development program.

My second observation concerns the structure of some of the sections. I think that the one on river basin development should be broadened to infrastructure for development and include roads and communications as well as river basins.

I prefer that infra structure be in terms of physical needs rather than educational needs.

The latter depend upon the former. The educational needs I agree are very important and deserve a special chapter (or section) in our report.

C. Dr. Bunting

First, I would suggest we discuss the river basins in terms of river and drainage systems development. This is more comprehensive. I believe we are talking after all about a large area--some 500,000 hectares in the Sahel.

The development of such a large area implies closest cooperation in planning and management of the basins among the governments involved. Also, the irrigated farming will have an enormous impact upon the kind of dry land farming that will continue to be done in the countries involved. Planning for these inter relationships needs to be taken into account.

The transport system, likewise, will have to be devised in concert in order to be most effective

The combination of roads and developed water resources make possible many things which were impossible to do previously. Therefore governments must plan carefully and wisely to set up administrative mechanisms that will lead to change and not coerce change. What I am really talking about is another kind of infra-structure and that is one which can develop, utilize and manage the new inter-governmental infra structure; I hope the flavor of that gets into the report.

D. Dr. Adams

I have some problems with the format suggested. I think it must address governments in an unpresumptious manner. There needs to be some element of understanding, of insights which others have not brought forth. I believe Dr. Bunting's statement on inter-governmental organizational and planning imperatives may be just the element.

E. Dr. McKelvey

I think the introductory statement must do just that.

F. Dr. Bunting

I am responsible for the drafting of the introduction. So far I have cast it in terms of development goals for the Sahel (survival, reconstruction, enhancement of quality of life.) Now I am hearing the group ask for something broader; namely, a philosophy for development in the Sahel itself.

G. Dr. Doo Kingue

I agree that the introduction should be broader than the definition or elaboration of our development goals. The items to be added should be (a) the inter-governmental dimensions and (b) the perspective of 1974.

H. Dr. McKelvey

I thank you for those suggestions. If the document introduction sets the stages properly, we have done one of our most important tasks.

I. Dr. Adams

I want to urge that the overall document be integrated in a coherent manner. The picture presented must not be made up of isolated segments.

J. Dr. Van Dyne

I agree. We have begun to draw a circle with straight line segments of people, soil, water, animals--this is easy to do and is

classical and it will not contribute very much. What we need is to view the whole, the entirety of the system. That is no solution, I realize, but it represents where I feel we need to go.

K. Dr. Doo Kingue

I feel our introduction is very important. It is there that we can convey an overall thrust even if later sections look somewhat classical.

II. Climate and Weather

A. Dr. Mensah

Under this heading, we must emphasize that development can go ahead. The Sahel is not a lost cause. We must be positive and reflect hope.

B. Dr. Pagot

The problem of the drought in the Sahel is one special case of a wider problem of cattle and people in arid lands. (Australia, Western USA, etc.)

C. Dr. Malone

Which in turn is a special case of balance of food and population.

D. Dr. Doo Kingue

I would not want to go that far.

E. Dr. Adams

The fact of underdevelopment of the Sahelian area was one element in making the drought more severe and pronounced. Because of the gross level of underdevelopment aid agencies had fewer options in helping people help themselves.

F. Dr. Kates

To equate drought with underdevelopment is not quite correct. I think the area in its former times was more equipped to cope with drought conditions.

It is the factor of limited (partial) development which alters traditional balance in the area without compensating advantages. For example, because of the trend to cash crops in recent years there was less food in storage to cope with drought. This would not have been so pronounced in the years before independence. Thus, we cannot equate drought with underdevelopment.

G. Dr. Doo Kingue

We are not trying to equate drought with underdevelopment in some linear way. We are trying to say that the region should be helped (developed) to have a higher resistance to drought consequences.

Now, a comment. Shouldn't we link this section with the request of the CILSS countries for a regional meteorological center. The WMO study on this is already complete and is being considered by the 7 member countries.

H. Dr. Bunting

I think that an institute for study of the climate must be considered as an integral part of any Sahelian R & D nerve center. If the two are separate we lose an important opportunity.

I. Dr. Doo Kingue

I don't agree. I see the Sahel institute as a network of institutions which could incorporate an independent meteorological center.

J. Dr. Kates

One of the disturbing things is that climatic data collected by meteorological institutes tends to be an end in itself. I think we need to start with the needs of the farmers in the Sahel so that decisions can be made in response to climatic data.

K. Dr. Sauger

I agree with Dr. Kates. We have in the Senegal in connection with OSTROM made studies of rainfall. We can, for example, after the first rain in the season say what is the probability of having another within 15 days. Knowing what is the reserve water in the soil we can give predictions to the farmers as to the probability that the seeds will germinate. This kind of forecasting study is very important.

L. Dr. Bunting

This kind of prediction is very good but very dependent on exact locations where the data are collected.

III. Soils and Water

A. Dr. Fauck

First I would emphasize that the Sahel is not a homogeneous zone with respect to soil and water resources. This is very important to state in the report.

B. Dr. Kates

To sharpen our document we should emphasize that soil and water interactions need to be taken into joint consideration. That rarely takes place because institutions tend to separate the two.

C. Dr. Fauck

Yes, I call this the ecological approach (multidisciplinary study of soil-water interactions). We have more technical knowledge than management-organizational knowledge to form adequate systems of production.

D. Dr. Doo Kingue

It is important to include a point that states we should seek an appropriate technology to utilize the least productive of Sahelian soils.

E. Dr. Horowitz

Should we not also discuss water spreading techniques for remote areas?

IV. Drainage Basins

A. Dr. Doo Kingue

In this section we should recognize that drainage basins are to be developed not only for agricultural purposes but also for power, river transport and industries such as mines and fisheries.

B. Dr. Van Dyne

Shouldn't we, therefore, re-label the section industrialization?

C. Dr. McKelvey

A section on industrialization hasn't been written as yet but needs to be included and then cross referenced to this one on drainage basins.

D. Dr. Pagot

We also need a section on health to include river blindness, schistosomiasis and sleeping sickness. And malaria.

E. Dr. Bunting

Why haven't we discussed malaria before? Is it because it is so well controlled?

F. Dr. Doo Kingue

No, it is not.

G. Dr. Bunting

What this is getting to is the following. I hear from many people that we must avoid developing river basins in dry regions because of health consequences. To me that merely means we deal with those health consequences.

H. Dr. Kates

We have overlooked the problem of human settlements.

I. Dr. Doo Kingue

That might be dealt with by adding a "point 4" under "B"--Appropriate human settlement planning.

J. Dr. Mensah

I suggest that the report deal with migration and land use under the report section entitled farming, pastoral and land use systems.

K. Dr. Bunting

There is the problem of equity. Irrigated land is a great advantage. How do governments sort out who will be favored, etc.

For me, I feel that unless you have a firm central government scheme for the redistribution of wealth you cannot have development without inequalities. This is based on experience all over the world; development is not easily spread over a whole population. This is really the essence of political decision; we must recognize it so we are not criticized for forgetting it.

L. Dr. Mensah

Correct, we should not advise on the political points.

V. Farming/Pastoral Systems of Land Use

A. Dr. Mensah

The first need is to look into population dynamics--not only size but migration patterns.

B. Dr. Doo Kingue

Do we think of the population dynamics as applying to the animals as well as to the people?

C. Dr. Bunting

There is a carrying capacity of the land under the worst drought conditions as one figure and a different one in normal or good years. If the target is the lower figure during most of the years we would be wasting resources. What, therefore, is the reality of carrying capacity?

D. Dr. McKelvey

This is the very basis of nomadism. One needs a sliding scale of a philosophy of nomadism.

E. Dr. Bunting

Yes, and in the old Africa that is what was done--management of land, people and animals under a philosophy of transhumance. At the present time it is very difficult. States have to know what is the size of their population, etc. How do you organize for development in the face of these artificial barriers enforced by government?

F. Dr. McKelvey

Partly you go to river basin development but of course it is more difficult and complicated than that.

G. Dr. Sauger

We have to estimate carrying capacity on the basis of drought occuring 20% of the time. We must remember that the droughts are not distributed evenly in time.

H. Dr. Bunting

This means that 4 years out of 5, on the average, you can support a human and animal population of a certain size.

Then one needs to organize storage for man and his cattle to provide for years of drought plus transport, etc. What one, in fact, is doing therefore is to begin to institutionalize a nomadic system.

I. Dr. Mensah

The organization need not necessarily be in terms of moving nomads and animals. It could be approached from the standpoint of bringing forage and food into a drought stricken region.

J. Rapporteur's Note

A long discussion then began on "quality of life" vs. achievement of one's own "aspirations." The entire exchange turned out to be largely a semantic one and the chairman assured the skeptics that "Western oriented" participants were not implying any values of their culture in the "quality of life" phrase.

VI. Crop Production

A. Dr. Kates

I would like to suggest an item 4 under needs----"Tuning marketing, pricing and storage systems to improve the capacity for drought disaster prevention. This is partly incentives, local rather than too greatly centralized storage, timing of marketing, access to markets, etc.

B. Dr. Van Dyne

This is a more general problem of pricing and marketing--economics which affects not only crops but also livestock.

C. Dr. Kates

I think we should be careful about too much economic generalization. Economists almost always talk in terms of economic efficiency defined by their concepts. What I am talking about could be slightly more costly in the short run but certainly more efficient, and I believe less costly, in the long run when one has factored in the variable climate.

D. Dr. Adams

I feel that this section doesn't give enough attention to food production within the total crop production concept. Secondly, I agree with Dr. Kates and I believe we must take into consideration all the variables he advocates plus the effects outside the Sahelian zones which affect the agriculture/pastoral system.

E. Dr. Doo Kingue

I think we must signal not only dry land farming but also irrigation in this section.

F. Dr. Mensah

I am disturbed by the emphasis in development planning on cash crops (cotton, ground nuts, etc.). Food production for man and his animals should be the paramount priority in the Sahel.

VII. Animal Production

A. Dr. Pagot

The scheme suggested by Dr. Van Dyne based upon his literature search is one possible system and I believe it is the one which is best suited to Sahelian possibilities and needs.

B. Dr. Mensah

I must disagree with the statement suggesting alternative east-west patterns of flow. That I believe is beyond practical possibilities.

C. Rapporteur's Note

The topic of animal production was so fully discussed on 26 October, first section, that there were few additions made during the session reported here. The chairman was asked to take the following points into consideration in the report preparation: (a) Possibility of establishing disease-free zones for cattle raising, (b) linking the process of rangeland/pastureland management to efforts to retrain herdsman in artisan crafts and other appropriate skills producing a marketable product, and (c) signaling the problems of animal nutrition and fertility.

VIII. Education and Training

A. Dr. Adams

I would suggest that we head this section "Human Resource Development" rather than education and training - infrastructure.

B. Dr. Doo Kingue

Also, we should add a section on health showing we are recognizing the problems even if we are not going into detail. The drought has left the region with a serious problem of malnutrition.

C. Rapporteur's Note

Again, much of the relevant discussion was that covered on October 27th, morning session.

IX. Institutional Arrangements

A. Dr. Doo Kingue

Once more I would stress that the preliminary concept of the Sahelian Institute is one which (1) does not duplicate existing

institutions, (2) concentrates on adaptation and transfer of technology to the region, (3) serves as a center of information and coordination and (4) provides, through its staff, consultation in planning research and development and in the broad area of technical assistance.

B. Rapporteur's Note

See notes for October 27th, afternoon session.

X. Conclusion

A. Dr. Kates

I am concerned about two things. First, the presentation is rather conventional. If we could find a way to be more imaginative, emphasizing the totality of the problem rather than its various components I think the contribution of this Bellagio conference would be greater.

Secondly, I feel we must take advantage of the accumulated knowledge of drought disaster experience in the Sahel and record and document that experience so we may learn lessons from it. If we do not do so, and reasonably quickly, the people responsible for the disaster relief operations will be so scattered and their ephemeral records destroyed or otherwise lost.

Conference on

INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

Villa Serbelloni

Bellagio, Italy

October 24 - 29, 1974

Notes: Monday, October 28, 1974

The final session was a general discussion by the participants of the content of the report, its structure, preparation in final form and review prior to issuance.

Dr. Pagot

Since our report relates directly to the program of CILSS, I believe it should be sent to the CILSS secretariat for comment. Perhaps that comment should be printed as an appendix.

Dr. Doo Kingue

Mr. Chairman, what do we intend to do with out conclusions? Will the report be in the form we have been working on, or can it reflect a more "systems approach"?

Dr. McKelvey

The report will be labeled as a Bellagio Conference document; the recommendations will come from us as a group of concerned and specialized individuals. (It will not be a report coming from our organizations) I agree that we should ask one of our members, perhaps Dr. Mensah, to discuss it with CILSS. (Note: Dr. Mensah expected to see Dr. Conate, CILSS Executive Secretary, at the World Food Conference in Rome beginning on November 6, 1974.)

Dr. Horowitz

Perhaps our report should state somewhere that full consensus was not achieved by all members on every statement but the totality represents a prevailing consensus.

Dr. Adams

I wonder whether we should publish the papers that were presented here by some of our colleagues. I feel they were intended mainly as

contributions to our discussions and may need refinement before being published in full.

Secondly, I hope, as Dr. Doo Kingue has stated that we may move to a less classical (conventional) report format. Would we not sharpen the presentation by stressing points of issue rather than the very valid, but more classical points we have in our outline.

Finally, I believe we can have a marked impact upon the course of events which will shape Sahelian long term development. This is a prestigious and important gathering and I know it will be recognized as such by others.

Dr. Doo Kingue

I endorse Dr. Sam Adams recommendations. I personally do not feel we will have the impact we wish to have unless we have a report that is quite different in format. This raises for me the need to see an introduction quite different from the one we have.

Dr. Van Dyne

Perhaps we could have a document as follows--(a) Two page summary of key points of the whole meeting, (b) ten to twenty pages following the outline we have been developing and, (c) appendix materials containing papers which were available at this meeting. In this way we could, I believe, fill the needs of a variety of people who will be concerned about the results of the Bellagio discussions. Perhaps the appendix materials should only be made available on request.

Dr. McKelvey

That is one suggestion; how does it seem to you, gentlemen?

Dr. Bunting

Mr. Chairman, what is for me new about these discussions in Bellagio is not what should be done about the present drought but rather how does one cope with the phenomenon of recurring drought in the Sahel. If we are to use, as Dr. Van Dyne suggests, a systems approach, these are the elements of the system which must be addressed. If someone else wants to break down the problems of the Sahel, he is welcome to try. I am convinced he will come back to the same elements of the system which we have elucidated because they happen to be the right ones. There is no magic about a systems approach; we run our homes and economies with systems. I believe what is important for us is how we write (present) these elements. We are not trying to recite a catechism learned at our professor's knees but rather to say the new things we have been saying and reflect the new events and discoveries that have been reflected here.

Dr. Adams

I find myself agreeing with Dr. Doo Kingue. I have read with great admiration the introduction which Dr. Bunting has prepared but I do want to see another format for the report. I also agree that the elements are those which make up the system under study; we should deal with them in a non classical manner.

Dr. Van Dyne has suggested a two page summary and I think that is very important. I think we should make clearly, clearly evident why the conference occurred, highlight special information and insights coming from our discussions, and deal with solutions. Furthermore, we must convey an urgency about long term development in the Sahel with reference to organizational arrangements for actions which are needed.

Dr. Bunting

In other words the present introduction doesn't do what you want to be done.

Dr. Adams

I didn't say that.

Dr. Bunting

But it is quite plain that the draft introduction does not do what you have suggested, perhaps that is why you feel we need another two pages.

Dr. Doo Kingue

Mr. Chairman, I have a suggestion. Dr. Bunting has prepared a good introduction and I believe we need to add only a paragraph or two to stress our concern - that actions for long term development in the Sahel need to be initiated now to lessen the effect of a future drought. If we do not begin to act (on long term projects) now, when a new drought occurs we can be rightly blamed for our lack of initiative based upon knowledge gained during a previous disaster. What must be done can be outlined in terms of climate, soils, water, etc.

I have some difficulties with some of the sections as they now are presented. I understood yesterday that we would separate education and all other matters dealing with manpower and make it a special section dealing with human resources.

Dr. McKelvey

Of course. Please consider what we have before us only as a draft, or working outline. We have much work to be done. I invite each one to turn in to me before he leaves the topics (or format) that are truly

overpowering or sobresaliente. (Note by the Rapporteur: There was then a short break for coffee and informal discussion on the report format)

Dr. Doo Kingue

Mr. Chairman, I have a suggestion for the report structure which is based upon two major questions:

First Question - What is responsible for the drought in the Sahel? If the answer to this question enables one to avoid future drought, then we should elaborate on how that can be done. If the answer is that drought is unavoidable, then we must address ourselves to measures that may reduce its disastrous impact.

Second Question - In the context of the realities of the Sahelian geographic area, what would be broad strategy for development? I realize that there is one solution based upon the Sahel itself; we must consider adjacent areas and world realities (food, energy, population, etc.)

The manner in which we express the strategy might be (a) management of the resources of the area, (b) introduction of modern technology to speed development, (c) adaptation and innovation in dealing directly with traditional education and human settlement patterns, and (d) complementarity of development of Sahel and other geographic areas.

The above is a very rough idea of what I have in mind but I believe it would give a different report format from that which we have already considred.

Dr. Bunting

Mr. Chairman, I believe the introduction does all those things which Dr. Doo Kingue has suggested it ought to do. Now I do agree that we can improve upon the introduction, but the essential ideas are there.

Dr. Doo Kingue

I did not wish to imply that the introduction by Dr. Bunting did not deal with the points I raised. Maybe I read his introduction too quickly but I thought we could highlight certain points, or draw attention to them more forcefully.

Dr. Horowitz

I am troubled by what seems to be missing from the introduction and the body of the paper itself and that is the absence of the aspirations, dreams and needs of the rural people who represent greater than 90% of the population. There is no sense of involvement of these rural people in the design and management of the program. We must get that into the document.

I invite Sheik Hamidou Kane to address us on this point and particularly suggest that he do so in French if he would prefer.

Rapporteur's Note

Dr. Hamidou Kane did address the group in French stressing the importance of involvement of the rural people in the conceptualization of program development. Dr. Adams in a comment upon this recommendation by Dr. Hamidou Kane observed that experience in the United States in social development programs (Office of Economic Opportunity) again and again demonstrated the necessity of full, free participation of affected groups in planning and managing any development projects.

Dr. Bunting

I would stress at this point that foreigners must be very cautious when moving from technical matters to what are political decisions. How the involvement of the rural peoples in matters affecting their lives is to be accomplished is not my prerogative as a foreigner to determine.

Dr. Doo Kingue

I agree with Dr. Bunting, but Dr. Kane is emphasizing to us the need for long term development to be based on the aspirations and participation of the people who are the subjects of that development. We are on the border line of the internal affairs of a country.

Dr. Kates

I feel we are dealing with more than the aspirations of people. We must join in a dialogue to benefit from their knowledge of their resources and environment and ask of them questions concerning use, management, etc.

Dr. McKelvey

Time is passing gentlemen. I hear the complaint that we are too classical in our approach. Please be specific in suggesting how this report may be improved.

Dr. Kates

Could we not have a report that (a) poses questions and (b) suggests courses of action designed to answer the questions.

Dr. Doo Kingue

I would agree that questions could be asked in our introduction and then we might follow our outline (given by the Chairman) with modifications as suggested in the sessions around this table.

Dr. Sauger

Yesterday we recognized the importance of economic policy of the governments--incentives, tax structure, market forces, etc. I do not see these mentioned in the report.

Dr. Bunting

Yes there should be an added category of economic questions and institutions.

Dr. Pagot

I would also like to see a very good, up-to-date list of reports and documents in an appendix.

Rapporteur's Note

There followed an interchange to determine whether the group should break up into a smaller report writing committee which would then reconvene in the afternoon with all the participants. Because of the shortness of time, it was agreed this could not be done.

Dr. Mensah

I might suggest a format, based upon our discussions, as follows.

1. Food security. This involves the whole question of storage facilities and movement of food within the area to improve the ability to survive future drought disasters.

2. Infra structure development. This point would emphasize roads and water basin developments.(For water basin development I especially am thinking of a system of dams)

3. Improved participation of local people. Here I am thinking of mass communication and education to help in the long term ability of peoples to cope with their own development needs.

4. Long term development. Increase the ability of Sahelian countries to deepen thinking on development programs of the Sahel. The major instrument for this is the proposed Sahelian Institute.

Dr. Sauger

Related to Dr. Mensah's point on food security is the organization of trade within countries and between countries.

Dr. McKelvey

Dr. Mensah, have you thought in terms of costs, or a quantification that would lend itself to deriving costs?

Dr. Mensah

I could do it, but not now. It takes time.

Dr. Kates

I want to endorse Dr. Mensah's four points; I did a small summary and three of my four points are exactly the same as those put forth by Dr. Mensah. Perhaps my greatest difference is that I did not include the Sahel institute specifically but I believe it should be.

Perhaps one of my major differences is an emphasis on modifying the productivity of pastoralism while preserving the essential adaptiveness of the system. We spent a good portion of our time discussing this matter.

I would also like to call your attention to another point; namely, maintaining the memory of the experience in the Sahel. I would propose some short term studies (no more than one year) to preserve, synthesize and analyze the drought studies. There are at least six types of what I shall call "mini studies"--(1) Lessons to be learned from drought relief distribution program; (2) performance of various types of animal and crop varieties under drought conditions; (3) macro economic survey of drought impact on the economies of the countries concerned; (4) conference of scientific field workers to report on changes of economic and social activities resulting from the drought; (5) special study on the sequence of the return to normalcy (how and when people leave the drought-emergency camps and any associated data relating to this subject) and, (6) bringing the studies together in a seminar on the drought experience. Such a seminar might be held in connection with the founding of the Sahel Institute.

Dr. McKelvey

Our problem now is to get all of our information collated and in a proper form. I am not certain just how far we can go in the remaining time.

Dr. Doo Kingue

Mr. Chairman, before we leave, I think we should discuss the problem of how to insure that the goodwill for the Sahel that has been expressed all over the world might be mobilized and utilized speedily for recovery and for long term development.

Does Dr. Adams have special comments on this?

Dr. Adams

I would stress the need for, and importance of, institutional arrangements for the organization of donor commitments. Take for example the problem of river blindness (onchoceriasis). Until the Bank came forward with its commitment there was no programatic framework to attack

the problem over the long term; and by that I mean a development program for donor commitments which may require 20 years of efforts.

The current development situation requires, in addition to commitments for ongoing programs, a special structure to handle the very long term situations. For example, and as a contrast to the onchoceriasis program, we have the recent experience of the Senegal River Basin Commission (Mali, Mauritania and Senegal) in which donors made individual pledges. There is no concept of a common fund for development of the Basin. In contrast, the Institute of the Sahel could be structured on the common fund model.

Dr. McKelvey

Perhaps we need not discuss the very specific question of how one would develop a Sahelian institute.

Dr. Adams

We must not end our deliberations here, however, without establishing the fact that an institutional arrangement for donors to relate to a Sahelian institute must occur.

Dr. Kates

What are the options, what are the real specifics.

Dr. Adams

One option is the arrangements followed by the Senegal River Basin development group. In that circumstance I fear that the broader considerations of Sahelian problems requiring long term answers may not be factored in.

We really don't know the best way to package an enterprize as extensive and diverse as the proposed Sahelian institute. Talent is needed and we don't know for certain how to attract such talent on a sufficient scale.

My bias is that we need a talent pool to look at the larger problems. Additionally, there are a range of costs. For example, there are different estimates for different river basin schemes. These need to be examined.

Dr. Doo Kingue

Mr. Chairman, I want to share with you a few thoughts without necessarily having something very concrete to suggest.

I think we are facing programs with two magnitudes

- one which is at the national level
- a second one which is at the regional level.

At the regional level we can look at the CILSS program (approved by the heads of government of the 7 nation group). I think they can bring the international donors together.

At the regional level, matters are not very simple because there are various types of organizations existing in the area. Four are quite significant: (a) the organization for the development of the Senegal River Basin (it already has its plan, has presented it to potential donors and is mobilizing help in an appropriate manner), (b) the second is the Chad Basin Commission which is also mobilizing resources, but much less systematically than that of OMVS, (c) the third one goes beyond Sahelian countries and is directed to river blindness irradication, and (d) the fourth is Liptako-Gourma authority which is initially one for mineral development but hopefully much more than that in the future. This illustrates that there are complexities even at the regional level.

At the national level there is less coordination and this brings difficulties in mobilizing international donors. I don't believe that Sahelian countries should continue their policy of knocking separately at the doors of the donors for their national programs if those programs are linked to the overall exercises. First, some donors like US AID are putting more emphasis on the regional programs. Perhaps "packages" made at the national level should also be presented to donor groups in order to capitalize on the present good will found in the community of development donors. This then implies a need for a mechanism of coordination among the programs at the national level.

In summary, at the regional level there is no excuse for delay of some programs but at the national level a coordination among the countries needs to be created.

Dr. Adams

It is interesting to observe that donors shift postures almost unnoticeably. Although response to the Sahelian drought has been on a regional basis, funding in the future (for AID) might be much more on a bilateral basis.

This is often dictated by accountability requirements. AID has found it just cannot manage its operations on a completely regional basis. Thus we have seen a shift toward the bilateral approach.

Dr. Malone

Mr. Chairman, I have asked myself the question of what we did as a group in Bellagio. To my colleagues back home I would answer in the following manner:

1. The problem of the drought disaster in the Sahel is a single, exacerbated instance of a more general world discontinuity in food production,

its storage and mobility. This problem will be one of increasing importance in the years to come.

2. In the Sahel we recognize drought as a recurring,cyclical phenomenon. The present drought disaster has had a long term effect on a fragile environment. We must be very wise in dealing with the problem so as to help the area recover and renew itself so that when drought comes again, it may be better managed than in the past. This is particularly true because the population is increasing and even more people will be affected by future droughts than were affected in this one.

3. The Sahel demands a regional development approach. The nomadic life must somehow be brought into better balance with the carrying capacity of the land and the availability of renewable and non renewable natural resources.

4. There is a clear need for an institute in the region to catalyze and mobilize resources in the long term and bring about development to improve the quality of life for its people.

Dr. McKelvey

I believe it is appropriate that we close at this point. We have met, deliberated and ploughed the ground well even though our ideas have gone beyond our abilities to put them on paper to the satisfaction of all.

Dr. Mensah

I want to emphasize that within the region, and with a regional vision the CILSS (Comite Inter-Etats de Lutte Contre la Secheresse au Sahel) exists. It offers the common denominator to: (a) Formulate projects and programs; (b) conduct a dialogue with donor organizations; (c) serve as a nerve center for information, research and development; and (d) assume administrative responsibility for a development program over the long term.

Dr. Pagot

Mr. Chairman, I have attended many conferences in recent years on the problems of the drought in the Sahel. This one I feel should stand out as a landmark effort - we have spoken of facts, we have avoided passions of the moment and above all we have spoken of hope for the Sahel.

Dr. McKelvey

I thank you Dr. Pagot for that summation. I thank each of the participants for his efforts and I pledge our best efforts to come forth with a Bellagio document that is representative and worthy of your dedication and expertise.

Appendix III

LONG-TERM DEVELOPMENT STRATEGIES IN RELATION TO ENVIRONMENTAL MANAGEMENT IN THE SAHEL *

OCTOBER 1974

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* NOT FOR PUBLICATION OR CITATION

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ABSTRACT

Many developing nations have characteristics similar to those in the Sahel -- they are landlocked, are not rich in natural resources, and are subjected to harsh environmental conditions. These characteristics must be recognized and reckoned with in a development program which provides for short-term emergencies and long-term contingencies. Long-term development is the focus of the present report after a brief review of the characteristics of the Sahelian countries, emphasizing natural resource systems. A systems view is taken to avoid a narrow focus which could lead to the right answer to the wrong question. The report is based on analysis and integration of ideas from a large number of proposals for development and aid to these nations. Survey and critique are made of plans for development in the following areas: communication, transportation, dryland crop production, irrigated crop production, livestock and range production, technological and industrial developments, sociocultural and health developments, and institutional, policy, and economic structural development. Concepts of extent and equity of development are considered, leading to a focus on an integrated plan for range livestock production with improved animal husbandry and range management procedures. Preliminary conclusions are stated after accepting the thesis that change is occurring and will occur in the Sahel due to fluctuating climatic conditions, population growth, and migration. It has also been accepted that there is a definite limit to the carrying capacity of the Sahel and that stocking rates have been excessive and have compounded the effects of the drouth. The basic strategy proposed is to improve human welfare by developing an integrated and expanded livestock grazing and agricultural production system, with associated developments in training and education, communication and transportation, agricultural based industry, and national infrastructures. A plan is developed for moving livestock from northern arid and semi-arid rearing units to southern sub-humid and humid pastures for further growth and finishing to be sold or slaughtered at equivalent weight, but much less age, than under the present system. The rangelands would be grazed under a system of cooperatives or centers where educational, health, and financial services would be provided. Some areas of land would be put into national grazing reserves, for use during drouth and to help distribute grazing loads in a manner to optimize range improvement. A system of movement of animals southward and concentrate feeds and supplies northward would replace much of the present-day, long-distance trekking with trucking. It is proposed that an international institute of the Sahel be formed to help assist in the long-term, regional development. Institute functions would included training, communication, documentation, land use planning including reconnaissance and survey, organization and conduct of cooperative resource research and conservation studies, and resource and technological developments. To maintain flexibility, the institute is proposed as an independent unit receiving funding from various donor governments and foundations and working interactively and cooperatively with governments of the Sahelian nations. A prototype organizational structure and a time-phased plan are outlined for the proposed institute. The development and successful functioning of the institute would have meaning transcending the Sahelian countries. It would provide critical assistance in an integrated development program which is aimed at a large segment of the population, founded on ecologically and culturally sound premises, and providing for technical and infrastructure growth in the involved nations leading to self-sufficiency. This could be a prototype for planning similar efforts in equivalent nations and regions of the world affected by harsh environments.

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1. INTRODUCTION

1.1 Environmental Impact on National and Regional Development

On a worldwide basis, if one uses the United Nations method of judging development of a nation on the basis of national income, manufacturing activities, and illiteracy then the impact of environment is paramount. Coldness or dryness result in harsh human environments. When harsh environments coincide with landlocked, isolated independent nation states, lacking richness in resources, the result is a set of nations which are classified as "least developed" by the above standards. These nations fall mainly into two environments (157)* -- the Sahelian-Sudanic, semi-arid zones of Africa and semi-tropical, mountain-lands of south Asia. Thus, environment strongly influences global poverty.

1.2 An Overview of the Sahel

The geography, climate, non-renewable and renewable natural resources, and human resources of the Sahel are reviewed in detail elsewhere (15, 40, 58, 63, 70, 171, 194, 195). For present purposes, a summary of this system, the components and their functions, is necessary. Also, it is useful to compare the Sahel proper with adjacent zones.

The Sahel is hot. Maximum temperatures in the northern areas exceed 50° C. Seldon do readings drop below 0° C. Solar radiation is intense; there is cloudy weather only during the rainy season. Much of the year the dry north-easterly trade winds influence the region, and because of the high temperature, evaporation rates are high. Rainfall is highly variable. Many areas experience virtually no precipitation for several years. Early in the rainy season thunderstorms are common with associated violent winds. Rains come in the summer in the Sahel zone. The length of the wet season is directly proportional to the amount of annual precipitation. A rule of thumb suggests there is one day of growing period (wet season) for each 5mm annual precipitation (212).

Several east-west oriented climatic zones, and associated vegetational patterns may be identified.

Zone	Millimeters Annual Precipitation	No. Rainy Days Per Year	Rainy Season	Percent of Region
desert	≤ 100	≤10		36
subdesert	100-300	10-25	July-Aug.	28
Sahel	300-650	26-46	June-Sept.	17
Sudan	650-900	50-65	May-Oct.	10
woodland	≥ 900	65-80	May-Oct.	9

*References are identified by numbers enclosed in parentheses.

Within the Sahel drought is frequent and severe. Estimates of drought lengths since the 16th Century show the following results (212). Of the 22 droughts listed, 6 lasted for 1 year, 8 for 2 years, 2 for 3 years, 1 for 4 years, 4 for 5 years, and 1 for 18 years.

Except for a few mountainous areas, the Sahel is relatively flat. Soils are relatively erodable by wind and water. In numerous areas the amount of soil covering is minimal, and there are bare rock outcrops throughout the region.

The vegetation of west Africa has east-west oriented vegetation zones more or less corresponding to the rainfall zones noted above. For simplification, the precipitation zones may be grouped into three main vegetation zones -- northern desert, savanna, and southern woodlands. The vegetation in all of these zones has been strongly impacted by man and his grazing animals.

The desert zone contains little or no vegetation and a predominance of annual grasses and forbs where there is vegetation. As rainfall increases going southward there are more woody plants and a greater abundance of grasses and forbs with some perennials entering the vegetation. The savanna zone is characterized by relatively short grasses, predominately perennials, with overstory of scattered thorny shrubs and small trees. As one moves southward within this zone, the trees become taller and often are broad-leafed and deciduous and the grass and understory vegetation becomes taller and predominantly perennial.

Woodland zones vary from more northerly deciduous forests to rain forest characterized by diversity of tree species including broad-leafed evergreens.

Relatively little is known about the wild animals, insects and decomposer organisms of the region. Many of the big game species characteristic of East Africa have been eliminated from this region by climate or man or both. There are records of large breeding colonies of various pest species, including weaver birds which damage cereal crops.

Agriculture in various forms is practiced throughout the region. In the most northern areas nomadic people with herds of camels, horses, donkeys, goats, and sheep rove the area. Further south there are transhumance herdsmen with predominately cattle and sheep herds. In this zone there is increased amounts of cultivated lands. Further south yet, much greater percentages of the area are cultivated. Cultivation includes dryland farming, flood retreat farming, and wadi farming. Usually the farming practice is rudimentary without extensive cultivation. There are indications that the soils are relatively infertile in the southern zone; fallowing is a common practice to help maintain fertility. At any one time, a sizeable proportion of the cultivated land is abandoned. Cereal grains are the most common crops over the entire region, but in zones with more rainfall peanuts and cotton are important. Particularly, in the southern regions, dates, cowpeas, manioc, yams, sugar cane, and tobacco are produced.

Wood is utilized primarily from naturally-occurring vegetation throughout the region rather than from planted woodlots. This wood is the principal source of fuel energy throughout the whole region.

The region is rather sparcely settled by people. For comparison, the land area is about two-thirds of that of the United States whereas the six Sahelian countries have only about 10% of the population of the United States. If one includes the neighboring countries affected indirectly by drouth in the Sahel, the resultant total area is twice that of the United States and the population is 150 million (103).

Populations are increasing; growth rates exceed 2% in the Sahelian countries. Birth control is practiced by less than 1% of the couples. Some 80 to 90% of the population is occupied in agricultural tasks. Agricultural products account for the majority of the exports. The majority of the people live at subsistence levels, depending primarily on agriculture and animal husbandry for their existence (211). National populations vary from about 1.2 million in Mauritania to 5.5 million in Upper Volta. Life expectancy at birth varies from about 31 to 41 years. Generally less than 5% of the people are literate. Only in Senegal are more than 10% of the population living in cities of greater than 100,000 population. Gross national products for all the countries except Mauritania and Senegal are less than $100 per year per capita.

Cultural and ethnic influences have strong impacts on these peoples. More than two dozen cultural cluster types can be recognized in the Sahel-Sudan. The major culture clusters include the Tuareg, Fulani (Bororo-Tukulor), Senufo, and Songhai. Particularly in Upper Volta, the Mossi predominate, in Senegal it is the Wolof, in Niger the Hausa, in Mauritania the Moor, in Mali the Mande-type Bambari, and in Chad the Arab-type Shuwa.

These nations are characterized by a relatively undeveloped infrastructure in government, communications, education, and commerce. Within a nation there are generally five levels of structure including the region, the circle, the arrondissement, the canton, and the village. In urban areas, the commune and the ward replace the district, canton and village of the rural areas (211).

Civil administration, where developed, includes departments related to customs, animal husbandry, endemic diseases, gendarmarie, health services, justice of the peace, post office, railroad, schools, agriculture, rural development, import-export, water and forest, and weather stations. The governmental type in Senegal, Mauritania, and Chad would be considered a "single party", and in Upper Volta, Niger, and Mali it is a "military government." In recent years only Upper Volta has experienced a multiparty system. All of the countries have had changes at least once in governmental form within the last fifteen years.

Within each of the six countries the official language is French. But in most of the countries there are up to 24 different languages available. Arabic is a major language in Chad and Mauritania, Bambara in Mali, Hausa in Niger, Wolof in Senegal, and Mossi in Upper Volta. These major languages are common in the capital cities of each country, but in Niger, Songhai is also common. None of the countries has more than three major commercial radio transmitters; four of the countries use French in broadcasting. In Senegal and Upper Volta various other languages are utilized in broadcasting, particularly English in Senegal.

1.3 The Development Problem

In several areas of Africa there are examples of development projects that have failed because technology was not matched to the environment nor the people. Two examples are the provision of bore holes in the Sahel (see section 4.8.2) and some irrigation projects (see section 4.7).

Early after the independence of the Sahelian nations development programs were initiated to increase water availability by drilling deep wells, often equipped with pumps (104). Rules were initiated, but not enforced, for controlling the access of the animals to these wells. For example, a maximum grazing burden was not to exceed one bovine per five hectares per year. Furthermore, zones were set aside for herding communities taking into account customary rights. What happened, in fact, was that animal numbers increased rapidly and stocking rates exceeded carrying capacity by a factor of 2 to 3. There was no way to enforce the restrictions on utilization of a given well. The wells became available to all herdsmen. The end result was massive overgrazing and destruction of the vegetation resource leading to localized wind and water erosion. Permanent bore holes have resulted in denudation for as far as 20 km in some areas where grazing control was not practiced. Irrigation projects have been abandoned in some areas because they were not culturally acceptable. Intoduction of modern ideas of pastoral and agricultural economy come up against incomprehension, distrust, and even opposition of the people concerned if action is not taken to insure their active participation (58).

Sometimes developers seem to be seeking a quick technological fix to a complex problem. For example, the idea of large-scale reforestation to change the macro-climate of the Sahel region and to slow down the advance of the desert can be considered one without adequate thought or analysis. The area is incapable of supporting extensive forest. The concept of advancing deserts breaks down, on examination, to a problem of spreading desertification throughout large regions.

It has been noted that the major problem with studies made in the Sahelian zone is the inability or unwillingness on the part of most of its students to see the region in its totality (67). The region, for all its simplicity compared to many other regions of the world, still represents a complex series of ecosystems in which there are plant, animal, and human populations tied together in a web of energy flow and conversion. Failure

to recognize the inter-relationship of these populations, and the impact of climate and the external world upon them, is only understandable. When faced with complex situations many developers are tempted to single out for their attention an isolated factor, or at best a localized system of factors.

Many development projects have failed largely because ecological principles were violated, the projects did not adequately consider the social structure and the needs of the people, or adequate government support was not provided (40). Recent philosophies toward development are to take an overall "systems view." The thesis of this approach is that a system's view is necessary for rational management and development of the resources of a region or nation. The system in question results from an integration of all the living and non-living factors of the environment for a defined segment of space and time. It is a complex of man and environment forming a functional whole. Such systems have been observed for some time, and measurements have been made of various parameters and components in isolated studies. However, our understanding of such total systems is meager and we lack the predictive power necessary for control.

A system's approach or systems framework towards development provides an organizational and conceptual structure to assemble knowledge. It requires identifying the boundaries of the system, describing it to give its components, determining the most important kinds of variables flowing in the system for present concern, and determining what factors affect the flows. Then, it is possible to use modern modelling approaches to examine overall systems responses in relation to the individual processes and controls upon them. This offers the opportunity of optimizing the management of such systems. The utilization of physical and mathmatical modelling techniques and system's methods has greatly enhanced the ability to investigate both the individual and interactive behavior of a large number of separate components from large systems (70).

A thorough and unambiguous explanation of all the causes of deterioration in the Sahel is not available (103). The exact relationship of man, land, and weather are not clear. The magnitude of the effect of weather on different portions of this vast region are not known with certainty. A general examination of the problem, however, suggests three major interactive feedback loops of negative impacts and effects (212):

(i) The Sahel is plagued by recurrent droughts. Tribal behavioral patterns for survival, sustenance, and improvement, have built up cattle numbers exceeding the carrying capacity. Accompanying increased human and animal populations there has been decreased fallowing of fields, leading to reduced soil fertility. The increased human populations have reduced wood resources for fuel, leading to deforestation. Overgrazing and deforestation are leading to desertification. Increasing desertification reduces the productive capacity and increases the stress on the remaining land. And the cycle continues.

(ii) The region has low production, low output, and subsistence living conditions. These factors in combination with mass-elite gap, low produce prices bearing little relation to world markets, and lack of opportunities for saving, credit and investment, and lack of employment opportunity have led to secular and seasonal out-migration of people. The traditional sector has suffered for it has been heavily taxed. The traditional sector has suffered inadequacies in health care facilities, infrastructure, educational systems, and other social ammenities. Thus, the well-being of the region's habitat and inhabitants has deteriorated. The only form of savings has been in terms of increasing cattle numbers, and increasing cattle numbers is counterproductive, as noted above in (i).

(iii) Migration of people from the traditional sector and rural areas into the modern sector and urban areas has been much higher than rate of increased employment, thus causing high unemployment rates. When combined with minimum wage laws, over-valued currencies and low level of worker skills, this has adversely affected international competition. Furthermore, the over-population in the cities has led to inadequate housing, sanitation, water systems, health care and nutrition, and a poor quality of life among the city dwellers. Industrial policies are geared to foreign markets and prices of imports and modern sector products are high, thus market growth has been inhibited in the traditional sector, decreasing employment opportunities and increasing cost of goods.

2. OBJECTIVES

The objectives of this report are:

*to briefly report, review, and analyze literature on facets of the problem related to drought in the Sahelian countries

*to review and critique alternative development strategies and their consequences

*to discuss the concept of an extended Sahelian zone and its components

*to provide integrative and innovative suggestions for possible development strategies

3. METHODS

There is an impressive and extensive recent accumulation of literature on facets of the problem related to drought in the Sahelian countries (see section 7). Much of this literature is not in the conventional scientific journal or book form. Instead, it is composed of lengthy symposia reports, proposals for aid to the suffering peoples and countries, and national and international agency reports. Much of this literature is recent, being generated in the last few years during the period of intensive drought. This literature is supplemented with widely scattered technical journal articles written over a long period of time.

I have accumulated a considerable body of this literature through assistance of various sources, primarily the U.S. National Academy of Science, Office of Board on Science and Technology for International Development of the Commission on International Relations and from several offices in the U.S. State Department Agency for International Development. Additional suggestions for literature and copies of manuscripts came from the U.S. National Academy of Science Panel on Drought in Sub-Saharan Africa.

This literature was briefly scanned, indexed relative to the outline described below, and is listed in section 7. As the literature was scanned it was related to a frame of references outline (Table 1). An early version of this outline was critiqued by the Panel (mentioned above) and elaborated during the process of the review of literature. The outline in Table 1 provides a preliminary structure in which the Sahelian problem can be viewed in a "systems context." Particularly, it identifies major system components, the main kinds of flows of concern in the system and their state variables, the driving or external variables outside the system, and the sub-system processes related to the various kinds of flows through the system. Inter-relationships of system structure and function and man's impact on the system through emergency, short-term, or long-term developmental tactics and strategies are also considered.

Table 1. *FRAME OF REFERENCE OUTLINE: PROBLEMS OF CONTEMPORARY MAN IN A FRAGILE SYSTEM--THE CHANGING SAHEL*

0. INTRODUCTION
   - 0.1 Perspective on Problems of the System: Historical Changes; Current Changes.
   - 0.2 Rationale for Systems View--During Variables, State Variables, Rate Processes - Flows, Parameters Compared to World Dynamics Model and their State Variables
   - 0.3 Brief Example of a Problem Solution Taken out of Context.
   - 0.4 Idea that a Model Must be Simple.
   - 0.5 Boundary of a System.

1. THE SYSTEM AND ITS STRUCTURE
   - 1.1 System Components.
     - 1.1.1 Geography
     - 1.1.2 Climate
     - 1.1.3 Non-renewable natural resources
     - 1.1.4 Renewable natural resources
     - 1.1.5 Human resources - social, political and economic
   - 1.2 Main Kinds of Flows of Concern in the System and their State Variables.
     - 1.2.1 Problems of units
     - 1.2.2 Times for flows/1 week - 1 month: energy and water/seasonal: money/yearly: land use, population information/decades: influence.
     - 1.2.3 Energy flows and energy state variables
     - 1.2.4 Water flows and water state variables
     - 1.2.5 Population flows and population state variables
     - 1.2.6 Land use flows and land use state variables
     - 1.2.7 Information flows and information state variables
     - 1.2.8 Influence flows and influence state variables
     - 1.2.9 Money flows and money state variables
   - 1.3 Important Variables Outside the System
     - 1.3.1 Climate as a driving variable
     - 1.3.2 Man's inputs as driving variables
     - 1.3.3 Exports
   - 1.4 Interactions in the System
     - 1.4.1 A system diagram
     - 1.4.2 Geographic subunits
     - 1.4.3 Couplings of subunits

2. SUBSYSTEM PROCESSES AND FACTORS CONTROLLING THEM
   - 2.1 Selected Energy Flow Processes
     - 2.1.1 Plant growth
     - 2.1.2 Plant death
     - 2.1.3 Weathering
     - 2.1.4 Animal reproduction
     - 2.1.5 Animal maturation
     - 2.1.6 Animal growth
     - 2.1.7 Animal death
     - 2.1.8 Decomposition
   - 2.2 Selected Water Flow Processes
     - 2.2.1 Infiltration and groundwater
     - 2.2.2 Runoff
     - 2.2.3 Intermittent streamflow
     - 2.2.4 River flow
     - 2.2.5 Reservoir retention
     - 2.2.6 Evaporation
   - 2.3 Selected Population Flow Processes
     - 2.3.1 Immigration
     - 2.3.2 Natality
     - 2.3.3 Emmigration
     - 2.3.4 Mortality
   - 2.4 Selected Land Usage Flow Processes
     - 2.4.1 Maintenance of types
     - 2.4.2 Conversion of types
   - 2.5 Selected Information Flow Processes
     - 2.5.1 Education
     - 2.5.2 Extension
     - 2.5.3 Generation of information
   - 2.6 Selected Influence Flow Processes
     - 2.6.1 Transferance
   - 2.7 Selected Money and Product Flows

3. SYSTEM FUNCTIONS AND THEIR RELATIONS TO PROCESSES
   - 3.1 Responses to Climatic Changes
     - 3.1.1 Stability of agriculture
     - 3.1.2 Human and animal population movements
   - 3.2 Impact of Technology
     - 3.2.1 Population increases
     - 3.2.2 Resource development
     - 3.2.3 Population migrations
     - 3.2.4 Educational balance
   - 3.3 Impact of System Structure on Function
     - 3.3.1 Isolation impacts
     - 3.3.2 Comparative ecological uniformity
     - 3.3.3 Ethnicity, class, and power
     - 3.3.4 Geographic impact of river systems
     - 3.3.5 Power and population centers
     - 3.3.6 Comparative low productivity
   - 3.4 Limits of System Dynamics
     - 3.4.1 Irreversibility of manipulations
     - 3.4.2 Inherent time lags to change

4. THE SYSTEM, MAN, AND TOMORROW
   - 4.1 Rational Management - Living with the System
     - 4.1.1 Emergency measures
     - 4.1.2 Short-term tactics
     - 4.1.3 Long-term strategies
   - 4.2 Strategies in Relation to Classes of Problems
     - 4.2.1 Transportation and communications
     - 4.2.2 Dryland crop production
     - 4.2.3 Livestock production
     - 4.2.4 Socio-psycho-cultural-educational-health
     - 4.2.5 Technological and industrial
     - 4.2.6 Institutional-policy-economic structures
     - 4.2.7 Irrigated crop production
   - 4.3 Extensions to Other Man-Environment System
     - 4.3.1 Comparable physical systems
     - 4.3.2 Extension of the approach
   - 4.4 Updating the Viewpoint with Increased Knowledge
     - 4.4.1 Securing knowledge of structure and function
     - 4.4.2 Process of an structures for implementation into the framework
     - 4.4.3 Utility and utilization of the conceptual framework

4. ANALYSIS OF INFORMATION ON DEVELOPMENT

4.1 Literature Characteristics, with Special References to Development Strategies

The literature is highly variable in breadth, depth, and quality. This variability is perhaps greater, proportionately, than would be the case for conventional scientific literature. The relationship of the documents reviewed to the frame of reference outline is shown in Table 2 where the columns represent the sections noted in the frame of reference outline of Table 1. The rows represent the references listed in section 7. An entry in the matrix of Table 2 indicates that the report relates significantly to the particular outline topic. These entries, of course, are based on qualitative judgements.

The general availability of information in predominantly report literature is in the areas of strategies for development (see section 4 of the outline in Table 2). Relatively little information is available in this set of references on the factors affecting the processes accounting for the flow of matter, information, power, and land use (see section 2.1 through 2.7 in Table 2). Few authors have attempted to diagram the systems or relationships with which they were concerned. Few have thoroughly divided the countries or region into functional subunits other than political boundaries. Several of the references are bibliographies and should be consulted for much more information in the scientific journal and book literature (49, 77, 165, 198, and 200). Numerous acronymns and abbreviations were encountered in the literature search. The most common of these are listed in Table 3.

As has been noted in several of the recent reports, for example see (58), the emergency operations have brought together a large number of groups into the Sahel. Simply the interactions and activities of these groups of experts has created a sort of "collective memory" which has identified and transmitted information on a great many documents on the Sahel. Their collective experiences and knowledge have not been thoroughly documented. It is probable that an exercise of this kind will not be repeated and the recording and transmitting of this collective knowledge will be lost unless the opportunity is seized upon soon.

The references listed in section 7 have the following characteristics. The percentage distribution of reports according to kind is: 73% agency, task force and consultant, reports and proposals; 14% scientific journal articles; 11% symposia and conference papers; and 2% books. With respect to timing, for 1974 through 1971 respectively, there were 70, 16, 6, and 2% and 6% 1970 or before. With respect to size, expressed in double-spaced manuscript page equivalents, 11% were greater than 200 pages,

Table 2. Relationships of the references to the frame of reference outline in Table 1.

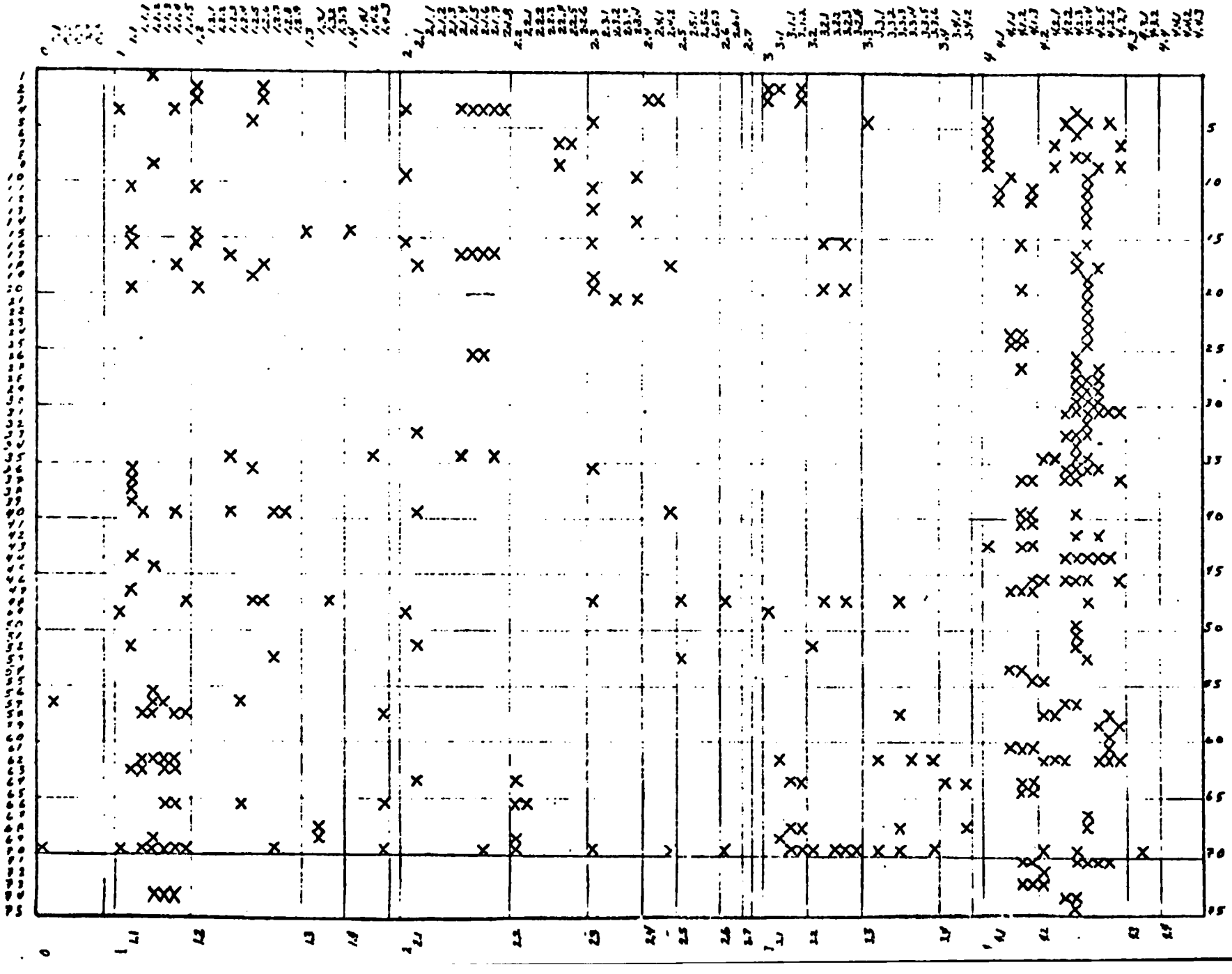

Table 2. Continued.

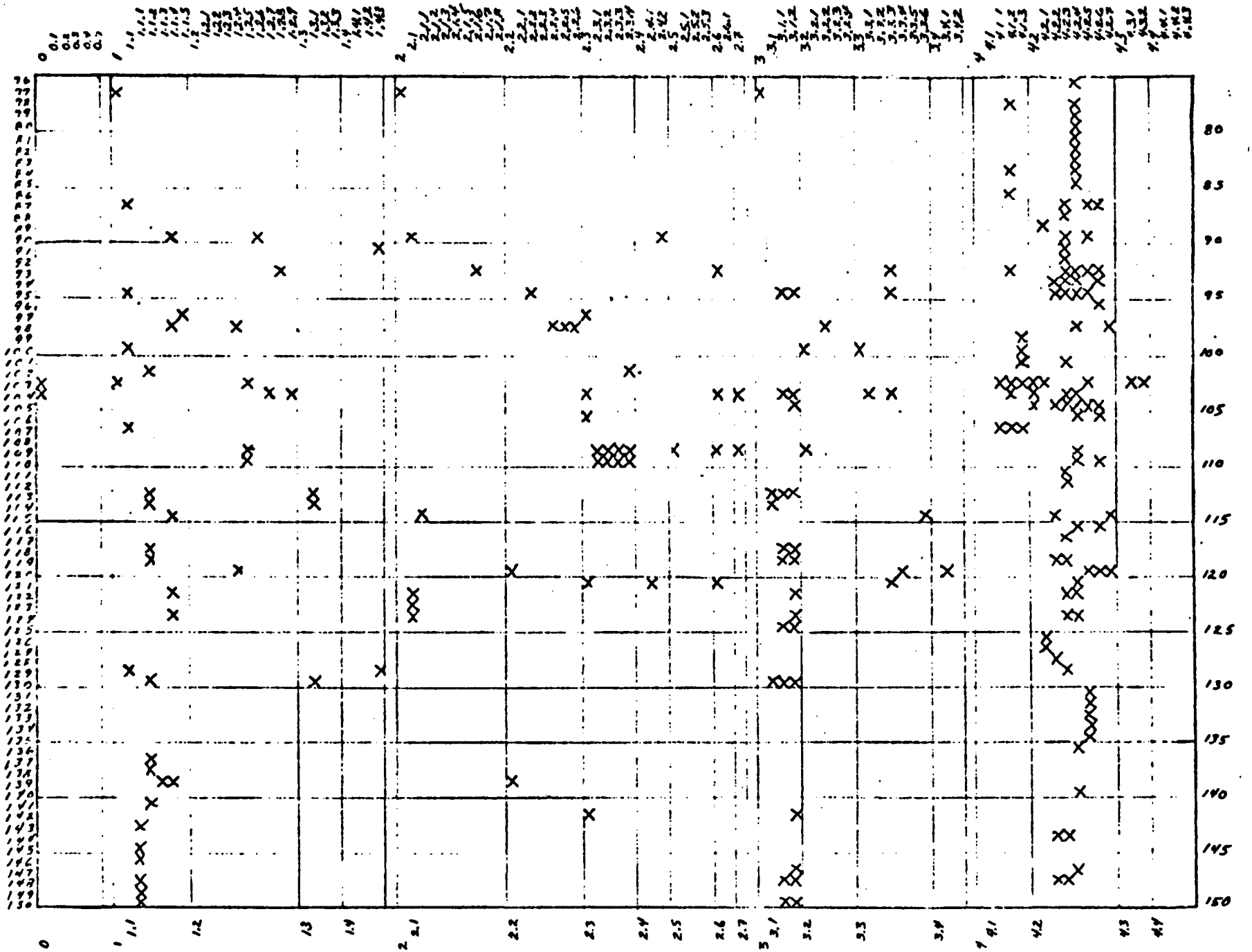

Table 2. Continued.

References 219 – 228 not directly pertinent to the frame of reference outline

Table 3: Some agencies and organizations concerned with the problem of drouth in the Sahel (approximate titles).

BRGM	Bureau du Recherches Geologiques et Minieres (France)
CEA	Commission Economic du Afric
CEBV	Comite Economique du Betail et de la Viande
CEPE	Centre de'Etudes Phytosociologiques et Ecologiques (Montpellier)
CIEH	Commission Inter Etat Hydraulique (France)
CILSS	Comite Inter-Etats de Lutte Contre la Secheresse au Sahel
CTFT	Center Voltaique de Reserche Scientifique
DRF	Drought Relief Fund
ECOSOC	Economic and Social Council of the United Nations
ELC	Economic Livestock Community
ENTENTE	Conseil de l'Entente (Interstate council-Dalhomie, Ivory Coast, Togo, Niger and Upper Volta)
FAC	Fonds d'Aide et de Cooperation of France
FAO	Food and Agricultural Organization (UN) Rome
FED	Fonds European de Developpement of the European Common Market
IBRD	International Bank for Reconstruction and Development
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
IDRC	International Development Research Center of Canada
IEMVT	Institute d'Elevage et de Medicine Veterinaire des Pays Tropicaux
IFAC	Institute des Fruite et Agrumes
IITA	International Institute of Tropical Agriculture (Ibadan)
ILCA	International Livestock Center for Africa (Addis Ababa, Ethiopia)
IRAT	Institute des Recherches Agronomiques Tropicales
IRCT	Institute de Recherche Coton et Textiles
IRHO	Institute de Recherche des Plantes a Huile et Oleagineuses
ISRA	Institute Senegalais de Recherche Agricole
IUCN	International Union for the Conservation for Nature and Natural Resources (Morges)
LCBC	Lake Chad Basin Commission (CBLT in French)
MAB	UNESCO programme on Man and the Biosphere (Paris)
OECD	Organization for Economic Cooperation and Development (Brussels, OCDE in French)
OCGEE	L'Organisme Central des Grandes Epidemies et Endemies Humains
ODA	Overseas Development Administration (Great Britain)
ODC	Overseas Development Council
ODEM	Office de Developpement de l'Elevage de la Region de Mopti
ODG	Overseas Development Group (Univ, of East Anglis, Norwich)
OMVS	Office de Mise en Valeur de fleuve Senegal
ORSTOM	Organisme de Recherches Scientific et Technique Outne Mer
OSRO	Office for Sahelian Relief Operations of FAO
PISC	Permanent Interstate Committee
RDFD	Rural Development Fund Division of Banque Nationale de Developpment de la Hute Volta
REDSO	Regional Economic Development Services Office (US AID, Abidjan)
SEDES	Societe d'Etdues pour le Developpement Economique et Social
SIES	Secretariat for International Ecology of Sweden (Stockholm)
SODELAC	Society de Developpement du Lac
UDEAO	Union douaniere des Etats de l'Afrique de l'Ouest
UN	United Nations (Headquarters, New York)
UNEP	United Nations Environmental Program
UNICEF	United Nations Childrens Emergency Fund
UNSSO	United Nations Special Sahelian Office
USAID	US Agency for International Development (Washington, D.C.)
WHO	World Health Organization (UN) (Geneva)
WMO	World Meterological Organization (UN) (Zurich)
WP	World Food Program of FAO

15% were 100 to 200 pages, 8% were 50 to 100 pages, 30% were 25 to 50 pages, and 36% less than 25 pages. The total volume is equivalent to about 21,000 manuscript pages!

A unique characteristic of the national and international agency and institute reports, as well as consultant and expert panel reports, is their lack of reference to previous information! It is clear from the phrasing of the reports that the authors have seen many of the previous documents, but these are seldom cited or referred to explicitely.

If one views the reports within a time series, it is noted that there is relatively little new in any given report. There is an incremental approach to developing ideas, a repetition of the same ideas and information and, unfortunately, this pertains to both what appears to be bad ideas as well as good ideas! Many of the reports I received for review had passed through two or three owners and had been successively photocopied or xeroxed so as to accumulate sets of interesting, and sometimes humorous, marginal notes from previous readers! During the process of copying and transmission there tends to be losses of the first and last pages of many of the documents.

Another feature characterizing a great number of the international and national agency reports whether by staff, consultants, or expert panels, is the lack of diagrammatic presentation of ideas. This does not seem to be a mode of communication for scientists and technicians in the international development field.

Many of the reports are prepared without summary or abstracts, which makes it difficult to read or sort them rapidly. Many of the reports are internally repetitive as well as time-sequentially repetitive.

Particularly for those reports from the governmental or intergovernmental organizations, there seems to be a time lag built in. Complex procedures for classification and declassification of reports are common, even when they do not appear to have highly confidential information.

Most of these reports have very limited circulation; that circulation is not generally noted.

The citations given in the references may not represent standard scientific referencing procedures. However, an attempt has been made to identify author, year, title, and source of reference as well as its length.

4.2 Emergency and Short-Term Measures

The degree to which rains in 1974 have affected crop and livestock production in the Sahel is yet unknown. There are indications animals are moving out of the southern region back to northern pastures. Still,

for the next two years, there will be need to provide emergency food, medicines, seeds and other supplies as has been done in the past two years to avert famine (103). Special attention must be given to refugees, many of which will not return to the Sahel.

It is controversial whether or not to maintain or increase animal numbers by emergency measures. One relief plan suggests priorities be given to systematic vaccination, anti-parasite treatment of young animals and again at weaning, and distribution of supplements and relief rations to young animals and females (93b). In contrast, other plans suggest that unless accomodations are made for grazing the excessive numbers of livestock outside the Sahel that some of the present herds should be sold.

Medium-term measures are suggested for a 5-year time span. These proposals focus on an early warning and alert capacity to allow people to recognize signs of impending disaster such as drought (103,169). Techniques proposed include improved weather recording and forecasting, data-gathering using satellite technology, improved mass communication in education programs, establishment of national grain and grazing reserves, and related measures which would substantially reduce human and productive losses from future drought.

4.3 Macro-Strategies for Long-Term Development

4.3.1 Donor and recipient aims.

Some of the main aims for development in the Sahel zone include increased food production, improved quality of life for rural and urban families, ecosystem stablization, increased exports, and increased opportunities for industrial employment and entreprenurship (212). Accomplishing these aims often requires large-scale capital investments in water control, irrigation, transportation, and agriculture -- these imply changes in the people's life style. But there are limited resources, domestic as well as donor, and choices will have to be made among alternative strategies (203).

Each strategy carries explicit and implicit assumptions that have enormous implications for national direction, institutional frameworks, political stability, social organization, and human lives (203). There are both real costs and opportunity costs for any development strategy. Major developments imply a degree of committment by the governments and donors for the next several decades. Here a conflict arises. Governmental leaders often want projects with short-term results for demonstration to their constituents (211). Donors may also want projects with short-term results because they do not like to commit funding for long periods of time. Thus "development as usual" is the traditional project-by-project approach, which is acceptable to both donors and recipients. But it may be counter-productive or at least inefficient.

Conventional categories of projects for development include improvement of rural water supplies, stock water supplies, small scale irrigation, soil and water conservation schemes, livestock disease control, forestation, fire break construction, village warehouses, road repair, inventory studies and surveys, technological assistance, and establishing and staffing national organizations for managing projects (169).

4.3.2 Extent and equity in long-term strategies.

Interest in long-term development is not common (103). This interest will not grow unless such developments can be shown convincingly to be directly related to human needs. Long-term developments must have clear, unambiguous goals. But donor organizations and nations need a measure of achievement in the short run. Thus, any long-term program must have intermediate objectives which have meaning for the lives of the people in the region in question.

To go beyond important but short-term humanitarian relief imlies major changes over periods of at least 10 to 20 years. The importance of not only the Sahel but also the Sudan region should be considered in relation to world needs for assistance and particularly competing African needs (103). A problem in long-term development projections is estimating the kinds and magnitudes of investments that are needed to have an appreciable effect on the lives and opportunities of the people of the region. The nature of various governmental and national interests over a long period of time must be clarified and consolidated rather than taking a piecemeal approach.

Improvement in quality of life for the population in the regions of concern is a major goal of many development programs. Yet many well designed and well intentioned proposals result in payoffs to a very restricted number of persons (104). It may be more beneficial to substitute actions which broadly benefit a larger population even though the net benefit to each beneficiary is less. Of similar concern is the strategy and development of equity. If it is not possible to benefit a large segment of the population, the groups to receive benefits should be chosen from the less privileged segments of the population (104).

Development will be an almost unending task in the forseeable future. There will be inequities between nations in terms of quality of life, availability of resources, and productive potential. This has been and probably will always be, but development is undertaken to minimize the differences. In the last thirty years people have sought simple solutions to the problems of development (212). There are not quick and easy solutions, for progress comes in small steps and only after much struggle, effort, and time. This also has ever been, and probably will ever be.

4.3.3 Classical alternatives of national and donor participation.

Leaders in the developing nations seek out various strategies which seem attractive to them (157). Often this focuses on rapid modernization, but it is also accompanied by significant stress. Special attention must be given to the control of the rate and process of change. National leaders are attracted to the most advanced techniques and technologies in the hope of making quantum leaps in overcoming severe environmental constraints. These strategies generally are not very well thought out upon careful examination. An alternative approach is pragmatic self-reliance. National leaders and donors should focus on mobilizing the labor of the people by means of social decentralization in planning and decision making and through re-organization of education and manpower training to provide independence from exclusive reliance on international aid, skills, and personnel (157). These are long and difficult tasks. This sort of grass-roots or broad-base technology approach affects the welfare of large segments of the population. In many developing nations, such approaches should be given priority over capital-intensive, sophisticated technologies of questionable feasibility and expensive in terms of future research, development and engineering costs (211).

Whatever the approach to development, any activities undertaken should only be done so as the host country concurs and provides assurance of wholehearted participation (33). It is also necessary, in many instances, to single out a particular agency to provide for planning, financing, staffing, and operations. The classical approach is cooperation between a single donor government agency and a single developing nation. The cooperation of other assistance agencies on a given project is welcomed only to the extent that they do not dilute the responsibilities of the action agency to produce results (33). It becomes difficult for a single external agency to deal with many countries individually. But many development plans should involve a linkage between areas in different countries, e.g., linkage between range areas and dryland farm areas and markets. In some instances, in a given country, the project may be concerned with an important sector of the economy. Then it may get good local support. Another segment of the same project in a different country may not be concerned with a main sector of the economy. It may not receive good local support. Thus, the overall project may be doomed to failure. This illustrates the need for a good organization among the national governments so that development projects will be optimal for the region as a whole, rather than for a given sector of one nation's economy.

4.3.4 Ideas for consolidated development.

These problems have lead to suggestions for "centers" or "consultant task forces" for different ecological zones (40,58). An example of the importance of this concept follows. Many of the nomadic people have moved through the Sahel independent of national boundaries. Thus, in effect, the nomadic people and their herds and the land they graze upon become

an international resource, problem, and opportunity. The same is true for many of the river development programs or the development of Lake Chad. If regional centers can be developed with inputs from the various nations, a more cohesive, rational, and integrated plan for development of the peoples of the region in a logical manner can be developed. This contrasts the piecemeal approach of individual agencies working with individual national governments or sections thereof. The regional centers could provide many facilities and services that would not need to be duplicated for each nation. The centers are needed to gather, store, retrieve, process, and edit data and conduct training -- all of which have region-wide meaning (40). With the limited number of scientifically and technologically trained personnel in any of the nations, such centers could provide expertise in service from their staff and consultant task forces for the various ecological zones in the different nations.

Such a development scheme requires not only the cooperation of the recipient governments but also the donors. Donors have been responsible for much of the piecemeal nature of project development. But there is evidence, as one reads the reports from the different agencies, that the donor agencies are communicating, even if they do not acknowledge the communication. The problem appears to be a more world-wide human interaction one. It occurs because individuals and institutions are content with, and in fact have shown a preference for, carrying out and protecting their own specialized, discipline-oriented program (70).

The conventional approach usually includes the introduction of foreign expertise, equipment, and personnel. This may be supplemented with counterpart personnel and at least "paper matching" of support monies. Many of the more successful development programs involve a sizeable educational component, but these are most successful if they are relatively long in duration.

4.3.5 Conceptual and analytical tools for development planning.

Some recent proposals for development strategy include a more systematic approach to analyzing problems (211, 212). In some instances a "framework of reasoning" may be developed which specifies the sequence of methods to analyze the impact of a given strategy. In one instance for agricultural development the steps were as follows (212):

division of the area into climatic-land use zones;
defining discrete activity levels;
selecting a mix of activities for agriculture;
allocating each land zone to a specific purpose;
determination of potential crop and wood production;
determination of potential livestock production;
determination of potential production of milk, poultry, eggs, and fish;
summation of potential production in terms of calories and proteins;

estimation of carrying capacity, surpluses and shortages relative to the human population;
comparing these results with existing situations;
determining steps for implementation;
determining impacts of the strategy on other aspects of society;
and iteration through this approach with alternative strategies.

More ambitious proposals suggest the use of interactive simulation modelling in strategy development. Simulation models are proposed as additional tools for the planners from the Sahel-Sudan region and the donor agencies to analyze the implication of technological choices (211). Although the number of experienced users of simulation models within these developing nations and donor agencies is relatively small, the approach has some merit. Simulation modelling in an interactive mode can be useful in sharping planners thinking by focusing on issues and tracing their implications, providing mechanisms for generating and evaluating new ideas and policies, and accounting for changes in the system or in the people's perception of the system (211). A sufficiently broad-scaled and long-range model could assist in evaluation of policies such as buying technologies at high cost vs. developing the country's own specialities at risk, cooperation among countries on technological policies, and governmental support and intervention.

Detailed computerized calculation models have been proposed which would utilize economic and demographic time series as inputs, and would make allocations to water planning regions and apply water use coeficients. Supply models have been proposed which are mixed-integer mathmatical programming models that can be used either to find least-cost sources of supplies or to maximize net benefits from the investment.

4.3.6 Impact of origin of report.

The environment of development report origin seems to have a significant impact on the structure and ideas of the report. If the reports are developed by expert panels or consultants from developed nations but working in the developing country, then the emphasis is on direct observation and conversation. There is relatively little backup data and information, and the report seems to pinpoint specific problems and often includes a variety of unique implementation concepts and limitations. If the reports are developed by institutions or groups in developed nations, but with limited access to the field, then the emphasis is on the data base and imaginative integration of concepts and ideas for unique plans. In this case enthusiasm reigns and the reports tend to be voluminous, packed with data, and wide ranging. In these alternative report development schemes, there seems to be a lack of significant input from scientists, managers, or technologists from the developing country. This is understandable becuase of the lack of such people in those countries, but undesirable in the long run. When the report is developed by a group of scientists in a developed nation it tends to include a large amount of technological

state-of-the-art appraches. When the report is developed by a team working in the developing nation, it is based on "tried and true" methods as applied in other development schemes, but sometimes lacking careful examination for the problem at hand and frequently lacking in imagination.

Certainly some compromise between the two approaches to developing management plans and strategies should be derived. And such a method should include in some way inputs from the persons in the developing nations.

4.4 Communication

Information about the Sahel is widely scattered. It has been proposed that a documentation center be set up for the Sahel (58). This documentation center would have all forms of information about the Sahel including monographs, articles, surveys, project reports, and legislation. This center would at first offer documentation services and subsequently would engage in processing of documents.

Documentation and analysis centers could provide economically for securing and distributing maps for grazing zone development. These could include standard topographic maps showing networks of roads, watering points, railroads, and population centers. Secondly, standard black and white aerial photographic coverage would be needed for thorough resource management inventory and survey. Thirdly, for dynamic analysis of the status of rangeland conditions imagery obtained from satellites would appear to have usefulness (211-215).

Such a center is necessary in the long-run view. There are few university bases or agency bases within these nations to provide this type of service. There is little justification, considering the lack of qualified personnel and other resources, to develop such centers in more than one location in the region.

Becuase of the mobility and dispersion of people in the Sahelian zone, communications regarding pasture, markets, prices, and related items are difficult. A center does not solve the problem of transmitting information, but would be useful in condensing and collating it prior to transmission so that optimal returns or benefits for the region are received.

4.5 Transportation

The transportation network in the region is minimal. With respect to development, construction of access roads to the existing road systems may be necessary to provide movement of feed into and animals out of the grazing areas (35). In some instances, properly constructed fire breaks can serve as access roads. Similarly, tse-tse barriers and watering facilities may need road construction. It is also necessary to train manpower to maintain and manage these facilities once they are developed.

The building of specific roads is a type of project of particular

interest to donor agencies. This is because the major thrust of the activities are terminal by nature, thus lending themselves to grant treatment. All too often, however, the follow-up maintenance and management superstructure and technology is not left after the initial grant.

4.6 Dryland Crop Production

People in the Sudano-Sahelian zones will try to improve production methods for crops (58). These will be integrated activities interrelating agriculture and animal husbandry and focusing on the cereal growing system, consistent with soil and water conservation, and aimed at animal production in connection with animal-powered cultivation and stock fattening. Improvements will involve research and development focusing on topics such as improved varieties and strains of crop plants, analysis of the relationship of agricultural systems to the cultural system, crop rotation systems, and fertilizer sources and substitutes. In the sub-humid regions this will also consider the use of catch crops, such as annual forages, to be planted on areas where the initial seedings fail (33). In the higher rainfall areas cropping practices may involve protecting against runoff by planting in contour strips, growing deep-rooted species and varieties that use soil moisture not available to shallow-rooted crops, and other technological and cultural practices which will increase yields of both food crops and exportable cash crops.

One strategy for consideration is the use of rotation and fertilizers in combinations. Industrial crops receive mineral fertilizers, usually at subsidized prices (58). Perhaps the procedure of year-to-year rotation from an industrial crop to a food crop should be undertaken. Thereby the food crop could receive some of the benefits of the carry-over effect of the fertilizer from the preceding year. This could lead to a recommendation that the government departments should only allow industrial crops to be grown in the Sahelian and Sudano-Sahelian zones as part of a complete rotation. This policy would lead to an improvement in food production, which means fewer imports and an increase in foreign exchange.

Early warning systems interrelate climate and crop production. Such early warning systems would be utilized for predicting drought and rainfall, particularly related to planting of cereals (31). Some consideration should be given to selection of superior varieties of seeds for each zone. For example, in the Sahelian zone where soil water availability is limited to a short period of time, species that mature rapidly should be encouraged. For the more southerly zones with somewhat longer rainfall periods, deep-rooted crops that utilize stored soil water may be advantageous.

There are some indications that farmers in the Sahel-Sudan zones should be encouraged to move into more productive areas, and they would gain through economy of scale (5). The farming of larger units will require changes in cultivation practices, particularly the use of animal power. For intensive crop production improved management will require more timeliness in cultivation, thus the use of animal traction (31).

Numerous practices are utilized in other parts of the world to store water in the soil profile by increasing infiltration rates through rough tillage, surface mulches, and sod crops. Some of these practices should be considered, particularly the possibility of summer fallowing as used in marginal rainfall zones of North America, Australia, and South America. Again, a problem of scale is important and animal traction becomes necessary.

There is little discussion in the literature on harvesting techniques. There is some indication losses from birds are important in some regions, but little information is available on insect pests, weathering, and rot. These problems should be considered further, but it is doubtful that much can be done for improvement here in an already labor-intensive production system.

4.7 Irrigated Crop Production

Various reports have suggested examining more use of water resources such as lake beds, seasonal runoff, and low technology input irrigation systems (31). These suggestions have included water supplies for pasture production related to livestock finishing. But success of irrigation schemes has not been great (58). This is particularly true with some of the small individual schemes involving resettlement and control of water flow. Results have not been as anticipated. This has lead to an emphasis on major dams on the Senegal and Niger Rivers allowing water flow control, irrigation, and possibly power generation. Problems raised by the major irrigation works relate to land tenure systems, organizational constraints, marketing of crops, size of land holdings, rent, and related items.

Lake Chad offers unique potential for development of irrigated cropland within the Sahel (98). Polders can be developed around the margin of the lake and water can be pumped through the polders periodically to leach salts through the soil profile. The polder soils are relatively high in organic matter and nutrients. Various crops, notably wheat, can be grown there successfully. The problem in polder development comes in selecting the approach. The alternative strategies are for the (i) development of large concrete canals supported on pilings with a pumping station at the lower end of each drainage ditch in contrast to (ii) the use of many small low-lift pumps in a network of shallow hand dug wells.

A major problem in all the irrigation development schemes is a change in cultural habitats that is necessary to make irrigation systems successful. The societies of the Sahel are much more resistent to changes demanded by development than one thinks they are; their natural tendency must be taken into account (58). A change, such as adapting to irrigation agriculture on a large scale, is of a fundamental kind. There is risk that the introduction of modern ideas here will come up against incomprehension, distrust, and opposition of the people. Necessary action must be taken to insure the people's active participation in the development. Some of the intensive development schemes, such as utilizing high inputs of technology in irrigation over large areas (as in the first

alternative for development in the Lake Chad polders) indicates there will be a lack of people to carry out these projects. That is, a lack of people with background and knowledge of that type of agriculture. There is potential ultimate development for 150,000 hectares in the Lake Cahd archipelago. In theory, such a production area could provide sufficient food from one crop for about half of the present population of the country (98). But in order to carry this out it would require extensive immigration into the area. The major source of people now seems to be from the Sahel where there is indication of an overpopulation. Yet, these people have very little background or inclination for agriculture, particularly intensive irrigated agriculture.

4.8 Livestock and Range Production

By far the greatest attention to problems of the Sahelian drought has been given to the inextricably interrelated topics of livestock and rangeland grazing. This attention is not just recent. Presumably the most ingenious and efficient way to make the best use of the Sahel was worked out by the nomads' ancestors (105). Over many centuries, various socioeconomic strategies have been evolved by the people using the arid and semi-arid regions of Africa and the Near East (40,216). Most of these people depend upon livestock for survival and to fulfill community needs. They utilize nomadic practices or transhumance as a necessary drought-evasion strategy. Some of these populations are based primarily on cattle or camels, others on sheep or goats.

The ecological and sociological conditions of may parts of arid and semi-arid Africa and the Near East are not immediately favorable, but have the general characteristics for development of sedentary livestock operations similar to those in the arid and semi-arid regions of Australia and of America. Many practices of the nomads, theoretically, could be combined with modern practices of range management, such as rotational grazing and control of grazing intensity, to lead to a real turnaround in the management of the Sahel.

It is not entirely clear how many animals the Sahel could carry. But problems in the Sahel have dramatically intensified over the past several decades in response to both population growth and to a shift from nomadism to a more sedentary existence (70). These changes in recent years were aggravated by techonological developments such as the use of the deep drilling, the creation of wells and bore holes subject to the high demand pressure. These have become the object of much bitter afterthought and in the past ten years there has certainly been a decline, if not a halt, of such construction (93b).

The problem is to develop a strategy for use of the Sahelian countries with increased livestock production as a central goal but consistent with the habits of the pastoralists. The pastoralists have three basic economic objectives that under conditions of communal and unrestricted land use resulted in overgrazing (171): (i) The herd is kept to secure milk for

the family diet and for regular cash income. This lead to keeping a high proportion of adult females in the herds. Thus, the herd was capable of rapid increase in periods of favorable weather promoting good grazing conditions. (ii) The herd provides savings for the family. Savings are only provided in numbers of animals. A large number of animals is the pastoralists insurance against loss during drought. (iii) Individual herders attempt to get maximum individual gains from communally owned rangeland. This leads to the strategy "we will get the most while we can before somebody else does."

Numbers of animals in the Sahel are as difficult to estimate as numbers of people. About 25% of the population of the six Sahelian countries depend exclusively or largely on nomadic or semi-nomadic animal husbandry for their livelihood (171). This represents about 1 million families of nomads, although data on family size are difficult to obtain. The definition of a nomad's family is also elusive, but they tend to be monogamous (216). In any event about 1 million nomadic families after the 1972-1973 drought had about 10 million cattle, 22 million sheep and goats, 1.5 million horses and donkeys, and 1.5 million camels (171). In the period 1970-1972 there was about a 40% loss in cattle and a 5% loss of sheep and goats. But numbers remaining at the end of the drought still exceed estimated carrying capacity of the Sahel for optimal production.

The goals of livestock development in the Sahelian countries may be summarized as follows (31): to increase production of meat and quantity of meat delivered to the final domestic and/or export market; in this process to maximize benefit to the largest number of people, producers and consumers, through mixed farming to increase production and to maintain and improve soil fertility; to contribute to the national budget and to contribute to the earning of foreign exchange.

Any plans for changing the grazing system in the Sahel should attempt to keep the real income to the herdsmen at least to that realized prior to the drought and should attempt to keep the gross national product at least equal to that prior to the drought (35). Various strategies have been proposed to accomplish these aims including the following: clearing and developing large regions of the Sudan zone to draw off as many as 1.25 million animal units from the Sahel grazing load; to develop water for optimal distribution of grazing within the Sahel; to provide for fire control to prevent wastage of forage; to supplement minerals to increase fertility; to control grazing so as not to over use the rangeland; and to practice selective culling of herds to emphasize productive efficiency. It is estimated that such strategies would allow double the pre-drought output of animals with about the half of the pre-drought herd size. It is uncertain whether or not this would bring the area into balance with the carrying capacity, but is certainly much closer than at present.

4.8.1 Animal husbandry practices.

Although the nomads have maintained grazing animals in the Sahel for centuries, human populations were lower, technology was not available to

assist with natural practices, and as a consequence several animal husbandry practices have been suggested as alternative or added procedures to increase livestock production. These practices relate primarily to animal nutrition and animal health. There is a need to increase fertility and to decrease calf mortality.

Reducing the stocking rate will have a major impact because it is probably energy or total dry matter that is most limiting to animal production. There is information to suggest that supplies of supplemental forage for feeding of breeding herds and weaned cattle would give particularly good returns (33). There are also suggestions that special attention should be given to protein and phosphorus deficiencies. Correction of these would greatly increase conception rate, calf crops, and survival rates (33). Throughout many areas of arid and semi-arid rangelands of the world phosphorus supplementation has been economically beneficial in livestock production. In fewer instances protein supplementation has, and even yet fewer instances, Vitamin A supplementation has been economical.

The impact of simply getting enough energy into the animals is illustrated as follows. It is estimated (35) on a herd basis that 50% of the feed requirement goes for physiological maintenance, the next 25% for reproduction, and the final 25% for milk flow, growth and fat storage. Thus, relatively small increases in total energy intake could have relatively large impact on production. One estimate suggests that a relatively small input of salt and mineral, other things being equal should increase the fertility level among cows in the Sahel by about 50% over the present level (35). It is estimated that the present fertility level is only 50%.

Bore holes have been introduced to increase the number of permanent water points. However, it is noted above, this may have led, because of lack of restriction of grazing use, to intensive overgrazing around the bore holes. Improvements in livestock production depend on the proposition that herdsmen will submit to self control in the use of the range and will protect it from intruders (35). This is related to the problem of land tenure, discussed in section 4.8.2.

Animal health problems from pathogenic organisms do not seem to be a major problem in the Sahel zone. They are definitely problems further south, however. Minimal animal health care requirements will include dipping, spraying, and vaccination on a recurring schedule (33). But the herdsmen must realize that eventually they will have to pay for the services rendered to animal husbandry by the government administration, particularly in the case of provision of bore hole water and veterinary assistance (58).

4.8.2 Range management in the Sahel.

Grazing management -- There are four major considerations in management of rangeland; these are selecting the proper intensity of grazing for optimal sustained livestock and forage production, grazing at the proper season for optimal use and maintenance of the range, selecting the

best species of animals to graze the range herbage, and securing adequate distribution of use over the range. The first and the last of these factors are certainly interrelated. With respect to the situation in the Sahel, it would appear that many of the herds are of mixed species. Thus selection of the best species suited to the herbage probably is not an important consideration. Probably the major problems relate to intensity and distribution of use.

The problem of grazing intensity is related in part to the strategy of the herders. In essence these nomads are subsistence dairymen (104). The herdsmen feel they need large numbers of animals to survive drought. They also need large numbers of animals to provide sustenance to their family and for produce for sale. A considerable part of their diet comes from dairy products rather than from meat products.

Watering points and control -- The introduction of a large number of permanent watering points, in comparison to the historical situation with many points only semi-permanent, has lead to more concentrated and more sedentary usage of the range. It has been noted that the herdsmen determine their areas of movement by the existence or absence of watering points with a permanent pumping facility (93b). This is in contrast to the historical situation when standing water was utilized in season, or the herdsmen drew water for their herds from shallow wells. At present in many instances herdsmen have set up relatively permanent encampments at some distance from the water and the herds are trekking each day to and from the water, crossing areas of completely overgrazed vegetation for as many as 5 or 10 kilometers (93b).

Presuming there is adequate control of grazing intensity, a large number of watering points would be ideal. It may be considered ideal if there is just enough water at a given point for an evening and morning watering of one herd (159). This suggested strategy of development seems infeasible in terms of cost of water development. In order to enable such a large number of watering points, watering would have to be done by using small bore wells dug by hand and pumped with hand pumps (159).

Many development strategies call for closing of some of the watering points at least temporarily. This would assure some opportunity for forage growth to provide for the following season. It is suggested that many of the watering points could be closed for one or two years to allow increase in vigor of the vegetation (93b). It is also suggested that all the wells could be shut down at the beginning of the rainy season. This would allow the herdsmen to disperse the herds over a larger area and decrease the grazing intensity around the permanent water points.

There is insufficient knowledge, however, as to the density of permanent and temporary water points at different times of the year, feeding or forage potentials, and the average distribution of livestock. A sequence of overlaying maps of water potential, feeding potential, and livestock distribution would be necessary, and this sequence would have to characterize the situation at different times of the year.

Stocking rate -- A livestock management practice suggested to aid in reducing the numbers to more closely match the carrying capacity of the range is to encourage herdsmen to sell all males and non-productive stock as soon as possible at the end of the rainy season (93b).

Although it is widely agreed that grazing control is the first line of defense against the continuing degredation of sub-Saharan pasture lands and an essential first step in establishing livestock productivity (26,171), there is not as much agreement as to the degree of reduction of grazing. One estimate suggests setting stocking initially to one-half that of the numbers in 1965-1970 (33). This would require restricting increase of herds that move back into the Sahel after the drought is broken. Secondly, although some indicate that no research is needed on control of livestock numbers (70), very little information is in the literature as to the impact of different intensity of grazing levels or seasons of grazing on the vegetation resource. Yet proposals have been made to utilize rotation grazing systems with four to five grazing areas, rotating every three to four years, and holding at least one area in reserve for abnormal years (33). The degree to which brush control and unpalatable plant control is needed is uncertain. Presumably there is need for demonstration trials of long-term nature throughout the different climatic zones on characteristic sites. For purposes of experimentation, these would have to be fenced pasture trials. Experience in other continents suggests that long-term trials in arid and semi-arid rangelands need to be continued for as many as 50 to 60 years to secure information to determine optimum stocking rates.

Control of grazing -- Intensity of grazing control appears to be largely an administrative problem and depends largely upon persuading or requiring people to sell animals and graze properly (70). Control cannot be imposed in the Sahel countries readily, because these countries are limited in their managerial capacity to implement intervention projects and programs (93b). Intervention should be linked with efforts to enhance or increase the supply of natural forage and there should be incentives or tradeoffs. The most important incentive is the exclusive grazing rights. The possibility of providing minerals and vaccines is another incentive.

The simplest way to increase the carrying capacity is to allow the vegetation to recover under simple protection from grazing (58). This may not be politically feasible for it is difficult to convince the herders that the area must be rested. It must be policed and the infrastructure may be inadequate to the task. The problem of communication, noted above, is severe. To reach this proud and roving people with new ideas and regulations is a formidable task. This is so even if the communication is to inform them of factors that would facilitate the grazing operations, such as forecasts as to available grass and water in the remote areas of their lands (70). There is a suggestion that such communication will require devices not generally in use. To communicate effectively requires sensitive perception of the culture and will require an array of printed and audio-visual materials that are not now available (70). This must be done in the long run for there will have to be limitations to the rights of usage and the subjugation of different zones and areas to management

control. Somehow this must be done in relation to the social structures that exist, for forms of organization that build on existing social structures are likely to be the most effective (40).

Most of the research and management advisors and government agencies have agreed to the need for control of grazing. But this will require that the herders secure the right of occupancy and controlled access to specific areas for development. This will be difficult to accomplish. There is not a formal land use law throughout these nations. Yet historically it is assumed the herders had a clear understanding of how to use rangeland in minimum conflict with each other (26). But the situation has changed with the introduction of new technology, increased numbers of watering points, and so forth.

The governments need to adopt and publish a range policy which will include guidelines for range development based on ecological principals (40). It has been suggested that no future range development project should be funded by international agencies until the recipient governments have issued a range policy, established an executive agency with authority to control and coordinate all the departmental activities in the range area, and develop the range extension service. It is necessary that they enact such legislation to prepare or caused to be prepared a project plan based on ecological and socio-economic studies (40).

The securing of land tenure, the establishment of grazing reserves, and the regulation and control of grazing are going to require massive changes in the practices of livestock production and in the interaction of the nomadic peoples with government agencies. This will require a great deal of background work and education. It will be facilitated if there can be demonstrational areas and if there can be interim rewards towards comliance. It is doubtful that such regulation can be imposed by force.

4.8.3 Grazing development in a finishing zone.

Most observers agree that (i) there must be a reduction on the grazing load in the Sahel zone, (ii) from the national and regional economic standpoint, livestock numbers should not be decreased overall, and (iii) it may be more feasible to transfer some of the animals from northern to southern areas than to attempt to utilize irrigated pasture areas or irrigation-grown feed in the Sahel zone. Livestock production should not be developed on irrigated lands (101). These lands can be used instead for grain production, thus shortening the food chain to humans. Consequently, to maintain livestock numbers yet to reduce pressure on the semi-arid ranges it is necessary to bring additional sub-humid grazing operations into effect. But acquiring rights of occupancy for controlled grazing in the sub-humid areas may provide a considerable problem because many of these areas are already utilized for crop production and for local herds (26).

The greatest potential for grazing development lies in the tse-tse zone (26, 31, 33, 91). Some utilization is made of this zone at the present. The fly lives in woody vegetation along stream courses. When livestock come in to water they are affected. Local management practices to

reduce the problem include various strategies (26): (i) bringing livestock to water only where there are extensive sand bars along the river and open areas; (ii) sheep and goat raising, especially the hair sheep, often is carried out along the river and stream areas where there is woody vegetation; and (iii), perhaps 2.5 months of the year, when the tse-tse fly covers a wider area due to flooding or other climatic conditions, the cattle are kept out of the area or else they are corraled during the daytime and smoke fires are built to keep the insect away. The animals which are much more resistant to infection from trypanomaisis include the Taurn or cross-bred cattle and zebu cattle (31).

The development inputs into the higher rainfall zones have clear advantage over equal inputs into only low and intermediate rainfall zones (91). Thus, the potential production may justify the relatively large cost of clearing areas of woody vegetation and spraying with insecticides in order to suppress the tse-tse fly (33). Such lands could be developed as range and pasture lands to receive livestock from the zones further north and provide for growing and finishing animals for marketing yet to the south. It is presumed that an intensive management scheme would be required here because of the higher rainfall levels and the potentially higher production rates. It is not clear from review of the literature, however, whether or not there is adequate knowledge for converting the vegetation systems from a tree and shrub growth into a pasture which will be freed of the tse-tse fly. It is not clear either how far away from trees and shrubs the tse-tse fly extends under different climatic conditions and seasonalities. This would affect the scale of operation and the shape of the land holding for such grazing systems. It is not clear what succession of vegetation would be induced under a continuous or rotational grazing scheme in these areas.

4.8.4 Transport, marketing, and slaughtering.

At present animals are trekked several hundreds of kilometers from the northern reaches of the Sahel zone to the area in which they are finally slaughtered and utilized in the sub-Sahelian countries. Even under the best of conditions this trek takes a severe tax of the livestock production. In many instances the trek route includes stopping at various points for grazing crop stubbles and refuse as well as utilizing pasture lands in the higher rainfall areas to the south. But in other cases it appears that lack of water and food reserves along the trek routes lead to considerable livestock loss. Strategies being proposed to alleviate this include water development, food reserves, and better holding facilities on the trek route (31). If there is an adequate chain of holding areas losses could be minimized.

If animals could be taken out of the northern areas at a relatively young age it would decrease the grazing load in the northern regions and allow them to be used as breeding areas. But price arrangement must be considered. There is indication that under the current price system approximately seven yearlings are worth the same as two 4-year olds (26).

The herds now have an imbalance of age and sex classes, as compared to pre-drought conditions, because of losses and sales occuring during the drought. There is an over-abundance of older age classes now in the herds. It is estimated it would take two years of almost no sales, except for old cows and bulls, to get the herds back into proper balance (26). But it seems that if there were growing and finishing areas in the southern portions of the Sahelian countries that it may be more profitable to utilize the Sahel itself for older stock. This suggests that the herds now may have near optimal age and sex composition for such operations. If grazing areas for growth and finishing of animals can be secured in the southern areas then the first priority is for removing steers from the Sahel herds (91). There is also a need for providing some dry-season and emergency grazing areas for migratory cow-calf herds at the southern reaches of the Sahel zone itself.

An additional advantage in utilizing the higher rainfall zones for some combination of year-round grazing and of finishing of cattle from the northern regions is that suitable slaughter cattle are more readily available (concentrated) and at shorter distance for purchase by butchers and export traders at all times of the year (91). The present system requires the movement of animals out of the Sahel primarily in or near the beginning of the dry season when forage becomes limited in the Sahel. Furthermore, if large mixed herds are maintained by a single family, the number of animals of appropriate age and sex which could be removed at a given time would be relatively small. It is expected that these factors will combine to make the flow of animals into market rather unequal seasonally unless there was the buffering of animals being held in the Sudano-Sahelian and northern Guinean zones for additional feeding before going to the coastal markets.

Within the high rainfall zone, there is a great potential reserve of undeveloped resources. Even though there would be extensive clearing of vegetation and control of the tse-tse fly, one must consider also using animals resistant to disease. The question can be raised are the animal races which are resistant to trypanosomisis also the most efficient in the northern Sahel. If an animal population is to be developed which is optimal for the total production scheme, it must be able to survive the relatively dry and poor forage conditions of the North in the breeding zone, have the ability to move readily over the long distances involved in the treks to the South, and be able to survive the insect pests and heat of the Southern zone. In the long term, some breeding and selection for animals with those characteristics would seem justified.

4.8.5 Use of crops, crop residues and fattening.

There is considerable migratory use of the Sudan zone by livestock from the Sahel zone in route to markets in the Guinea zone. But the magnitude of this forage supply and the mechanisms for its usage are not clearly indicated. The seasonality of this forage support, in relationship to the seasonal movements of the animals when forage is lacking in the North, is not clearly established. Historical agreements between different tribal groups, nomads and agriculturalists, should be maintained and perhaps

supplemented with purchase and storage of reserve feeds for drought protection for livestock brought out of the Sahel and for livestock from within the Sudan zones.

The idea of fattening and finishing is noted frequently in the literature. This needs to be clarifed. It seems unlikely that there is sufficient market demand and price differential in West Africa to justify the fattening of animals as is done in North American, parts of Western Europe, and certain other areas of the world. It is more likely that a grass-fat animal rather than a feed-lot fattened animal should be the goal. Given the cost of energy for mechanical cultivation of supplemental feeds of high concentrate content, it seems that such crops might best go into the human food chain directly rather than being passed through livestock. High quality pastures in a moderately high rainfall area with moderate supplements can produce highly satisfactory beef carcasses for the markets in the South.

It has been suggested that attempts should be made to provide for industrialization utilizing primary agricultural products as raw materials. In this process there may become available by-product feeds some of which if sufficiently concentrated, could be shipped to the northern zone for use as supplemental feeds for range livestock production. Other high-concentrate and high-quality by-product feeds could be used in the Sudan and Guinea zones in the process of producing grass-fat cattle. Even other feeds could be utilized in non-ruminant animal agriculture.

4.8.6 Integrated livestock production systems.

Feeder livestock zone -- Several agencies and groups have suggested that a good portion of the Sahel zone be utilized to produce feeder livestock (e.g., 104, 105, 158, 159, 211). Breeding herds would be maintained in the Sahel and animals at the age of 1.5 to 2 years would be moved south for further grazing in the Sudan and/or Guinea zones. Still, it should be possible for nomads to move considerably in the Sahel with the seasons as always. By selling more young animals, the herds would be smaller, better fed, better cared for. Water development would be undertaken so that, whether in wells or bore holes, water would be spaced out to service only livestock allowed to graze in a particular vicinity. Bore holes would be shut down in alternate years to rest pastures (105). Improved nutrition would result in the cows calving two to three times more often than at present, stock would be sold at age 1 to 2 years instead of the prevailing 7 or 8. This would provide for a great part of the relief of the pressure on the grazinglands. In any program of further water development, the herdsmen must become intimately involved with the rotation of water and pasture, with the establishment of collection of fees for use of the wells, and for all other managerial functions (104). Reducing the number of lactating females in the herd means alternative food sources must be developed for the nomads, especially in the dry season. If calf production if to be maximized, then little or no milk would be diverted for human consumption.

Grazing centers -- Under one suggestion (159), a strategy for the development of "grazing centers" in the Sahel is outlined. At a grazing center

information would be disseminated on the status of pasture, advice would be given to herders on best grazing routes, etc. The grazing center would also be a place where animals could be purchased from nomads by traders. The herders themselves should be involved in the development of veterinary, nutritional, and medical capabilities. Under one approach, this would be done in part by establishing field seminars for paraprofessional training in the bush (104). Herdsmen who have already exhibited skills and interest in each area would be invited to participate for further training.

One approach to development suggests that grazing centers would also be places which would raise supplemental feed under irrigation (159). This feed would be available to herds in emergency conditions or to finish animals before slaughter and possibly to maintain a breeding herd. It seems questionable that under normal years it would be possible to compete economically with the native forage for maintaining breeding herds by use of irrigated forage. This same plan suggests the development of slaughter houses at the location of grazing centers with carcasses being flown out or hauled out and secondary products beings hauled in. The relative cost of transporting the carcass vs. trekking or trekking plus hauling animals should be given careful consideration. On first examination, it would appear that it would be more feasible to truck and trek animals to the South than to develop slaughter houses and deal with the power, refrigeration, storage, and transport problems of handling carcasses.

Further activities at a grazing center would be to produce food for the center population under irrigation, provide holding areas for herds of passing nomads, dispense supplementary feeds and veterinary services to nomadic herds, and maintain a school for nomadic children. There would be an information network from center to center, sensing of seasonal pasture quantity and quality from satellite information, and transmission of this information to each herd, the herders having transistorized radios (159). It is doubtful that the cost of use of satellite information-receiving equipment could be justified for more than one place in the Sahel. It should be possible to transmit this information by a radio to relatively distant centers.

In any plan under which the herdsmen markets his sellable animals at one time of the year, in contrast to marketing a few at a time throughout the year, there is a difficulty under present monetary situations. At present, the herdsmen would not have a sufficient way to invest his money (104). Now he enters the market as he needs money to pay taxes or make purchases, etc.

Many of the ideas regarding centers would allow efficient use of the technical capabilities of a limited number of people. Integrated management plans could be developed for the regions adjacent to the centers including development and dispersal of water points under an optimal procedure, optimal movements of animals to areas with suitable forage, control of flow of water, regulation of pasture utilization and stock movements (if by no other means than keeping track of the radio locations where

different herds are located), developing planned pasture reserves, supervising or supporting or controlling artificial feeding, and aiding in control of bush fires.

Livestock finishing zone -- The herdsmen should have an interest, personal or financial, in what happens to the livestock after they leave the feeder producing region (104). Developing the Sahel region as a feeder livestock production region would alter the traditional relationship between the herdsmen and the farmers. Likewise, with more efficient livestock production, fewer people would be needed for herding in the grazing area. Both of these factors require considerable analysis because of the social changes they would introduce. In the proposed plans, once sold from the feeder producer areas in the North, livestock would go south where they would be further grown and fattened on higher quality pasture. They could be brought up to a weight of 800 to 900 pounds within two years instead of the present six or so.

One strategy would be to support the development of the herdsmens' entry themselves into the operations related to the continued feeding, fattening, and slaughtering and distribution of animals in the more southernly zones (104). This would require even further establishment of credit, skills, materials, and advisors for the herdsmen to profit directly from increasing the offtake of young animals from their herds in the northern zones. At present the herders probably have inadequate information about marketing their animals, and thus are at part at the mercy of traders who have more current information about market prices (58). Collecting into some form of a marketing and management cooperative. the herders could overcome this difficulty.

Any cooperative developed for centers within the Sahel or for grazing lands in the Sudan-Guinea zones would need to consider economy of scale. A physical development or construction unit should be structured around equipment capable of significant developments on grazing units over a relatively short period of time. About 8 years is the time required to fully utilize the economical life of heavy equipment (91). Full replacement of light equipment and transport vehicles will be required once during that time. One plan calls for developing grazing units consisting of 5 blocks for a total of 50,000 hectares and a management unit consisting of two such grazing units. Sufficient equipment would be obtained to complete two grazing units or one management unit per year and, during the life of the heavy equipment, some 16 grazing areas could be developed. This would require careful planning to coordinate the number of grazing units to be developed in the Sudan or Guinea zones along with the developments of grazing centers in the Sahel zone so that there was close match on the numbers of the livestock over time.

Time and costs -- The idea of a broad-scale, long-term approach merits immediate consideration in order to capitalize on the interest and availability of resources now in the world community. The plan will include goals of restoring the range condition and returning the pastoral peoples

to self sufficiency (158). This would require a major training component for, and staff input from, Africans themselves and agreement of governments so that such programs could become institutionalized. A 25 or 50-year perspective is reasonable for such a massive change in the way of life of the people, in the increased utilization of technology, and in opening up the south for new uses.

Considerable coordination of donors and sources of funds will be required to implement any long-term, broad-scale plan. Other than the short-term suggestions of developing regional teams of specialists, task forces, and committees, costs are going to be high. The above groups are needed to prepare timed-phased, long-term programs plans, to accurately estimate overall costs, to make national governments aware of the problems and opportunities, and to identify technical and other parameters (171). Considerable lead time is needed, not so much for identifying key range development areas, for basic studies, and for project planning, but in the development of national absorptive capabilities. It will be necessary to advise on and assist in the establishment of "national range development planning agencies," including establishment of training facilities (171).

Costs for broad-scale, long-term, semi-intensive range deveopment programs can be estimated at the outset from livestock projects in Mali and from ongoing projects in East Africa (171). Such projects would include grazing control promoted through pastoral institutions which serve as a medium for helping to implement grazing control activities. These programs typically involve capital investments of about $500 per pastoral family. With 6 million people primarily dependent upon livestock in the Sahel, there may be one to two million families of nomads. Such development would require $500 million to $1 billion. Thus some $50 to 100 million per year would be required for a reasonable development period. It is estimated (171) that this kind of program would generate an economic return rate of 15 to 20 percent and after a 10-year development period, gross family income might rise 30 to 40 percent above predrought levels.

4.9 Technological and Industrial Developments

The long-term development potential in the Sahel-Sudan region for achieving economic viability and growth has not been fully assessed (103). Such development is almost surely dependent upon introduction of significant technology and infrastructure and development of skills in the population. Assistance programs for technological and industrial development are extremely costly in terms of money and manpower. Most developing nations, and the Sahelian countries are no exception, have extreme shortages of both money and highly trained personnel. The shortages of highly trained personnel and the lack of a public acceptance of technical innovation will require a gradual development and buildup of the capabilities of the nations to absorb technology (104).

Several new techonologies related to agriculture have been identified in various proposals for development (211) -- monomolecular layers to decrease evaporation loss over water bodies, dirigibles to decrease transportation

costs, nuclear complexes to provide electrical power and fertilizer and water as by-products, greenhouse-irrigated agriculture, weather modification and precipitation augumentation technology, use of ERTS resource management sensing technologies, and so forth. Most of these technologies would contribute little real development to the majority of the people and would reinforce the dual modern-traditional system and the mass-elite gap. More appropriate developments related to agriculture are noted below, but any agricultural-based industrial development should be labor intensive, should be designed to create ancillary and local employment opportunities, should reflect balanced growth and response to the traditional sectors demands, and should be responsive to both north-south as well as east-west trade relations (211).

The costs of technological and industrial developments are substantial. For example, the development of the Senegal River basin alone to provide for irrigated agriculture, power and mining, is estimated at $3 billion (103).

Technological and industrial developments particularly key to the agricultural situation include the construction of livestock markets, loading chutes and platforms, commercial and sanitary control posts, a modern system of transport and distribution, and, in a few instances, feedlots and feed-mixing equipment for fattening livestock, slaughter houses and cold storage facilities, and factories for utilizing animal by-products and converting them to such products as soaps and feeds (93b).

The development of slaughter houses within the Sahel or Sudanal zone requires considerable planning. At present, many of the livestock are trekked into the Guinea zone for slaughter and utilization in the large coastal cities of West African countries, such as Dakar, Abidjan, Accra, Lagos, and Ibadan.

There appears to be some potential for development of mining, particularly as it relates to fertilizer plants. With improved agricultural production several processing industries could be developed, such as more cotton gins and a limited textile industry. The development of energy sources based on locally available materials other than wood would over a period of time have important economic and social as well as ecological impact (211). Units to produce methane from various cellulose products appear feasible and their development and application should be evaluated seriously considering the high cost and limitations of fossil fuels for these inland countries.

4.10 Socio-Cultural and Health Developments

Economic, institutional, and agricultural developments are highly interrelated with the socio-cultural and health developments in the Sahelian countries. Small cereal cultivators and pastoral herdsmen are the vast majority of the population of the Sahelian countries and development

should be aimed at improving the life situation of these rural populations (104).

Human aspects -- Health factors are extremely important in the well being of the people. It is estimated that at least 15% of all African children die before they are one year old, and in some of the more remote zones of Niger for example, 30% of all children die before they reach 5 years of age (97). Africa, as a continent, has the highest birth and death rates of any in the world, and 95% of the population is illiterate. The Sahelian countries represent some of the poorest within the African scene. Per capita income is less than $50 per year and the communication and transportation infrastructure is in very early stages of development.

Given these circumstances, small but intelligent changes can produce massive results in improving the quality of life. Generally, proposals for development should have low risk, low capital input, and high local participation. The main emphasis should be to improve the well being of the people through nutrition, health, and providing the funds to secure consumer goods. The emphasis then is to increase the amount of food the people have to eat with some reasonable surplus for commercialization and to facilitate a market system which will provide better return for labor (104). In this process, development should be aimed at arresting and reversing the progressive deterioration of the land resource base. Development should be aimed in the long run at improving the capacity of national and local governments to meet the needs of their own population.

A major fault with many development programs is that they fail to solicite and assure the active participation of the people in all phases -- planning, implementation, and management (104). One way of assuring participation would be to develop in-depth seminars with the people prior to any action. Such seminars would include discussion leaders, interpreters, and a cross-section of the people involved. The purpose, for example, would be to examine the people's view of range and water management and environmental degredation and other problems. Such seminars should result in a consciousness-raising. This increased interest level should subsequently facilitate not only the planning of development but also the implementation and management (104).

A variety of projects have been proposed in the human area (31). There are needs for examination of participant performance in successful and unsuccessful programs to derive information on approaches to be used in the future. Detailed study is necessary of the socio-economic behavior of the pastoralists including examination of acceptance and benefits of improved breeding stock and other technologies. For the cereal farmers, examination is needed of the role of women in the changing agricultural techonology which is still patriarchal, but in which women do much of the field work. Some problems needing further examination in the health area include the Onchoceriasis program.

Education -- A key to development in the socio-cultural area is education. The educational system in any developing nation is a source of manpower needed for the development. The educational system in the Sahelian countries shows all the characteristics of underdevelopment, low efficiency, high costs and lack of relevance to the needs of development (211).

To say that development of educational programs is needed is trite. A mix of both formal and non-formal programs is needed. Non-formal education programs may be closely related to major development projects and hence are short to medium-term in length and relate directly to employment opportunities and are likely to yield high social benefits. In a broader and less specific sense, development of sub-profressional technical training institutions is critical. It is important to use indigenous instructional manpower for these institutes, but such manpower must often be trained outside the region, perhaps in Guinea zone countries as well as the advanced technological countries of Europe, American, Asia, and Australia.

One proposal suggests a consortium of West African universities for research and training (211). Such a consortium becomes an attractive feasible alternative for generation of knowledge, formulation of policy, application and diffusion of technologies, and exploration, facilitation, and linkage of national, regional, and international agencies and programs. Considering political realities, however, such consortium would not replace the needs for a "Sahel Institute" or complex of centers discussed in earlier sections.

Health problems -- Within the health fields the infrastructure is poor. Yet a large number of health problems can be eliminated or greatly controlled through changes at the village level. Simple health practices and treatments, the improvement of public sanitation, and improvement in health education will bear large dividends. If many of these problems can be handled at the village level, then referral and subsequent movement to the dispensary and hospital level will be facilitated and better organized.

Proposed health plans focus on individual departments of given nations as models of what might be done. Thus the Difa department of the Lake Chad basin in Niger has been singled out as a starting point for such a health program (97).

Nomadism, sedentirization and urbanism -- The position of cattle in the national economies cannot be overlooked and thus an examination of the nomadic practices and their relationship to sedentary agricultural practices is critical. Cattle earn a great percentage of the income for foreign exchange within these interior nations. The system of production of cattle has caused the herders to subject themselves to the most rigorous hardships and deprive themselves of many of the economic and social institutional services including banks, personal health services, and schools (93a). Yet these people, individually, are not wealthy nor necessarily healthy

and they are in fact locked into a poverty system in an industry that is detained under their very pressure. Change is imminent and necessary, but the key to this change is finding and implementing innovative systems acceptable to the herders themselves. It should be noted that worldwide traditional nomadic grazing systems in steppe and savanna lands are based on procedures that most closely resemble the wild grazing animals (70). During much of the year the people and the herds are dispersed over vast regions. Local concentrations occur during the dry season, but this is in the period when the vegetation is least vulnerable to the effects of heavy grazing.

To restore the range and further develop it in the Sahel and the Sudan, the herdsmen must be willing to submit themselves to a new level of self-discipline in using the range, both individually and collectively (35). Yet these are alien and almost abstract cultural concepts for these people. The belief by some (35), however, is that the herdsmen will cooperate if they are consulted and included in the development schemes from the beginning, if they are given some legal assurance of exclusive land tenure, and if they are allowed to do their own policing and enforcing. There is a need for training herders and informing them of the management practices necessary to interact with techonological developments. There is also need for training some of the pastoral people for work in other trades. If economy of scale is to be realized, certain minorities living marginally from livestock are destined to disappear as producers unless they are regrouped among more dynamic elements.

All of these changes suggest a need for detailed analysis and study of the strategies, motivation, and behavior of pastoralists. Such information will be needed to prevent resistance to proposed changes (40). Among the factors needing examination, and which have been proposed for study, include the following: the demographic structure of pastoral populations, birth and death rates at present and in the recent past, immigration and emmigration, and traditional birth control methods. Studies are needed of the methods of distribution of stock wealth within the societies, in relation to class or caste structures, and on the way animals are used to build up social relationships. Studies are needed on the traditional system of resource ownership and management, particularly related to water and grazing. Examination of the efficiency of the nomadic herding system should be made carefully, with special attention to determine if the traditional systems allow grazing reserves or rotations in any methodical pattern.

Rural-urban shifts will have an increasing impact upon these nations. There is a higher rate of population growth in the urban settings than in the rural settings. This appears to be both due to immigration into the urban setting by rural peoples and perhaps higher birth rates (31). It is estimated that the rural population total growth rate is only one-third to one-sixth that in the urban populations of the Sahelian countries. The results, related to agriculture, are ominous. Formerly, the rural populations had to provide food for their own families plus perhaps an

additional 10% of their population size to account for the city dwellers. Now the rural families must provide food for themselves plus about 20% over their population size to provide for the urban dwellers (31).

4.11 Institutional, Policy and Economic Structures

Needs -- Only major investments which change the fundamental nature of the economy of the Sahelian nations will break the cycle of degredation and increase of poverty of the people (103). These investments are permeating and must be accompanied by major policy changes. Monetary and fiscal . policies must be modified and expansion of monetary institutions must be developed in the rural areas (211). Investments must be made to allow these areas to change from a predominance of subsistance farming and nomadic herding to include more intensive, irrigated, market-oriented agriculture (103). Investments in water development should be time-phased and multi-level, including large dam projects as well as smaller irrigation developments of polders, local tapping of aquifers, and related practices of water-spreading and water control as flood waters recede over vast plains.

Local capacity for implementing technical-organizational solutions must be increased and this requires mass communication, strengthening indignous authority structures, and extending structural mechanisms of mobilization (211). Such mechanisms include voluntary associations, cooperatives, schools, military, local governments, community development workers, etc. Investments must be made to train hundreds of officials and thousands of other persons in the Sahelian countries so as to enable the governments to plan and implement development programs at all levels on a much greater scale than heretofore possible (103).

One of the key features of the countries is that they are primarily landlocked. Thus, considerable investment must be made to open up the interiors of the countries, i.e., to couple the interiors to main markets along the coast of West Africa through the development of railroads, roads, and better river navigatability. As transportation systems become developed, market control and development need establishment for cereals, fruits, and vegetables as well as for livestock products. Market systems must include price stablization as well as analysis of demands for food products.

In all of the above developments care must be taken so as to build upon the strength and existing structures, as limited as they may be. In some instances, there is infrastructure to build upon. For example, in agricultural research, it has been noted that lack of operating funds more than deficiencies in structure curb the ambition of researchers (93b). Existing stations should be drawn upon in developing a network of research and demonstration areas to carry out programs of interest throughout the Sahelian zone.

Strategies -- Governmental approval and participation is essential in any development program related to institutional, policy, or economic structures. A suggested approach is as follows (196). At each stage of

development of a program there should be a presentation of the program, a response by the government, and then an action plan would be prepared for execution by the government. This is a parallel effort; development program resources are applied in parallel with the government structure at each level of responsibility.

The need of governments to operate in parallel with development programs is particularly true in the grazing situation, for many policy and legal changes are necessary. In the development of new laws related to grazing the following factors should be considered (93a): (i) The principal of "most rights" should be incorporated. The literature and sentiments seem to favor the traditional nomadic herdsmen, but in practice the sedentary villages seem to win out in use of grazing lands. A law should be developed which would classify and rank claims to public grazing lands; (ii) The principal of "social equity" should be considered when herd reduction must be made. Perhaps a minimum herd size could be established below which no member would be forced to reduce. Perhaps a maximum herd size would be established above which could not be exceeded until the other members of a region or cooperative had raised their herd sizes to some given level. For each region or cooperative there should be exclusion of non-members or those with subordinate rights; (iii) The principal of "trade-offs" should be considered when reducing the numbers of livestock in the Sahel to match the long-term carrying capacity. Such trade-offs could include the preferential use of new range sites taken from forest reserves or made accessbile by developing water or by clearing the tse-tse fly.

The above are but a few factors to be considered in land development. The governments of the Sahelian countries have only recently acquired these lands in public trust. The use of the lands, of course, should be dictated by national needs and aspirations, but there is a responsibility for the conservation and perpetuation of the land. This responsibility should be transmitted to the users so that they are dually responsible.

It has been proposed (171) that range development planning agencies be established in each of the Sahelian governments. These agencies could work with a regional or international planning group and could adapt overall regional plans to particular conditions in each country. Development projects could identified and prepared by a regional team of specialists, but projects would be implemented in cooperation with the operational government agencies at a national level. Perhaps a 5-year period of joint operation of development projects would be undertaken on any particular site, with the management becoming fully governmentally operated after that time. An advisory or review group in an international office would provide assistance and review to the national povernments once they fully took over the development projects.

The six Sahelian countries have already shown an indication for intensive cooperation by the development of their committee CILSS (Comite Inter-Etats de Lutte Contre la Secheresse au Sahel) (169). This committee is headquartered at Ouagadougou, Upper Volta, and facilitates the planning and conduct of

medium and long-term development efforts. The fostering of this or equivalent groups should be considered seriously. This is because when there is an integrated international program, projects are identified at the highest level of the government, and it brings to bear more resources on the project (93a). In the case of range and livestock projects, ministeries of agriculture, interior, parks, forest lands, and police may be involved.

The investments and plans noted above are so large that they cannot be undertaken by any single donor organization. There is considerable need for combining international investments that will make possible the sufficient scale, scope, and integration of development needed to bring about changes in the quality of life of the inhabitants. Such international cooperation among donors and recipients is fraught with the usual complications. Each donor wishes to identify a particular project or program they can "call their own" in such an effort. Perhaps this indicates further the need for the development of an institute of the Sahel which, in essence, would be a "think tank" for ecological, sociological, agricultural, political, and technological planning for the region as a whole. Even though such international cooperation faces organizational and operational difficulties, the Sahel offers one advantage. There are a minimum of political and strategic overtones, thus allowing the unique opportunity for various nations to cooperate to play simply and outstanding humanitarian role (103).

Example from East Africa -- As an example of a development program which would require various institutional, policy, and economic structures to be modified or developed, one can consider the range development program. One can also take numerous lessons from range development programs for the semi-arid and arid areas of Kenya (171). These programs began in 1953 and for ten years were quite successful technically. Still they lacked support of the pastoralists, and the programs collapsed with the advent of independence. Since then, more attention has been given in Kenya to win the support of the pastoralist. In areas of high rainfall and high production potential pastoralists are forming more group ranches which will enable them to gradually settle and become fully commercialized livestock producers. In the more arid areas, the semi-nomadic or nomadic ways of life is maintained, but provisions are made for the appropriate support of this way of life and production system.

Range development units in the Sahel should be selected so that the units contain the following (171): reliable dry season grazing; a balance of rangeland types allowing seasonal grazing movements; a network of permanent and temporary watering points; acceptable inter-tribal boundaries; acceptable size and shape and relationships to the topography of the landscape and existing features such as roads. Each of these development units would have the ultimate aim that they would become a self-contained group of ranching units with registered members and an elected board of directors.

Some principals to be applied in developing rules for grazing include the following: rotational grazing so that no one area is grazed for more than five consecutive months; dry-season grazing lands are used during the first half of the period by transistional grazing and the second half of the period by resident grazing; camel, sheep and goats are not allowed on the dry-season grazing areas, they are reserved for the major economic animal, cattle; and, development of an alternate movement schema in case of local or general drought.

The above types of developments and principles have lead to major gains in economic production in Kenya. These developments resulted in sales exceeding five times the amount of the pre-development situation, and cash incomes per family four times as high as pre-development situations. Operating costs, after the three-year investment, were estimated at about $1.80 annually per stock unit, and the internal rate of returns was 16%.

4.12 Extendability of Approach

As noted in section 1.1, harsh environments of the world for humans are the borderlands of snow and desert. When these environments coincide with isolated, independent nation states of Africa or Asia, they constitute most of the set of the world's least developed nations (157). Lessons learned from man's impact on the Sahel are not unique. For other parts of Africa growing ecological imbalances portend similar crises (103). Various nations to the south of the Sahel have arid and semi-arid lands. Portions of Botswana and southwest Africa have equivalent zones. To the north of the Sahel, semi-arid lands with generally similar characteristics are found in Morocco, Tunesia, Libyia, and the UAR. To the east portions of Kenya

Ethiopia, Somalia, and Tanzania are similar. Directly to the south portions of the border countries in Nigeria, Ghana, and Cameroons face similar problems and are becoming conscious of their implications. Development efforts in these several areas could profit from lessons learned in the Sahel (70, 103).

Some donors are beginning to ask questions about the logic of fragmented projects. For example, the US Agency for International Development has a policy directive calling for strong emphasis on "core problems" (70). These problems are listed as fundamental, multi-faceted problems, common to more than one country and affecting significant numbers of people. Focus on a core problem encourages an integrated approach to problem solving. This should avoid many of the pitfalls of single-purpose developments, and it facilitates the mobilization and optimum utilization of scarce financial and manpower resources. There are few test cases of implementation of this approach, however.

5. SOME PRELIMINARY CONCLUSIONS

5.1 General Considerations of Development

5.1.1 Assumptions regarding changes.

In making these preliminary conclusions, I start with several basic theses:

(i) Change is taking place and is inevitable in the Sahel. Changes in climate will occur in the Sahel periodically as they will in any other semi-arid area of the world. It is generally but not unanimously agreed that there is no strong, unequivocable evidence that there is a great directional change in the climate, only that now the Sahel is experiencing a recurring drought.

(ii) It is evident that the population is increasing in the Sahel and related zones to the south.

(iii) It is clear that agricultural production is limited by environment and, in the case of livestock production, overstocking can have a severe detrimental effect on the productive capacity of the rangeland in normal years as well as in drought years.

(iv) As animal and human populations increase in these countries the land use pattern is changing.

(v) Changes in population density, changes in food availability per individual, changes in technological innovations and urbanization all influence environmental quality.

Given that changes are taking place in climate, population, agriculture production, land use and environmental quality, several questions can be asked: What are the inter-relationships of these changes? What are the limits of these changes? How can one facilitate living with, responding to, and affecting an orderly change?

5.1.2 Integrated development programs.

Cautions toward development are noted in many parts of section 4 and the timeliness of an integrated development program is emphasized. Several factors favor the idea of an integrated development program, particularly in light of the limited amount of manpower and expertise to undertake these efforts within the Sahelian nations. Such an integrated development program should capitalize on the agricultural potential, both of the rangeland and the cropland, in the Sahelian countries. Such a program should capitalize on the considerable international interest in the Sahel. It has been noted that there is a considerable "collective knowledge" in and among the many donor and inter-governmental agencies as well as in the national structures. There has been a high degree of interaction of scientists and technicians and governmental officials in recent years, brought about by

the severe drought. There is also indication that the Sahelian nations recognize the magnitude and complexity of their problem and recognize the advantages of working together. With the participation of the governments of the Sahelian nations, it is possible to prevent the "development from above syndrome" which fails in so many instances (226).

5.1.3 Constraints and interrelations.

In section 4.3 macro-strategies for long-term development are reviewed. In section 4.4-4.11 many of the proposed development plans are reviewed and critiqued, largely on an individual basis. Yet much further attention must be given to these proposed plans to determine how each is constrained by social, economic, biological and physical limits. The inter-relationship of proposed development programs must also be examined. What are the impacts of projected development programs upon one another? What are the optimal uses to be made of internal and external resources in accomplishing these aims over the next 25 years?

5.1.4 A view of systems within systems.

In taking a system's view of the Sahelian problem it must be recognized that each system is imbedded with yet a larger system:

(i) At the smallest geographic scale, one can consider the important individual ecosystems or ecological systems. The ecosystem has both abiotic and biotic components. Important abiotic components are climatic, edaphic, and hydrologic. Important biotic components are producer, consumer, and decomposer organisms.

(ii) A given nomadic unit would utilize a large number coupled ecological systems into what would be called a "grazier system." In addition to multiple ecosystems, the grazier system would also include management resources.

(iii) A regional system would be made up by a complex of grazier systems, other resource systems, social system inputs, and legal-economic controls.

(iv) A national system would be made up of multiple regional systems, additional legal-economic controls, and policy strategy controls.

(v) A coupling of the nation systems would comprise the international system, the complex of the Sahelian countries themselves.

Separate problems and questions can be raised at each of these levels of aggregation of systems. At the ecological system level important topics to consider include: the long-term nature of grazing and its impact on nutrient depletion of soils; examination of the stability of the resource and determination of indexes to measure such changes; censusing procedures perhaps using a multi-spectural scanning approach with satellite imagery; development of reference areas for measuring trends in range conditions; better definition of optimal herbivore mixes for different vegetation types and seasons for efficient reproduction; determination of the impact of grazing intensity under climatic fluctuations.

One possibility which should be explored in relation to use of the Sahelian zone, is that of considering a new land use concept for the arid, semi-arid, sub-humid and humid areas as a complex. This might require putting up to the 25% of the land in some zones into strategically located "multiple-use grazing commons." This would require an analysis of the distribution of people, the transportation network, grazing capacities, depleted areas, and rainfall patterns, all over time and space to arrival at optimal land use plans.

One approach would be to devise an incentive scheme in which groups of graziers (representing tribal or sub-tribal groups) would be allowed to share the use of these common grazing lands. Movement of animals from the user group areas to the common areas would depend upon range, animal, and economic conditions. But especially it would depend upon the present and predicted weather conditions. To set up such a movement plan drought must be defined and probabilities of inter-spatial correlations of rainfall must be quantified. Rather than removing all the graziers from the area in drought times, with such grazing reserves some livestock could be maintained in the northern regions. This eventually would lead to a semi-nomadic type of operation rather than a completely nomadic or completely sedentary operation.

5.1.5 Relevance of other efforts.

The Sahel, at present, is largely conditioned by an agricultural economy dominated by pastoralism and cereal farming. Yet there are many possible developments that are compatible with these agricultural industries, particularly in the areas of manufacturing and mining. Any of these developments, agricultural or industrial, should proceed on a sound ecological basis and with knowledge of past successes and failures elsewhere in the world. Considerable experience, data bases, models, and expertise exists in the ecological, natural resource management, and agricultural disciplines based on work with situations similar to the Sahel. There are numerous other experiences of use and abuse of ecology in international development (226, 227). It is recognized that the ecosystem is the basic unit in natural resource management (223) and understanding this concept is critical for rational development of the resources. There is a great deal of background work on arid and semi-arid ecosystems, much of this having been conducted during the recently terminated International Biological Program (224). Grassland and desert ecosystem studies have been conducted as part of this program in several climatic zones in various continents. These studies have examined ecosystem structure and function and responses to management and manipulation stresses. In many instances mathematical models have been constructed to depict the functions of these systems and their responses to stresses imposed by climate or man. These models have major components useful for the kind of management planning studies needed on Sahelian rangeland. For example as part of the studies in the United States, various field, laboratory and modelling investigations have been made of desert grasslands (about 230mm annual precipitation) and shortgrass prairie (about 300mm

annual precipitation) and other grasslands of successively higher rainfall zones (224).

5.1.6 Use and abuse of a systems approach.

A major element of the development problem in the Sahel is that of renewable natural resource management involving simultaneous consideration of many variables. This presents staggering complexity to the decision maker. There is evidence to suggest that recent tools from operations research and systems analysis can be useful in the planning process. Numerous examples were proposed for the use of a "systems approach," even though there were inconsistencies in definition and application (211, 212, 214, and others). If these approaches are understood only to be tools to supplement time-tested procedures in planning and development, they can be extremely useful (219, 221, 222). Simulation and optimization models, modern computational tools, and system techniques can be useful in aiding large-scale system decision making (219). Combining simulation and optimization modelling techniques may be of value in bridging the gap between utilizing the information from biological, agriculture, and ecological fields (from which many flow equations must be built for the simulation models) and the pragmatic problems of the field resource planner (as in optimization models). Such techniques can be used to transfer technology from one region of the world to another. Such techniques are also useful to replace some direct field experimentation, which is much more time-consuming and costly. Systems techniques can provide background information for making decisions and possibly even for legislation.

5.2 Elements of a Strategy

The basic strategy proposed is to develop an improved economic and human welfare situation based on integrated livestock production and agricultural production. The plan is to integrate livestock grazing in northern and southern regions. This will require development of grazing reserves in both regions and development of new grazing areas in the southern regions. General and overlapping geographic divisions are considered here: arid and semi-arid, semi-arid and sub-humid, sub-humid and humid. This strategy would require a planned movement of animals and leads to improve rail or truck transport in some areas, development of slaughter plants in the southern zone, utilization of intensive irrigated agriculture for food production, and use of industrial process byproducts concentrate feeds for livestock production on grazing lands. The general thrust of this plan is illustrated in Figure 1. The zones for livestock and crop development are described below.

The arid and semi-arid rangelands systems of the northern portions of the Sahelian countries would be developed for livestock rearing units. On small areas there would be irrigation developments for food production, new employment, and occasional and localized forage production to assist the livestock industry, particularly in times of drought. The rangelands would be grazed under a system of cooperatives or centers where education, health, and financial services would be provided.

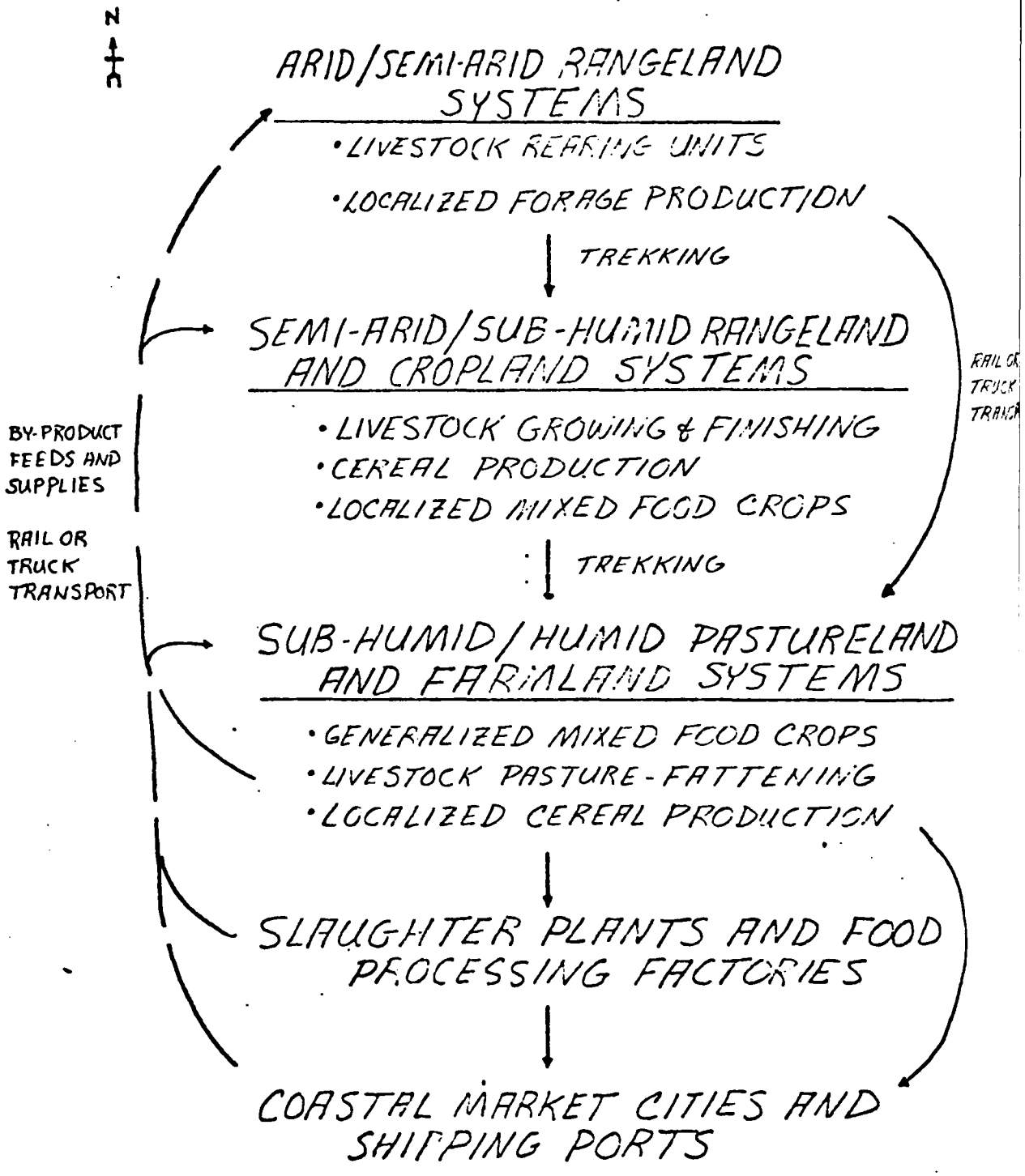

Figure 1. Examples of flows of primary agricultural products from north to south and flow of industrial by-product feeds and supplies from south to north through different climatic zones under an integrated development plan.

The arid and semi-arid areas would be divided according to topographical and tribal boundaries. Determination would be made of the tribal or sub-tribal groups having preference for grazing in each region. Surveys would be undertaken to assess the carrying capacity of the region. Complexes of these grazing districts would be serviced by centers as noted above. The herdsmen would be provided information about the places and amount of pasturage. Optimal grazing management plans would be introduced.

Certain areas in the arid and semi-arid portions of the Sahel countries would be developed as "national grazing reserves." These would not be assigned to individual tribal or sub-tribal units, but would be held in reserve for usage during emergency conditions. They could also be used to spread grazing loads during periods of abundant rainfall so as to maximize revegetation of specific deteriorated areas. The management of these grazing reserves and the provision of services to the nomadic peoples would be the function of a government agency, i.e., a "rangeland and livestock production" unit. These units, operating from centers, would provide information and facilities for marketing of animals, for purchase and storage and distribution of concentrate feeds and veterinary supplies and consumer goods. Thus, these locations would be "nerve centers" for the northern segment of the livestock production system.

In zones further south in the semi-arid and sub-humid regions, both rangelands and cropland systems would be developed. The focus here would be livestock growing and finishing, cereal production, and localized mixed-food crops where irrigation developments were feasible. Animals would be trekked from the arid and semi-arid systems further north into the semi-arid and sub-humid rangeland reserves and cropland system areas for grazing. It is likely and feasible that some industrialization could occur in this zone in fertilizer production for Sahelian usage and plants to process feeds and foods for international trade.

Further south yet in the sub-humid and humid zones the focus would be on generalized mixed food and cash crops, localized cereal production, and restricted livestock fattening operations utilizing by-product feeds. Slaughter plants would be constructed in this area, where possible in conjunction with development of rail and truck transport systems. Animals moved from the arid and semi-arid rangeland systems in the north generally would be brought to the sub-humid and humid areas by rail or truck transport, but animals brought from the semi-arid and sub-humid rangeland probably would be trekked into this region. The sub-humid and humid region would produce concentrate feeds which would be trucked back to the more northerly regions.

A truck transport system that could be used for hauling livestock south, where necessary could be used for hauling concentrate feeds and other supplies northward. Livestock products would move from the slaughter plants into marketing areas, predominately in larger coastal cities. Some by-product feeds from processing offal would move back northward.

In this system a given cooperative in the arid and semi-arid rangeland system of the north would have contracts with, or have as past of the overall operation, a land-holding system, for grazing further south. The plan of management would be developed so as to utilize efficiently a limited amount of managerial capacity. Joint tribal agreements would be sought on a voluntary basis for integrated management of the arid and semi-arid rangeland systems with development of government-owned pasture systems further south.

5.3 Elements of an Organizational Structure

To accomplish the detailed planning and analysis required to get optimal development schemes initiated, checked once in progress, and integrated into the national economies will require a centralized Sahelian task force. It has been suggested that some form of an institute be formed. In Figure 2 an idealized structure is outlined, called an "International Institute of the Sahel" (IIS).

The IIS would have a specific headquarters at a convenient and centralized location within the Sahelian countries. Locational requirements would include consideration of communication and transportation, interaction with other national, international, and inter-governmental groups, long-term space and facility support, interaction with educational organizations or institutions, and so forth. The IIS would have two major advisory inputs. One would be derived from the group of donor government and international agencies. The second would be a regional advisory and liason group involving the representatives of six Sahelian countries as well as approximately 8 other surrounding nations. Although there would be Sahelian headquarters for IIS, there would be branch organizations or offices in the different Sahelian countries.

The major functions of IIS would be in training, in communication, in documentation for the region, land use planning including reconnaissance and survey, organization and conduct of cooperative resource research and conservation studies (including human, physical, and renewable natural resources), and resource and technological developments (including agricultural and related industrial development).

Such an institute would require collaborative long-term funding assurance from one or more international agencies or donor governments. To maintain flexibility, perhaps this sort of an organization should not be incorporated as a member of the UN agency family. Similarly, perhaps it should not be an agency of any one of the Sahelian governments. Instead it would be an independent, flexible and innovative planning, analysis, and research group.

Probably work in the institute should be planned in approximately 5-year segments. For at least the first two such planning segments technical experts from outside the region should be in residence. It will be necessary to mobilize scientific and technical expertise within the Sahel countries to work hand in hand with experts from outside these countries. The IIS probably will need to develop cooperatively

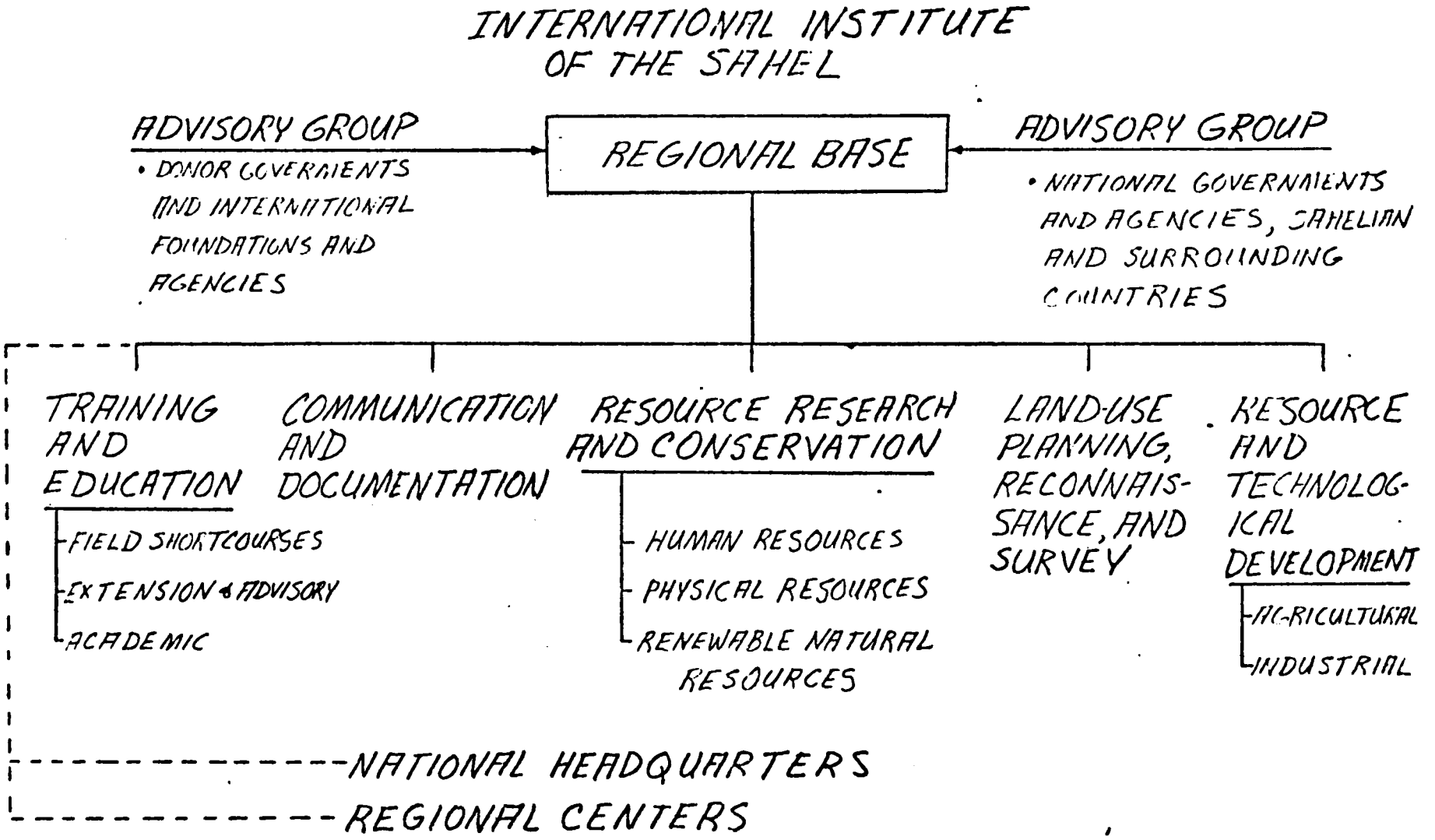

Figure 2. A prototype structure for some of the main activities and interrelationships in an international institute concerned with long-term development problems in the Sahelian countries.

contract studies with organizations, institutions, and individuals throughout the world in at least the first two planning periods. At the same time training programs will be initiated to expand the staff of the institute using Sahelian nationals. The foreign participants would be phased out as a central staff, but an external scientific advisory or consultative working group would be formed and continued.

Perhaps during early stages, e.g., the first two 5-year planning segments, the IIS would have a co-directorship, with one member of the team being a Sahelian nation scientist, technologist, or official and the other member being from outside the region.

5.4 Elements of Time Phasing

An IIS could not be formed immediately, but must be worked into an integrated plan over a period of time for development in the Sahelian countries. Figure 3 illustrates a few of the time-phasing aspects of the overall planning problem.

Emergency measures may be expected to be continued within the next two years. Development of an early warning and alert capacity for national needs related to drought or other phenomenon is also an immediate activity requiring priority. The development of an IIS should receive major emphasis within the next year, with initiation of the institute beginning perhaps as early as in two years time. Directly coupled with an IIS, and assisted by it, would be educational and training programs. These programs would be of four major types: (i) localized "bush schools" and other technological and extension training activities would be initiated first; (ii) more extended technological training, aiming at the technician level, would be the second phase to be initiated. An example would be to develop rangeland resource management technician task forces with background training to do surveys, analysis, management planning, and inventory work; (iii) a coorindated academic-technological training organization, or complex of organizations, should be developed in the Sahelian countries as a third phase in the education and training program. This phase must be delayed somewhat until the academic staff base capability can be increased over that existing at present. This may require selecting early a number of promising candidates from the Sahelian countries for advanced training in other universities in West Africa or in other parts of the world where special emphasis can be given to the countries' needs; (iv) after the development of a critical mass of academic strength within the Sahelian countries there will be a greater number of graduate-level persons available for pervasive reform of the educational system within the Sahelian countries. By pervasive reform, I mean a greatly increased intensity towards education at the primary and the secondary levels. This, of course, will require new systems of schools, development of standards for subject matter, development of appropriate African-language based educational materials, and so forth.

Note in Figure 3 that each of these four levels and types of educational and training activities begin in a time-phased plan. Note also that there is a "phase-down" date projected for each of the activities.

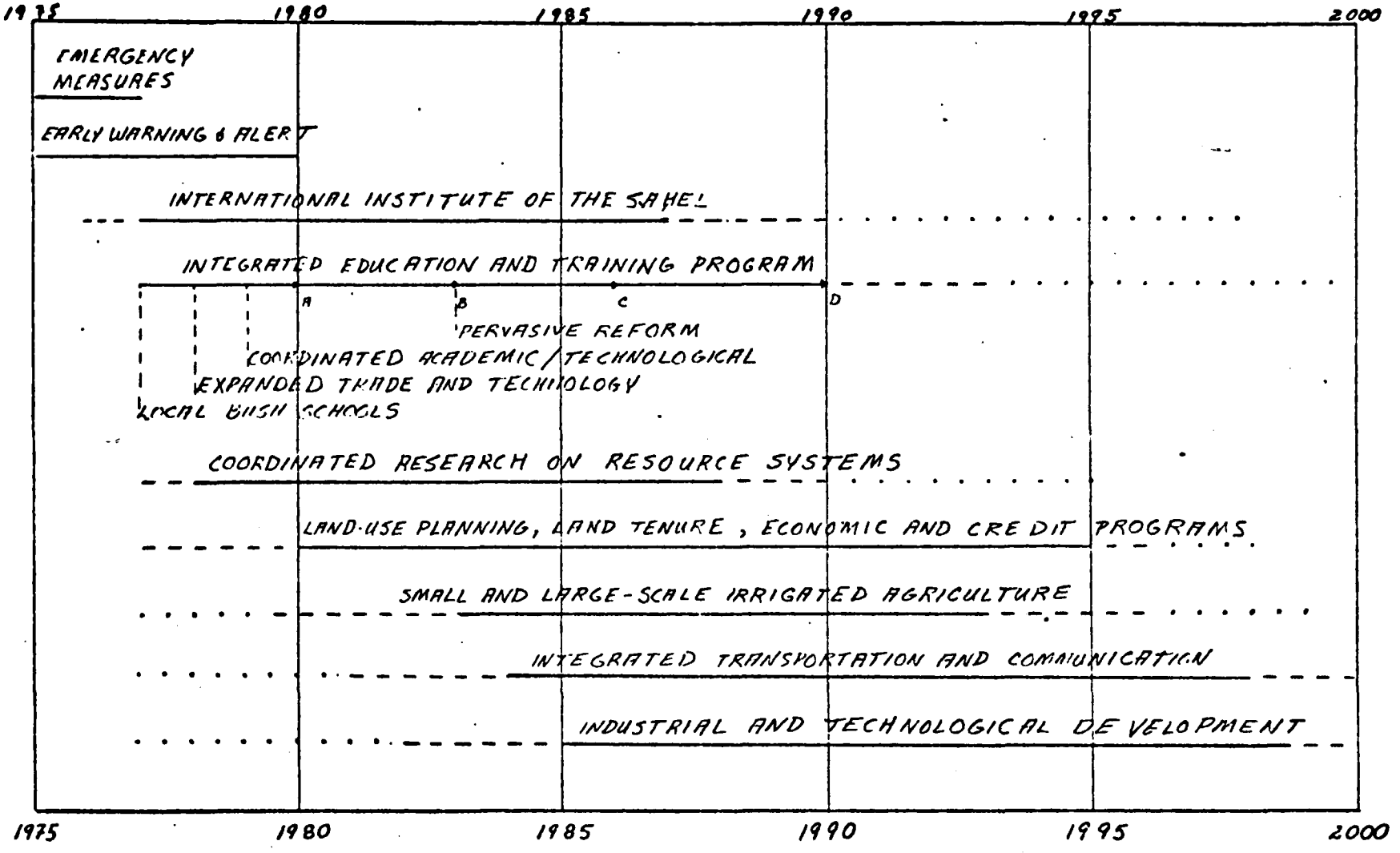

Figure 3. Some elements of time-phasing in a long-term development plan in the Sahelian countries. Solid lines represent major efforts, dashed lines represent planning or follow-up activities, and dotted lines represent minor efforts.

Of course, none of these activities would be phased out at the phase-down time indicated, but this terminal point indicates the end of the high-cost, high-intensity effort requiring external resources.

The various activities outlined within Figure 3 show a time-phasing for initiation. The date of initiation depends in part upon qualitative judgement as to the combined effect of priority, technical difficulty, relationship to the national infra-structure, and so forth. Thus, for example, coordinated research on critical aspects of resource systems should be initiated early. Much of the information produced in such work would be necessary for the next intensive activity of planning land use, land tenure, legislation and economic and credit structure development. These planning efforts would be followed by large-scale developments of irrigated agriculture integrated and coupled with dispersed small-scale irrigated agriculture developments. All of these efforts require a more developed and a more integrated transportation and communication system, and these activities enter the macroplan for the next stage. The final large block of development activity would be in the industrial-technological capabilities areas.

In each area of development priorities of projects would be established. It would be useful to develop one or a few well planned projects in each sector of the economy and cover all sectors rather than attempt initially to complete one sector in depth. That is, given the possibility of limited funding, a model type program would be initiated in a given problem area which could be used by the Sahelian nations as a prototype. For example, prototype projects are needed in grazing reserve development, small-scale but integrated irrigation developments, grazing area center developments, fertilizer plant development, and many more.

5.5 The Challenge and Potential Benefits

This macroplan may appear idealistic to the hardened, experienced development worker or government official. Questions, cautions, and concerns will be raised over many areas. A major question which can be asked is will agencies pool their funds for such an integrated long-term development program? Will the governments work cooperatively, develop the necessary bureaus or departments, and commit funding and personnel to them? Essentially, the question is can development be switched from short-term, project based national effort to long-term, regional-based effort? Can a scheme be developed that will allow long-term planning and direction and yet be compatible with short-term bilateral development projects in specific areas?

Given that positive answers can be found for the above (and many other) questions, then there is a tremendous opportunity for a significant program in the Sahel. Such a program could have impacts far beyond the boundaries of the Sahel. In section 1.1 it was noted the Sahelian countries are just examples of a broader set of countries faced with broadly similar constraints and problems. Solutions to the problem of ecologically

sound, long-term, integrated development planning in the Sahel would have spin-off many places in the world. If many of the world's developed nations could cooperate in a carefully integrated, time-phased program along the lines reviewed herein in section 5 and incorporating many of the facets examined in section 4, it would vastly improve the livelihood, health, and longevity of a large number of people in these African countries. More important, a major opportunity exists now to help these Sahelian nations take initial steps in a long-term program of self-sufficiency in long-term, optimum utilization of their regional resources.

6. ACKNOWLEDGEMENTS AND DISCLAIMER

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Errors herein -- in fact, in interpretation, and in insight -- are mine. There would be more of them if it were not for the people listed above, for although I have had a chance to work and visit briefly in East Africa and in tropical, humid West Africa, I have only set foot in the Sahel as a transit passenger.

I would appreciate comments and criticisms on this report.

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Appendix IV

WEATHER AND CLIMATE IN THE SAHEL

AN INITIAL STUDY

by

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1. On 23 August 1973 Mr. Melville asked us to study the rainfall climates of the dry regions of the tropics and to examine suggestions that had been made about changes in the agricultural climate of the areas.

Summary

2. We decided to start with the Sahel Savanna (figure 1) and to leave for further study other dry areas of the tropics which are more difficult to analyse climatologically. So far we have studied the rainfall records. The conclusions we have drawn are:

a) fluctuations have occurred in the rainfall of the Sahel and Northern Sudan Savannas since records began in about 1900;

b) these fluctuations occur without a clear regular period;

c) there is no firm statistical evidence for fluctuations of about 200 years in period for the main area of the Sahel using the 70 years of measurement available to us;

d) it may be possible to predict the total rainfall of a year, in June from radiosonde data and in July from the June rainfall.

3. This report contains proposals for a future weather watch and for further research (paragraphs 40-47) and recommendations relating to development policy in West Africa (paragraphs 48-56).

Introduction

4. In the Sahel region, seasonal changes and the rainfall regime are governed primarily by the large scale atmospheric circulation. The rainfall occurs in the general region of confluence between damp south west and dry north east winds. This produces rising air currents and general instability in the Intertropical Convergence Zone (ITCZ). The ITCZ is not always well defined on any one day but its daily and seasonal movements can be described and plotted. The ITCZ moves

northward in early summer bringing rain from June until October. Crops are usually sown in July and harvested in October. Rainfall within the ITCZ is through convective storms and it is locally very variable. Records from individual stations may not represent an area and it is necessary to aggregate the measurements from a number of similar stations.

5. From 1968 until now rainfall in the Sahel Savanna has been substantially below the 1931-60 average (Winstanley, 1974). Several such periods have occurred since 1900. Changes over millenia have occurred within the savanna zones adjacent to the Sahara (Jackson, 1957). Climate changes over periods of about two to more than 200 years have been identified in other parts of the world (Lamb, 1972).

6. Where the amount of rainfall is small in relation to the evaporative demand for water, small changes may have serious consequences. Winstanley (1973) wrote: "The strength of the general circulation and monsoon rainfall have now been decreasing for almost 50 years. Assuming a symmetrical 200 year cycle, this downward trend will continue for a further 50 years. Assuming that rainfall in the Sahel and Rajasthan continues to decrease as it has since the late 1920's, by the year 2030 rainfall will be some 40-45% lower than in the optimum years. The isohyets, and thus the Sahara and Rajasthan Deserts, will have advanced some 100 km further south. There will, presumably, still be irregular fluctuations superimposed on this downward trend. At a low point on one of these fluctuations around the year 2030, the isohyets and the desert climate will be some 150 to 180 km further south than in 1930".

7. Climatology is not an experimental science, and the classical methodology of the experimental scientist cannot be used. One line of argument (Lamb, 1973; Winstanley 1973, 1974) depends upon the following:

   a) at least within the northern or southern hemisphere the weather and the climate at a single place is part of a system for the whole hemisphere;

   b) therefore changes at one place must, at least in principle, be linked with changes at other places within the system;

c) we are beginning to understand the mechanisms which link the changes in different places;

d) fluctuations in climate have undoubtedly occurred, for example in Europe over the last 1000 years;

e) therefore fluctuations with periods similar to those of Europe should occur in the tropics.

8. It is clear from the use of 'assuming' in the extract that we have quoted in paragraph 5 (Winstanley, 1973) that Winstanley understands the difficulties of the global argument and the tentative nature of the conclusions. Winstanley (personal communication) feels, not unreasonably, that he has been quoted out of context.

9. The agricultural and social consequence of a change in climate of a particular size depends upon the period of change. When there are long term changes in climate men can migrate and crops, animals and the techniques of farming can change. Short term changes in climate on the other hand may cause disaster. Many of the farming systems of these regions are buffered against climatic variation to some extent by their own characters, for example the distance moved by cattle, multiple cropping, the use of non-photoperiodic varieties. None of these farming systems is entirely independent. For example those of the equatorial part of West Africa depend in part upon the Sahel for meat production and the Sahel depends in part upon more southerly areas for carbohydrate staples.

New Work

10. The problems of climatic change can also be approached by mathematical analysis of long runs of reliable measurements of rainfall which represent the whole area to see what fluctuations have occurred in the past. These fluctuations then give a scale for likely fluctuations in the future, if there are no discontinuities in the meteorology of the area. This and the global approaches are complementary. Neither approach is sufficient on its own.

11. The data must be examined to see if they are valid, and relevant to the area under consideration, and that no discontinuous change can be detected. If the measurements satisfy these requirements, then forward projections may be reasonable.

Measurements available

12. There are measurements of rainfall for short periods, often less than 30 years, for at least 50 stations within the Sahel. These are too short to be used for our analysis. If periods of less than, say, 50 years are used then fluctuations will tend to appear as trends and may lead to unreasonable conclusions. Regular measurements for more than 50 years have been made at few stations within the area. We have extracted the rainfall measurements for 11 stations in West Africa (table 1). Only two, Niamey and Zinder, are within the Sahel. Two, Dakar and Saint Louis, are on the Atlantic edge of the Sahel, but have rainfall patterns which are substantially different from the rest of the stations (table 2). Three stations, Kano, Maiduguri and Sokoto, are close to the south of the Sahel. The other stations are further South, but are all within the same rainfall system.

13. Rainfall records from individual stations have been aggregated to make zone 1 (7 stations) and zone 2 (5 stations). Zone 2 is zone 1 without Dakar and Saint Louis, and more closely represents the Sahel. To compare stations with different rainfall, the rainfalls have been calculated as percentages of the mean. The mean for the period 1931 to 1960 has been used, unless otherwise stated.

Analysis

14. There have been great fluctuations in the rainfall since 1905 (figure 2). Jenkinson (1973) using running averages has shown that the fluctuations have been of similar amplitude throughout the period (figure 3). There have been periods of particularly low rainfall before (table 3).

Table 1 Mean annual rainfall

	Latitude	Longitude	Height(m)		Zone 1	Zone 2	Mean (mm) whole period	Mean (mm) 1931-60
Saint Louis	16.02N	18.51W	4	1892-1973	+		356	348
Dakar	14.40N	19.46W	23	1897-1973	+		542	578
Zinder*	13.46N	06.41E	479	1923-1973	+	+	504	542
Niamey**	13.30N	02.08E	216	1923-1973	+	+	589	585
Sokoto	13.01N	05.15E	350	1916-1972	+	+	726	740
Kano	12.03N	08.32E	481	1905-1972	+	+	860	872
Maiduguri	11.41N	08.37E	354	1916-1972	+	+	647	653
Kaduna	10.36N	07.27E	645	1916-1972			1295	1272
Jos	09.52N	08.54E	1285	1922-1972			1415	1437
Ibadan	07.26N	03.54E	225	1905-1972			1235	1191
Lagos	06.27N	03.25E	3	1897-1972			1815	1825

* Station changed in 1966

** Measurements from Niamey aerodrome (13.30N, 02.10E, 226 m) used for 1972 and 1973

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Table 2

Monthly rainfall as a percentage of the annual rainfall together with coefficients of variation, for the period 1931 to 1960

	JUNE		JULY		AUGUST		SEPTEMBER		Total JUNE-SEPT.
	%	c.v.	%	c.v.	%	c.v.	%	c.v.	%
Saint Louis	2	200	13	75	46	48	28	61	89
Dakar	3	153	15	72	43	47	28	41	89
Zinder	10	61	27	36	43	38	13	59	93
Niamey	14	52	23	38	35	35	17	48	89
Sokoto	12	53	23	32	36	40	20	49	91
Kano	14	39	24	35	36	26	16	51	90
Maiduguri	12	62	28	39	35	30	16	53	91

Table 3

Previous extremes of rainfall

Runs of years of particularly low rainfall in ZONE 2

Years	Rainfall as % of 1931-60 mean					
1912-1915	85	55	78	94		
1940-1944	80	82	76	101	73	
1947-1949	83	93	64			
1968-1973	72	98	97	74	69	65

Runs of years of particularly high rainfall in ZONE 2

Years	Rainfall as % of 1931-1960 mean					
1929-1931	109	106	121			
1952-1955	117	116	114	108		
1957-1962	112	106	105	107	102	106

Long term trends and fluctuations

15. Smoothing measurements, by running averages and by bulking, lessens the variance and may make any changes more obvious. However the measurements may also be tested statistically for trends and for fluctuations.

Long term trends

16. The annual totals were first examined for trends. No consistent or continuing linear or non-linear trends were detected by either regression analysis or by rank correlation. This was true not only for individual stations but also for zonal averages. No trends were found in monthly data either.

Long term fluctuations

17. Next, long term fluctuations were tested using quadratic and cubic regressions of rainfall totals on year. The regression was statistically significant (at 5%) at only one station of the 11 tested. At Zinder, where measurements were available from 1923 to 1973,

$$R = -52.2 + 27.7t - 0.31t^2,$$

where R was the annual rainfall in mm and t was the year from 1900. The terms of the regression have no physical meaning and the relationship cannot be used beyond the period of observation. This regression represents a long-term fluctuation with a maximum around 1945. The regression is statistically significant because of a pronounced downward trend from 1955. The meteorological site was moved in 1966, but the effect of this change is not known.

18. For zone 2 the quadratic regression for the years 1904-1973 was

$$R = -8.7 + 0.58t - 0.0088t^2,$$

R being the % deviation from the 1931-1960 annual mean. t is the time after 1900 in years. This has a maximum in 1933 but the standard errors on the coefficients are so large that they are significantly non-zero only at a 20% level. For zone 1 a quadratic regression, significant at 2.5% was found for the period 1896 to 1973.

Here:

$$R = -11.2 + 0.854t - 0.0128t^2$$

This represents a long term fluctuation with a maximum in 1933 and a 20% decrease in annual rainfall since then. The regression was repeated for the period 1905 to 1973. Here:

$$R = -6.1 + 0.579t - 0.0097t^2$$

The regression is significant at 10%.

19. The quadratic regressions serve only to fix the position of a period of maximum rainfall, about 1933. They do not demonstrate the existence of any large scale trends or fluctuations in rainfall for the period studied.

20. Since the existence of cycles of about 180 years has been suggested (Gribbin, 1973), sine wave regressions for 180 year periods were fitted. The phase of the sine wave was chosen so that the maximum of the sine wave was co-incidental with the maximum of the quadratic regression in 1933. This procedure was adopted because the 70-80 year runs of data available are insufficient to fix the phase for a 180 year cycle with useful accuracy. The 95% confidence limits are wide and show that they cannot be used for practical forecasting purposes (Table 4). The data cover the flat maximum of a sine wave and the regressions are particularly sensitive to a few values at either end of the run.

21. Figure 4 compares the calculated quadratic and sine wave regressions with the data from zone 1 and zone 2 smoothed by a filter which removed fluctuations of less than 15 year period. The remaining fluctuations are irregular. This best fit of either sine wave or quadratic regression is substantially altered by a few values at either end of the records.

22. To find the periods of oscillation which are most likely to be significant, with no preconceptions, the technique of spectral analysis has been used. Tables 5, 6, 7 and 8 show the percentages of the variance of the unsmoothed data (Zone 1, Zone 2 and individual stations) that may be attributed to periodicities of various lengths. Before testing their significance a test for persistence was applied. Since this was negative the appropriate null hypothesis is that of 'white noise', i.e. the

Table 4

180 year sine wave regressions

		Fitted 180 year mean (% of 1931-60 mean)	amplitude (% of 1931-60 mean)	95% confidence limits to amplitude
Zone 1	1896-1973	79.8	+ or - 23.3	6.3 to 40.3
Zone 1	1905-1973	82.3	20.4	0.4 to 40.4
Zone 2	1905-1973	84.5	16.2	-1.8 to 34.3

Table 5

Spectral analysis of annual rainfall totals

% of total variance centred on frequency
(frequency in cycles per year, period in years per cycle)

Station	no. of years	0.025 40	0.05 20	0.10 10	0.15 6.7	0.20 5.0	0.25 4.0	0.30 3.3	0.35 2.9	0.40 2.5	0.45 2.2	0.475 2.1
Zone 2	69	6.0	12.3	12.5	10.6	6.3	5.7	8.3	9.2	12.6	12.7	9.4
Zone 1	78	4.9	10.8	10.9	8.3	5.8	5.7	14.3	16.1	11.2	7.0	5.6
St. Louis	80	2.8	6.9	10.1	11.8	11.4	10.5	12.4	13.9	8.4	4.9	5.9
Dakar	74	1.9	6.3	9.1	8.4	7.5	9.1	14.1	<u>17.3</u>	13.8	8.8	6.6
Zinder	49	3.3	6.6	9.3	9.3	5.3	11.1	16.3	10.1	10.0	11.7	9.7
Niamey	49	2.9	6.3	10.0	13.3	8.4	4.7	9.3	11.5	13.1	13.4	11.3
Sokoto	57	2.6	9.3	12.7	8.0	6.8	10.6	13.0	13.3	9.7	7.1	7.0
Kano	68	3.2	8.9	12.1	10.9	8.4	8.9	9.0	10.4	14.5	11.2	6.2
Maiduguri	57	5.8	10.8	10.0	8.0	6.4	10.1	13.1	11.0	11.1	10.4	7.9
Kaduna	57	4.1	9.9	8.3	7.7	14.9	14.2	9.3	9.2	8.9	8.8	8.8
Jos	51	2.9	6.3	5.9	7.4	11.8	12.7	15.4	<u>17.4</u>	11.5	6.5	5.3
Ibadan	68	5.5	8.5	8.6	12.2	11.0	9.4	8.2	10.1	12.7	7.8	4.2
Lagos	76	2.4	4.8	6.5	9.6	10.1	10.2	11.4	11.1	9.9	10.1	<u>11.3</u>
if RANDOM		5	10	10	10	10	10	10	10	10	10	5

_____ denotes significantly different from random expectation at 95%

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Table 6

Spectral analysis of August rainfall totals

% of total variance centred on frequency
(frequency in cycles per year, period in years per cycle)

	no. of years	0.025 40	0.05 20	0.10 10	0.15 6.7	0.20 5.0	0.25 4.0	0.30 3.3	0.35 2.9	0.40 2.5	0.45 2.2	0.475 2.1
Zone 2	69	6.6	12.9	11.1	7.4	5.0	7.3	10.9	9.7	8.9	11.1	11.8
Zone 1	78	5.4	10.3	8.3	5.6	4.7	6.9	13.3	17.3	12.5	7.5	7.0
St. Louis	80	4.5	7.8	7.0	10.1	11.8	9.6	9.3	10.7	11.7	10.9	9.5
Dakar	74	2.3	6.5	7.3	5.3	5.5	7.5	11.5	15.2	14.6	12.8	12.4
Zinder	49	2.0	5.6	9.5	11.3	8.9	7.5	7.2	8.0	13.2	15.1	13.6
Niamey	49	6.8	15.3	15.7	10.3	5.3	5.4	7.1	9.8	11.3	8.4	5.9
Sokoto	57	4.6	13.6	13.7	7.3	6.6	6.4	4.8	5.2	7.7	13.3	16.6
Kano	68	5.1	12.4	10.7	5.3	5.6	10.6	14.8	12.6	8.8	7.8	7.4
Maiduguri	57	2.5	5.9	6.8	5.7	7.6	13.3	16.4	15.1	12.0	9.0	7.5
Kaduna	57	6.8	14.6	10.6	6.5	11.7	13.1	9.8	9.9	6.9	4.6	5.4
Jos	51	8.7	15.0	10.4	5.7	5.0	6.8	8.8	13.6	12.5	6.8	5.2
Ibadan	68	5.1	7.5	4.9	5.4	7.4	10.6	9.9	11.1	15.7	13.4	9.9
Lagos	76	4.4	8.5	8.1	9.7	10.7	8.1	7.6	11.1	13.0	11.0	9.3
if RANDOM		5	10	10	10	10	10	10	10	10	10	5

_____ denotes significantly different from random expectation at 95%

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Table 7

Spectral analysis of July rainfall totals

% of total variance centred on frequency
(frequency in cycles per year, period in years per cycle)

Station	no. of years	0.025 40	0.05 20	0.10 10	0.15 6.7	0.20 5.0	0.25 4.0	0.30 3.3	0.35 2.9	0.40 2.5	0.45 2.2	0.475 2.1
Zone 2	69	5.4	9.2	8.9	12.5	12.0	8.7	9.6	11.0	10.7	7.9	6.0
Zone 1	78	4.5	7.8	8.6	16.5	21.4	13.8	7.0	6.5	6.5	5.8	4.7
St. Louis	80	8.9	15.8	14.0	11.8	9.6	9.9	7.7	5.4	6.0	5.7	4.9
Dakar	74	5.2	10.5	10.3	10.5	11.8	9.8	7.8	10.3	9.4	7.1	7.2
Zinder	49	4.9	10.1	8.2	5.6	6.9	10.6	10.8	10.4	12.1	10.9	9.1
Niamey	49	11.3	15.5	7.9	9.0	8.7	8.2	9.8	9.0	10.8	8.1	4.3
Sokoto	57	3.2	9.6	15.1	13.8	8.0	7.7	10.4	11.3	8.9	5.5	4.8
Kano	68	4.4	9.0	9.3	13.0	14.8	8.9	6.3	8.3	10.0	10.0	8.7
Maiduguri	57	6.2	11.9	10.1	10.4	11.7	8.5	11.0	16.8	10.1	2.1	1.2
Kaduna	57	9.2	17.2	12.7	6.6	6.9	9.6	7.5	4.9	5.6	9.2	11.3
Jos	51	3.5	7.0	7.4	10.0	11.5	10.1	10.8	12.8	12.3	9.3	7.4
Ibadan	68	4.9	8.2	8.2	11.8	10.9	8.5	10.2	9.6	7.2	8.5	10.5
Lagos	76	4.6	8.4	5.9	5.2	7.0	8.4	10.5	11.8	10.4	11.4	13.7
if RANDOM		5	10	10	10	10	10	10	10	10	10	5

_____ denotes significantly different from random expectation at 95%

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Table 8

Spectral analysis of September rainfall totals

% of total variance centred on frequency
(frequency in cycles per year, period in years per cycle)

Station	no. of years	0.025 40	0.05 20	0.10 10	0.15 6.7	0.20 5.0	0.25 4.0	0.30 3.3	0.35 2.9	0.40 2.5	0.45 2.2	0.475 2.1
Zone 2	69	1.4	5.0	12.6	16.5	12.8	11.7	9.6	6.8	9.7	9.7	7.1
Zone 1	78	2.7	7.5	14.2	16.3	11.7	9.0	8.2	9.1	9.6	7.3	5.9
St. Louis	80	3.8	5.8	8.9	15.1	14.6	10.2	9.5	12.8	9.8	5.2	4.8
Dakar	74	5.8	11.6	14.6	16.5	11.6	7.4	8.3	8.9	6.9	4.9	4.4
Zinder	49	3.9	10.2	12.8	10.7	9.2	12.5	11.7	6.5	7.8	9.7	8.3
Niamey	49	2.3	7.8	14.1	15.0	9.4	7.6	11.4	11.2	8.8	8.2	7.6
Sokoto	57	1.5	5.6	11.9	13.2	11.4	12.0	9.0	9.0	13.7	10.4	5.4
Kano	68	1.5	4.7	11.5	15.4	15.6	16.1	10.5	6.5	7.4	6.4	5.3
Maiduguri	57	5.5	11.5	12.9	15.4	13.5	8.6	6.0	5.5	9.4	9.6	6.5
Kaduna	57	5.6	9.1	6.8	9.4	12.7	11.8	8.7	6.9	11.9	13.6	10.3
Jos	51	3.4	11.0	13.9	10.7	8.6	8.1	7.2	7.0	9.6	11.1	10.5
Ibadan	68	2.3	4.6	4.9	4.9	6.3	8.9	8.9	12.2	17.5	16.5	14.4
Lagos	76	3.1	6.1	7.7	10.5	10.2	8.0	8.5	12.3	16.2	13.1	8.6
if RANDOM		5	10	10	10	10	10	10	10	10	10	5

_____ denotes significantly different from random expectation at 95%

variance is equally distributed among the spectral regions.

23. For annual totals (Table 5) the principal peaks were in a waveband centred on 0.35 cycles per year (2.7-3.1 year period). The Lagos spectrum was an exception with a peak at a 2.0-2.2 year period. The 3 year peak was present in zone 1 but not in zone 2.

24. Spectra of August totals (Table 6) were very similar to the annual ones. Again the difference between the two sets of zoned data was noticeable. July spectra (table 7) showed little of interest, except that zone 1 showed a significant peak at a 4.4-5.7 year period. September spectra (table 8) had a tendency for most variance to be found in a band of 5.7-8.0 year period. This was statistically significant only for zone 1.

25. When the spectral analysis appears to show a significant peak, a band pass filter centred on this peak is used on the original data (Craddock, 1968). The filtered sequence shows the distribution of the variance due to oscillations of the chosen period within the run of the measurements.

26. The use of the appropriate filters showed that the peaks in the annual and August spectra were due to large variations in the early (pre 1930) parts of the runs. The July peak results solely from the differences in the July rainfall pattern between Dakar and St. Louis and the other stations and should be disregarded. The variance with 5.7-8.0 year period of the September data was distributed over the whole run but fluctuations were not regular.

27. Such filtered data are suitable for comparisons with other quasi-periodic variables.

28. These analyses have shown that there have been short term fluctuations in rainfall. The components of the fluctuations have been neither large, nor regular. In no case was an oscillation stable enough to form a basis for forecasting.

Within season forecasting

29. Delsi (1973) has shown that in the Sudan zone of Africa variations from the average values of both rainfall and the 500 and 700 mbar geopotentials* tend to persist within seasons. To test the predictive value June and annual rainfall totals for zone 2 were divided into terciles and a contingency table made (table 9). When June was classified as dry, the year as a whole was wet only 3 times out of 23.

30. Winstanley (1974) has presented a correlation between June and June to September rainfall figures as a basis for seasonal prediction in the Sahel. He has calculated the regression of June rainfall on June to September rainfall instead of vice versa but our own calculations support his general conclusions. Using the Sahel data for 1953 to 1972 obtained from Winstanley's figure we find the correct regression:

$$Y = 63.7 + 0.291\ X$$

where X is the % of 1931-60 June rainfall

Y is the % of 1931-60 June to September rainfall

The correlation coefficient is 0.63. The regression is significant at 5% and accounts for 40% of the total variance.

31. For zone 2 over the period 1905-1973 a similar regression was obtained:

$$Y = 96.7 + 0.159\ X$$

The correlation coefficient is 0.37. The regression is significant at 1% and accounts for 14% of the total variance. Using such a regression for a particular year leads to large confidence limits.

* The geopotential is the height above sea level in metres at which the barometric pressure is 500 mbar or 700 mbar as appropriate.

Table 9

Contingency table for Zone 2, June and annual rainfall based on 69 years (1905-1973)

		Annual rainfall		
		dry	normal	wet
June rainfall	Dry	12	8	3
	Normal	8	8	7
	Wet	3	7	13

Chi-squared = 9.51 (using Yates correction) with 4 degrees of freedom. Significant at 5%.

32. It may be possible to predict the rainfall of the year from meteorological measurements made in June. A category classification into wet, intermediate or dry is more useful than any continuously variable regression.

Discussion

33. The data used in this study came mainly from a zone within latitudes 11°N and 14°N. The rainfall here is less variable than in the Sahel where droughts have been most severe. The data presented have limitations as a description of changes occurring within the Sahel. However where both have been calculated the main conclusions drawn from these longer records seem to agree with those from the Sahel.

34. Although some marginally significant 180 year sine wave regressions were obtained, they depend upon relatively unreliable records at the begining of the periods of observation.

35. No intermediate term cycles (greater than 10 years) were found which would acoount for the last six years of drought.

36. No periodicities were found that could be of use in forecasting. For Dakar and St. Louis especially it appeared that oscillations of around 3 year periods have been important, at least over part of the record. This effect has also been reported by Girand and Rossignol (1973) and by El Sayed and Landsberg (quoted in Davey, 1974). It is interesting to note that the barometric pressure in the Southern Pacific oscillates with a similar period (Troup 1965). This merits further investigation.

37. Whilst the last six years have had less than average rainfall, it should be noted that the 6 years 1957-62 had above average rainfall. Indeed from 1952 to 1962 only one year was drier than the 1931-60 mean. If the occurrence of above or below average rainfall is purely random then the probability of 6 year runs occurring is $\frac{1}{2}^6$, that is about once in every 70 years there would be six dry years together. Their occurrence once this century should not therefore be regarded as particularly abnormal for this region.

38. The 1950's were years of above average and more reliable rainfall and long term planning should take account of this fact.

39. We should stress that even if a connection between two variables is found which can be used as a predictor, such as the June rainfall or more speculatively a variable to describe the Southern Oscillation, the relationship cannot be relied upon until a physical relationship has been established. A statistical relationship may be coincidental and temporary.

Further studies

40. The Sahel is only part of a world wide area of unreliable seasonally arid climate. These statistical studies of long runs of rainfall measurement should be extended to other areas as soon as possible. In particular the Indian and Ethiopian areas should be examined in detail. The dry East Mediterranean and South American regions should also be assessed. We should see how frequently droughts come in phase in these areas.

41. The possibility of using meteorological measurements within a season to predict the summer rainfall in the Saheland in other regions must be further analysed. It is possible that synoptic information, such as the surface position of the ITCZ and radiosonde measurements, can be used to predict rainfall. These predictors can be tested in part by using information available. However the use of these predictors requires a reasonable understanding of the synoptic meteorology of the areas and needs further work.

42. These synoptic studies, based on the analysis of actual measurements, need the support of theoretical studies of the weather systems of the world designed to lead to a fuller understanding of the reasons for climatic change. Then it may be possible to develop predictors based upon known physical mechanisms, which should be more reliable than statistical predictors. The theoretical models used in these studies have to include measurements of the circulations of the atmospheres and the oceans. Such studies are one of the major aims of the Global Atmospheric Research Programme.

They are being vigorously pursued internationally through WMO. The Meteorological Office, the Department of Geophysics at the University of Reading and the Department of Meteorology at Imperial College are the main centres of such work in the UK.

43. It may be possible to model climate systems on an intermediate scale for the semi-arid parts of the world, as a subsystem of the general system referred to in paragraph 42 (Charney, 1974). We know of no work in which this subsystem is being examined in detail either theoretically or synoptically. These studies may directly and quickly affect the countries in the semi-arid parts of the world and could therefore reasonably be supported by the Consultative Group in association with UNDP and WMO.

44. Monthly and annual measurements of rainfall can conceal agriculturally important differences between seasons. In particular the distribution and intensity of the rainfall, the relation between rainfall and evaporation and the relations between climate and crop growth and yield must be examined for these areas. Such studies would allow more soundly based recommendations for patterns of agricultural development, including changes in land use and in improved control of diseases and pests, including locusts. It is particularly important to determine the limits of climatic tolerance of the existing farming systems and of any proposed alterations them.

45. It is possible to predict, with some reliability, the rainfall for the agricultural season for the area as a whole from the rainfall in June and from synoptic measurements made in late May and June. The measurements of rainfall and of geopotential needed to do this should be followed week by week for the coming season.

46. To continue the work at Reading described in paragraph 40, 41 and 45 a further research fellow is needed. If it is agreed, an application for funds will be made. To develop the work described in paragraph 44, would probably require another research fellow.

47. The development of the work suggested in paragraphs 42 and 43, would have to follow after discussions with the Meteorological Office and the Department of Geophysics at Reading, amongst others.

Conclusions and recommendation relating to development policy in West Africa

48. Our analysis of the rainfall data of the West African region has not yielded evidence of long term (> 30 year) trends, and even if it did, we would suggest that governments and people will tend to adapt to them. We have not found regular short term fluctuations either, but it seems to us clear that irregular fluctuations (cycles of unpredictable length) of rainfall are a consistent feature of the climate of the Sahelian region. Sequences of several dry years, separated by wetter periods, must be expected to recur at intervals of perhaps 10-30 years - at least once in a generation. It is not possible to predict when they will begin or how long they will last.

49. Cycles of this sort are too short to allow governments and people to adapt their patterns of resource use. Consequently the increasing numbers of people who live in the region, and their crops and livestock, are perpetually at risk of shortages. It is doubtless an object of national policies to prevent shortages from leading to disasters.

50. There are three ways, not mutually exclusive, of ameliorating the human situation in the Sahel - to improve crop and animal production in the region itself, to develop complementary exchanges with more favoured regions, and to lessen the number of people at risk.

Improving crop and animal production

51. In a marginal climate, where recurrent droughts are certain, crops will be reliable only in the wetter parts of the cycle, and in topographically favoured areas. Even with a well organised storage system, it may not be possible to base orderly economic development, or even a stable way of life, on local crop production. Where

irrigation is possible, the comparative advantage of investment in new water resources, or more effective use of existing resources (on which the average return over a period of years may well be small), may often be such that both governments and aid donors prefer to spend money in other ways. A sequence of dry years may not only put the investment at risk; it may also lead to a major disaster for a growing population which has come to depend on the water. It may be possible to improve dry farming methods for suitably chosen localities: among others, ICRISAT can help there. Improvements in animal production may well be possible as output channels are improved and responsibility for grazing and water comes to be more accurately aligned with the ownership of herds.

Complementary exchanges

52. Throughout the West African region and across to the Sudan and Ethiopia, dry regions and wetter regions are close to each other. Except in the Sudan, where the swamps limit north-south movement, the nomadic management of herds, and organised economic exchanges such as reciprocal trade in animals and grain, have traditionally enabled the ecologically complementary wetter and drier regions to complement each other economically also.

53. An essential task for the immediate future in the Sahel and the adjacent wetter regions is to develop communications within and between countries, reciprocal trade in crop and livestock products, and the associated organisation, administration and facilities (such as stores, abbatoirs, and processing plant). No individual country in the Sahel can hope to be both increasingly prosperous and also self sufficient.

54. Complementary development will doubtless include the establishment, financing and management of adequate food reserves, as has been done in parts of Botswana (where the complementary relations are with the Republic of South Africa).

55. It is through these complementary exchanges that weather and climate forecasting, which we believe may become possible, will have their most useful practical outcome, since there is little they can offer to a small holder who may simply be unable to respond to any meteorological warnings he may be given. Conversely, it is of little use to be able to forecast drought reliably if nothing can be done about it.

Changes in the distribution of population

56. Economic progress in the development of mineral and petroleum production, and the growth of secondary industry in the more southerly regions, may be expected to lead (if it has not done so already), to significant movements of population away from the uncertainties of the drier areas. In the longer term, in the West African region as a whole, the population of the Sahelian region may therefore tend to decline. Though this (like their interdependence with the more favoured states to the south) may be unpalatable to national governments, there may be little anyone can do about it, as the 'strange farmers' of the Gambia have shown for many years. There would seem to be no reason why humans should be obliged in perpetuity to battle with a seasonally arid and uncertain environment if they themselves, or their children, wish to take advantage of other opportunities elsewhere, nor why in a relatively thinly-populated region bilateral and multilateral donors should invest in the maintenance of the demographic status quo.

Acknowledgements

We thank with great pleasure Mr. J. Sawyer, Mr. R. Ratcliffe and their colleagues of the Meteorological Office who have helped us throughout this study. We are also indebted to Professor R.P. Pearce of the University of Reading and Dr. D. Winstanley, now of Environment, Canada.

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FIGURE 1 WEST AFRICA SHOWING THE SAHEL

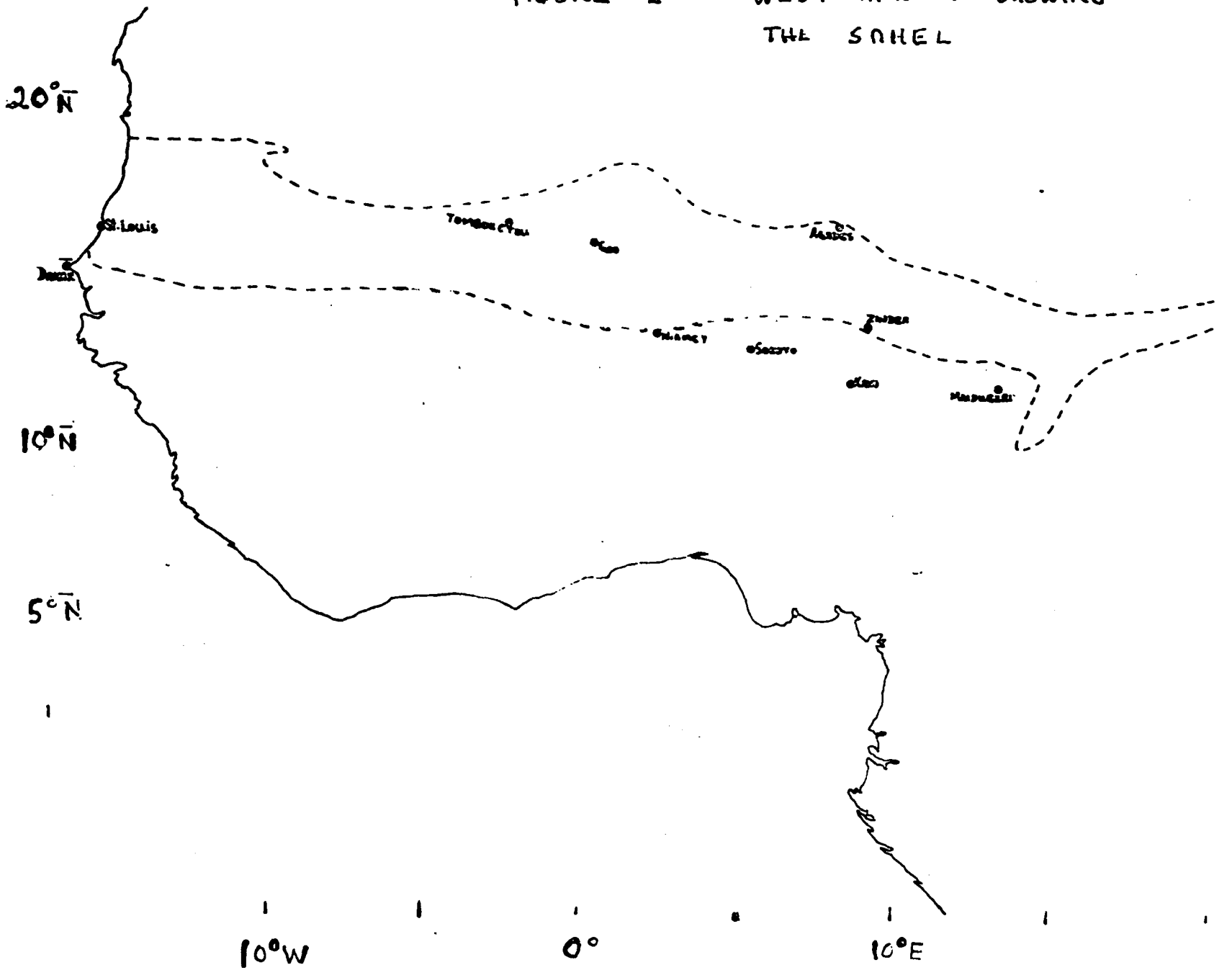


FIGURE 2 ANNUAL RAINFALL AS PERCENT OF MEAN ZONE 2

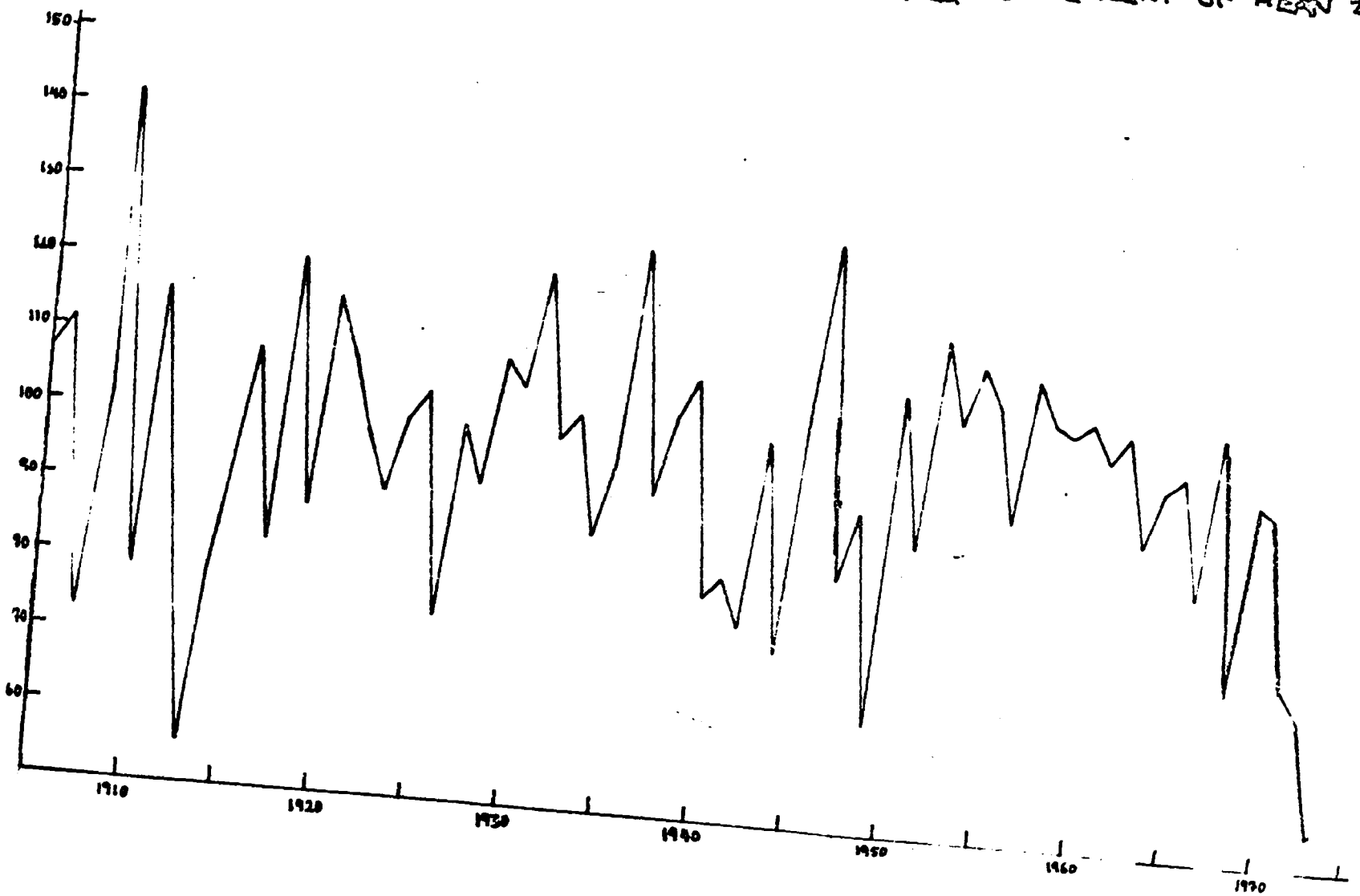


FIGURE 3 5 - YEAR RUNNING AVERAGES OF ANNUAL RAINFALL AS PERCENT OF MEAN (JENKINSON, 1973).

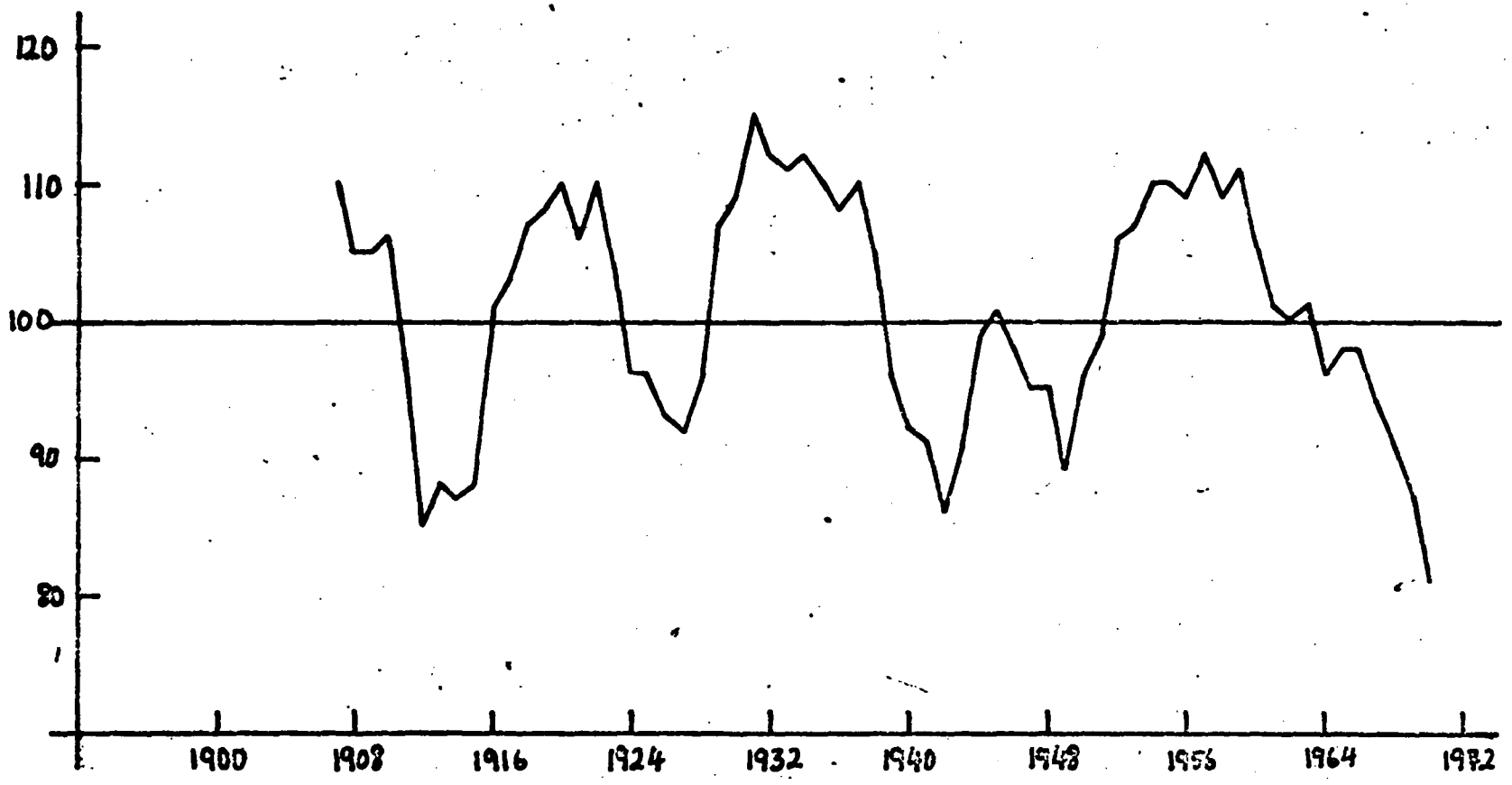
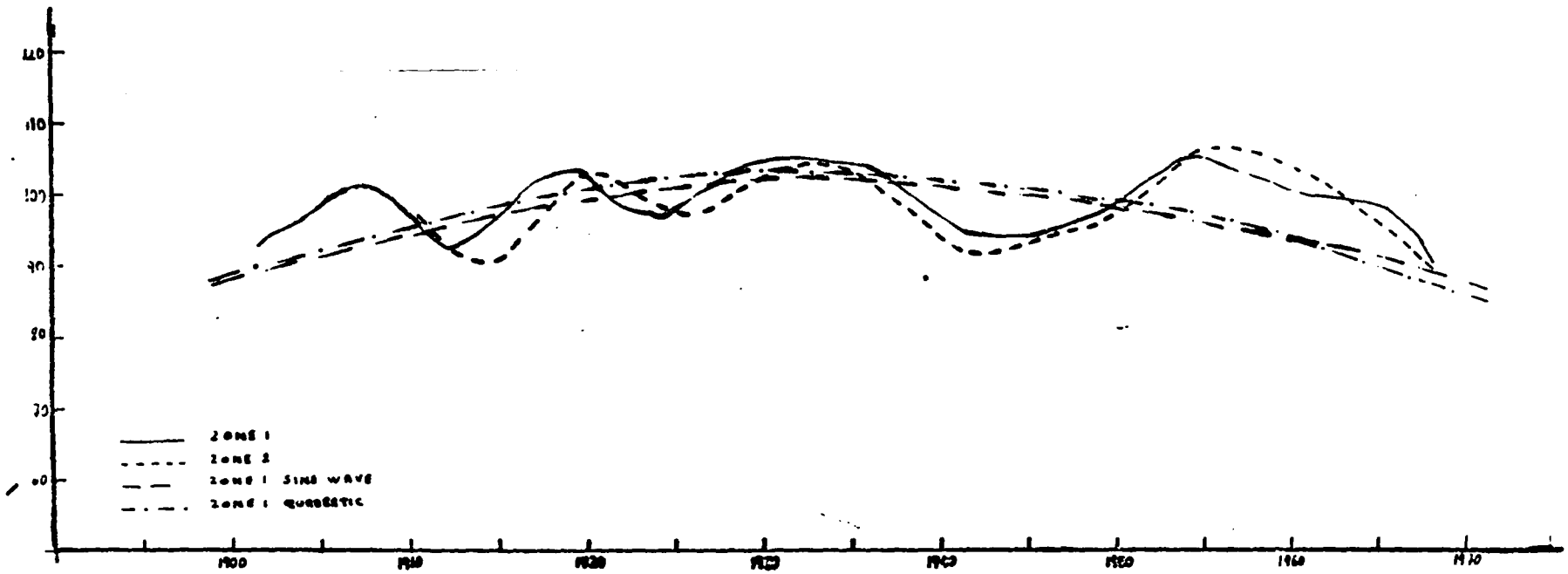


FIGURE 4 COMPARISON OF SMOOTHED ZONAL AVERAGES AND FITTED REGRESSIONS



Appendix V

THE ECOSYSTEM

What is the capacity of the Sahel to support people and animals ? How can the limits of this be determined ? What are the development implications for the next 20-30 years ?

Le Sahel est défini essentiellement par des données climatiques. Il s'agit des régions situées au sud du Sahara, soumises à un climat de longue saison sèche, avec des pluies d'été dont le total annuel est compris entre 100 et 500 ou 600 millimètres. Dans certains cas, le sens du terme Sahel est élargi et il englobe la zone sahélo-soudanienne où la pluviosité varie de 500 à 900 mm. Dans les conditions actuelles ce sont ces contraintes climatiques qui déterminent en premier lieu les possibilités limites d'occupation du Sahel par les hommes et les animaux. Mais ces limites sont très variables selon les régions car le Sahel est, en fait, constitué d'une série d'écosystèmes définis par les données de base du milieu naturel que sont les sols, le tapis végétal, les ressources en eau.

En ce qui concerne les sols, quatre familles principales couvrant de grandes superficies ont été inventoriées. Ce sont les sols sur sables, les sols sablo-argileux sur granites, les sols squelettiques sur grès et cuirasses ferrugineuses, les sols argileux sur schistes ou sur alluvions anciennes. Ces familles représentent des terres très diverses sur le plan de la richesse chimique et surtout sur celui de l'économie de l'eau. Leur distribution spatiale est relativement bien connue dans une grande partie du Sahel.

Les sols.

Au Sénégal, où les régions sud et sud-est sont cartographiées au 1/200 000 et la vallée du fleuve Sénégal au 1/50 000, la synthèse des travaux a été présentée sous forme d'une carte au millionième. En Gambie, il n'existe que des études locales, sauf pour l'ouest du pays cartographié à 1/100 000. En Mauritanie, la région du

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Guidimaka a été prospectée à l'échelle du 1/200 000, et l'inventaire des grands types de sols de l'ensemble du pays est terminé. Au Mali, les connaissances pédologiques sont plus fragmentaires, mais l'inventaire des sols peut être également considéré comme complet. Il existe notamment un certain nombre de travaux à grande échelle, en particulier dans toute la cuvette centrale du fleuve Niger. Les cartes pédologiques de la Haute-Volta et de la partie de l'Etat du Niger situé au sud de l'isohyette 200 mm, ont été publiées à 1/500 000, complétées par une abondante documentation sur les sols et leurs caractéristiques physico-chimiques. Dans ces deux Etats, il existe un certain nombre d'autres travaux aux échelles du 1/200 000, du 1/100 000, du 1/50 000 et du 1/20 000. Enfin, tout le Tchad agricole est couvert à l'échelle du 1/200 000, les derniers documents étant en cours de parution. Une carte au millionnième synthétise les connaissances sur ce pays.

Récemment, un nouveau programme a été lancé en vue de l'établissement de cartes de ressources en sols, précisant les possibilités d'utilisation agricole des grandes unités pédologiques. Le 1/500 000 de la Haute-Volta est en cours d'édition, les maquettes du Niger sont terminées, et les études sont en cours pour l'établissement de documents similaires pour le Tchad.

La végétation.

Les connaissances sur les grands types de composition floristique des pâturages sont suffisantes pour permettre une définition correcte des charges limites d'exploitation. Mais, la représentation de la distribution spatiale est plus fragmentaire que celle concernant les sols. Cependant, de nombreuses cartes agrostologiques ont été établies dans les régions suivantes : Nord et Est du Sénégal, Nord de la Haute-Volta, Centre du Niger et Sud du Tchad. L'échelle des représentations, le 1/50 000 le plus souvent, explique la lenteur d'élaboration de la couverture (900 000 km2).

La comparaison des données fournies par les cartes de sol et les cartes agrostologiques a été tentée. Elle montre l'étroite corrélation qui existe entre les faciès floristiques et les caractéristiques hydro-dynamiques des grandes familles de sols.

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Les ressources en eaux de profondeur.

Les connaissances sur les ressources en eau sont très abondantes. Une carte d'orientation hydrogéologique de l'Ouest et Centre Afrique, a fait le point des connaissances hydrogéologiques acquises jusqu'à présent. Elle indique que l'isohyette 400 mm sépare deux domaines, l'un au Sud où les nappes peuvent être réalimentées directement par les pluies, l'autre au Nord où il n'y a plus d'alimentation et où les aquifères doivent être exploités comme des gisements miniers. Durant la sécheresse qui a affecté le Sahel entre 1970 et 1974, cette limite a probablement été décalée vers le sud de plusieurs centaines de kilomètres. De plus, on peut distinguer deux grandes provinces hydrogéologiques, le vieux socle et les bassins sédimentaires. Sur le vieux socle, l'hétérogénéité des roches rend difficile la localisation des nappes. Ces dernières sont toujours très limitées en volume et conditionnées par une réalimentation périodique par les pluies. Une étude exhaustive fondée sur les méthodes statistiques a permis de dégager un certain nombre de lois sur les probabilités de l'existence de ressources en eau à faible profondeur.

Les bassins sédimentaires, d'âges géologiques très différents, recèlent souvent des réserves en eau très importantes, mais le plus souvent à grande profondeur. Ainsi, le forage Christine, en Haute-Volta, fournit un débit de 100 m3/h. Par contre, les formations continentales secondaires et tertiaires qui sont toutes aquifères ne fournissent que des débits de quelques dizaines de m3/h, mais la qualité des eaux est excellente. Au Niger, il y a des nappes en charge localement jaillissantes, dont la superficie est très grande puisqu'elle couvre la plus grande partie du bassin du fleuve Niger. Au Tchad, les formations quaternaires contiennent une nappe phréatique sub-affleurante. Sous cette nappe, une autre, en charge a été repérée par forages entre 250 et 375 mètres, et en Nigéria du Nord, une nappe encore plus profonde a été décelée.

C'est le bassin sénégalo-mauritanien qui a été le plus étudié. Les formations sableuses et gréseuses du Maestrichtien contiennent une nappe extrêmement puissante et généralisée qui s'étend sous la plus grande partie du Sénégal et de l'Ouest de la Mauritanie. Elle a une épaisseur moyenne de 250 m, et elle est exploitée par une centaine de forages dont la profondeur varie de 250 à 400 m. Mais la

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qualité des eaux est variable, et il y a une zone où l'eau est saumâtre (de 1 à 4 mg/l). Les débits susceptibles d'être obtenus par f rage d'exploitation varient suivant les zones de 100 à 200 m3/h. Dans les formations éocènes, il y a également une nappe généralisée à faible profondeur (50 à 70 m), mais cette nappe est limitée par u biseau salé qui pénètre profondément de l'Océan vers l'intérieur du pays.

Les ressources en eaux de surface.

Si les ressources en eau de profondeur sont localement très importantes, il en est de même de celles en eau de surface. Ce ressources commencent à être bien connues, en particulier grâce aux travaux de l'ORSTOM à qui la plupart des Etats du Sahel ont confié en gestion leurs réseaux hydrologiques. L'Office a recueilli et expl té depuis trente années, une documentation importante sur les régime de tous les cours d'eau principaux. C'est ainsi, que depuis 1949,son édités régulièrement des annuaires ou annales hydrologiques où sont contenus les débits journaliers d'environ soixante stations des zones sahéliennes et soudaniennes. Plusieurs monographie des fleuves ont été publiées rassemblant toute l'information hydrologique utilisable pour les grands projets d'aménagement, ponts routiers, amélioration de la navigation, protection contre les crues, adductions d'eau, pro jets hydroagricoles et hydroélectriques. Ainsi la monographie du fle ve Sénégal est le document de base qui a servi à la mise au point de tous les projets de barrage et d'aménagement en cours.

Le lac Tchad a fait l'objet de recherches interdisciplinaires associant les hydrologues, les climatologues, les sédimentolo gues, les hydro-géologues, les botanistes, les chimistes des eaux et les hydro-biologistes. Les recherches ont montré l'intérêt d'un aménagement rationnel des ressources du lac dans une région susceptible d'être gravement affectée par des sécheresses temporaires. La monographie du fleuve Logone est également terminée et celle du bassin d fleuve Chari a été publiée en 1974, de même que de nombreuses études sur les débits de crues sur bassins expérimentaux, et sur les crues décennales. Enfin, la synthèse des écoulements dans les régions sahé liennes est en cours d'élaboration, tandis que le Service d'Hydrolog poursuit la transcription systématique sur cartes perforées des rele vés pluviométriques anciens de toute la région sahélienne.

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L'examen, cas par cas, des caractéristiques des milieux physiques qui viennent d'être évoquées, ne permet pas à lui seul de définir les possibilités de développement. Celui-ci est accompli par des hommes et les données démographiques, sociologiques et économiques doivent être prises en considération. Dans le passé, c'est leur méconnaissance qui a le plus souvent conduit à l'échec de nombreuses opérations de développement.

Le milieu humain.

Les données démographiques actuellement rassemblées sont incomplètes, et elles ne sont guère valables car les évènements récents dans le Sahel viennent de modifier radicalement la répartition spatiale des populations des nomades (cf. note sur "les interrelation climat, populations, etc...). Par contre, la connaissance des sociétés nomades et celle de l'organisation des terroirs agricoles ont beaucoup progressé depuis quelques années. Les chercheurs français et quelques étrangers, Américains en particuliers, se sont attachés à définir l'adaptation des sociétés humaines aux conditions du milieu Bien que l'extrapolation soit extrêmement difficile, on peut affirmer que les populations sahéliennes ont conscience des contraintes du milieu physique et qu'elles ont toujours cherché à s'y adapter. Aussi les campagnes de protection sanitaire des individus et les vaccinations systématiques des troupeaux contre la peste et la péripneumonie bovine ont provoqué une accélération de la croissance démographique. La création de nombreux points d'eau a localement éliminé le facteur limitant des possibilités d'abreuvement. Lorsque les ressources en pâturages ont diminué par suite de la sécheresse, les sociétés n'ont pu s'adapter et les pertes en bétail ont été d'autant plus graves que les positions traditionnelles de repli des éleveurs vers le Sud, en particulier le long des grands fleuves, n'étaient plus accessibles.

En définitive, en tenant compte de toutes les conditions du milieu physique et humain, et en utilisant les acquis de la recherche, il doit être possible de définir dans le Sahel un certain nombre de régions naturelles et de préciser leurs capacités de production. Mais il ne faut pas oublier que ces dernières dépendent également des "inputs", c'est-à-dire de l'importance des moyens financiers consentis pour aménager le milieu. Parallèlement, intervient la position

Possibilités de développement.

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géographique des Etats et leur degré de continentalité. Il y a 1500 kilomètres entre le Tchad sahélien et l'Océan, ce qui est un désavantage par rapport au Sénégal, qui peut envisager de baser une partie de son économie sur les ressources de la pêche en mer, relativement indépendantes des aléas climatiques.

En restant dans un cadre extensif, il est évident que de nombreuses régions du Sahel avaient atteint en 1970 leur capacité maximum en populations humaines et animales. Lors de la période de sécheresse entre 1970 et 1974, pendant laquelle les animaux sont surtout morts de faim et non de soif, ce qui a privé les populations de leurs ressources habituelles, il semble qu'il aurait été possible de limiter les désastres en menant de concert, avec la protection sanitaire et le développement des points d'eau, des essais de réorganisation sociale, de rationalisation des circuits de nomadisme et de transhumance, d'amélioration de gestion des troupeaux par une commercialisation rationnelle, de mise en place de cultures fourragères irriguées. Il y a dans les régions sahéliennes des réserves en eau de surface, et en eau de nappe très élevées, qui ne sont que partiellement exploitées, et il y a dans les régions sahélo-soudaniennes des sols fertiles inutilisés. C'est pourquoi l'utilisation des ressources en eau pour des cultures vivrières et fourragères, et surtout la mise en place de grands projets d'irrigation pourrait permettre, en respectant les équilibres ressources-populations, d'augmenter sensiblement les potentiabilités de la plupart des écosystèmes du Sahel pour lesquels les possibilités limites de production ne sont pas atteintes. Dans la mesure où l'on admet que la mise en valeur du Sahel est interdépendante de celle de la région sahélo-soudanaise qui la prolonge vers le Sud, tous les espoirs sont permis de sauver le Sahel.

2. What changes are taking place ? Are they inevitable ? What are the major facets of interrelations of change in climate, population, agricultural production, land use and environmental quality ? Specifically, where is the energy to come from for development, for fertilizer, transportation, etc ...

La sécheresse s'est traduite par divers changements qui concernent les différents termes du couple ressources (sols, végétations, eaux) populations (humaines et animales) dont les effets et les conséquences seront de durée variable.

Ressources en sols

Sur le plan des ressources en sols, certaines transformations sont pratiquement irréversibles. C'est le cas de l'augmentation de la salure des sols dans l'estuaire du Sénégal du fait de la diminution du volume des crues et celui de la remise en mouvement de dunes autour des forages, consécutive à la dégradation complète du couvert végétal par surpâturage. Mais au total, les surfaces concernées sont relativement faibles.

Ressources végétales

Sur le plan des ressources végétales, très affectées par la succession d'années à pluviosité déficitaire, la modification des formations végétales peut être considérée comme temporaire. Dès retour d'une période de pluies favorables, de durée suffisamment longue, la recolonisation des terrains dénudés se fera progressivement. Cependant, une dégradation irréversible

de la végétation est à craindre par suite de l'érosion génétique de certaines espèces graminéennes et de la progression de la brousse tigrée, type de formation végétale qui se développe de plus en plus, et qui est considérée comme un faciès de dégradatio difficilement réversible.

Ressources en eau de surface

Les variations des ressources en eau de surface ont été le fait le plus apparent de la sécheresse. Si l'on considère les débits moyens annuels, le déficit par rapport à la moyenne a été de 65 % pour le Sénégal (264 m3/s au lieu de 764 m3 moyenne de 68 ans), 30 % pour le Niger à Koulikoro (1080 m3/s au lieu de 1540 m3/s, moyenne de 66 ans), 54 % pour la Volta noire, 36 % pour le Niger à Niamey, 45 % pour le Logone à Lai, 55 % pour le Chari à N'Djamena (578 m3/s au lieu de 1280 m3/s, moyenne de 32 ans). Plus au sud, pour la Sanaga à Edea (Cameroun), le déficit est de 30 % (débit moyen 1440 m3/s au lieu de 2070 m3/s) et pour la Sangha à Ouesso (tributaire du Congo) le déficit est de 30 % (1270 m3/s au lieu de 1800 m3/s). En Côte d'Ivoire, pourtant en dehors du Sahel, toutes les rivières ont été affectée soit par l'augmentation de la durée de tarissement, soit par l'époque anormale de ce tarissement, soit par une diminution de débit.

En Mauritanie et également au Sénégal, les conditions des cultures le long de la vallée ont été bouleversées soit à cause de crues trop faibles, soit en raison de décrues trop rapides du fleuve Sénégal.

Au Tchad, le niveau du lac a baissé entre 1964 et 1974. Il a atteint en juillet 1973 ses cotes les plus basses avec coupure de l'archipel au sud-est, exondation de la grande barrière et assèchement d'une grande partie de la cuvette sud. Le fait le plus important est la fragmentation des eaux libres de la cuvette nord en deux poches, à la suite de l'exondation de nombreuses îles sableuses dépourvues de végétation. Le volume des eaux stockées n'est plus que le quart de la normale et la surface du lac est réduite de moitié. Elle est devenue comparable à ce qu'elle avait été durant la précédente période exceptionnelle de sécheresse de 1906 à 1908.

De nombreux abaissements du niveau des nappes phréatiques ont été signalés. En Mauritanie, 10 % des puits sont asséchés ; au Tchad, certains puits de plus de 20 mètres de profondeur ont tari et partout des abaissements de nappes de 3 à 5 mètres ont été enregistrés.

Ressources en eau de profondeur

L'évolution des ressources en eau a été très rapide mais l'arrivée de saisons de pluviosité favorable devrait permettre le retour à des conditions normales. Ce retour risque d'être décalé dans les temps en ce qui concerne les nappes peu profondes pour lesquelles la réalimentation se réalise lentement par drainage dans les sols et les talwegs. Des recherches sur les conditions de recharge des nappes seraient donc nécessaires.

La mortalité du bétail, des bovins surtout, a été très spectaculaire dans certaines régions du Sahel, en particulier à Agadès (100 % des troupeaux), et au Tchad où les pertes sont évaluées à 1.500.000 têtes. Néanmoins les pertes sont difficiles à évaluer

et il ne faut pas sous-estimer celles dues à la mouche tsé-tsé dans les troupeaux qui ont eu la possibilité de migrer vers les régions soudaniennes. On peut admettre que la reconstitution des élevages est théoriquement aisée, mais de toute façon elle demandera plusieurs années lorsqu'il reste un troupeau suffisant. Quand ce dernier a été éliminé, le goulet d'étranglement, pour des éleveurs ayant perdu toutes leurs ressources, sera l'achat des premières têtes.

Peuplement Humain

Le peuplement humain a souffert de la sécheresse. Il y a eu des pertes de vies humaines, des problèmes graves de santé et de nutrition, enfin des déplacements importants de populations.

Les pertes en vies humaines sont difficiles à évaluer mais le chiffre de 100.000 morts a été avancé pour l'Ethiopie et du fait de la sous-alimentation, la mortalité infantile a été augmentée considérablement. Surtout les aléas climatiques ont modifié complètement la répartition spatiale des populations. Les nomades ont été obligés de migrer vers le sud où ils se sont trouvés au contact des agriculteurs dont la sédentarisation était parfois récente. L'équilibre traditionnel qu'ils maintenaient entre les parcours de saison sèche et les parcours de saisons de pluies ont été perturbés. Ainsi dans le cercle de l'Oudalan, en Haute-Volta, il en est résulté rapidement une surcharge locale de bétail et le surpâturage a obligé de nombreux éleveurs qui pratiquaient la transhumance à migrer vers les cours d'eau perennes.

Ceux des nomades qui avaient perdu tous leurs troupeaux se sont repliés vers les villes pour y trouver de l'eau et des vivres. Même si les conditions climatiques redeviennent rapidement favorables, la plupart d'entre eux seront dans l'impossibilité de reprendre leurs activités antérieures. Ainsi, la sécheresse aura provoqué un afflux de sans emplois dans les villes et ce phénomène sera pratiquement irréversible.

Production agricole

La production agricole a été perturbée car les rendements ont été fortement abaissés pour le mil, le riz, l'arachide le coton. Cette situation peut être que temporaire si les conditions redeviennent meilleures. Par contre, certaines des conséquences risquent d'avoir un impact de longue durée sur l'économie des Etats. En particulier la diminution des exportations, l'augmentation des importations de vivres, la dégradation de certains réseaux routiers localement surexploités, risquent de compromettre pendant longtemps le développement, d'autant plus que la réduction des réserves en devises provoque une diminution préoccupante des possibilités d'investissement.

En définitive, les changements occasionnés par la sécheresse concernent essentiellement les divers termes de l'équilibre population-ressources. Le retour de conditions climatiques plus favorables peut provoquer une reprise de l'économie agricole et pastorale. Mais certains changements sont irréversibles, en particulier ceux provoqués par l'érosion et la dégradation des sols et ceux qui se sont concrétisés par une migration définitive vers les villes.

Cependant il n'est pas souhaitable de voir se reconstituer les situations anciennes, génératrices de désastres dans de tels cas de plusieurs années consécutives de sécheresse. De tels accidents climatiques doivent être considérés comme pouvant se renouveler et il serait judicieux en conséquence d'organiser rationnellement le repeuplement du Sahel en hommes et en animaux.

Moyens à mettre en oeuvre.

Les engrais

Les engrais sont un des moyens pour augmenter les rendements sur des sols généralement pauvres sur le plan chimique. Mais leur utilisation ne peut se concevoir rentablement que si elle est strictement complétée par l'adoption de techniques agricoles combinant les assolements, les façons culturales, les variétés précoces. Il vaudrait mieux commencer par une diffusion accélérée de ces techniques avant de tenter un nouvel effort dans la commercialisation des engrais.

Les Transports

Une amélioration des conditions de transport est partout souhaitable, mais les investissements seront particulièreme rentables dans les régions actuellement privées de moyens de communication mais constituées de sols fertiles sous-exploités. Ces derniers sont d'autant plus productifs qu'ils sont situés sous des pluviométries plus favorables et à notre avis cela conduit logiquement à porter les efforts vers un développement coordonné des régions sahéliennes et des régions soudaniennes conti-gües. Les régions d'élevage exclusif, les régions d'agriculture et d'élevage et les secteurs d'irrigation doivent être interdépendants et c'est dans cette voie que les efforts seront les plus utiles.

Utilisation intensive de l'eau

Dans tous les cas, et quels que soient les écosystèm la solution des problèmes de mise en valeur du Sahel réside dans une meilleure rentabilisation de l'utilisation de l'eau. Elle peut et elle devrait se faire à plusieurs échelles et en premier lieu par la réalisation de grands projets d'irrigation avec création de barrages hydro-électriques(création de réserves d'eau) et régularisation des fleuves. Ce sont les seuls moyens de doter le Sahel et les régions adjacentes d'une économie relativement indépen dante du facteur climatique. Les avantages sont multiples : le développement de cultures variées de riz, de canne à sucre, permett de limiter les sorties de devises et de consacrer ces dernières à des investissements locaux.

Problèmes énergétiques.

L'augmentation du prix de l'énergie risque d'avoir des conséquences graves pour les Etats du Sahel. D'une part, il ne semble pas, dans l'état actuel des connaissances, que l'on puisse espérer trouver du pétrole dans cette région. D'autre part, les Etats en question ont des possibilités très limitées d'exportations leur permettant d'espérer une amélioration de leur balance commerciale. Ils risquent donc de faire partie d'une catégorie spéciale du Tiers-Monde, la plus défavorisée.

Cependant, deux sources d'énergie peuvent être développées au Sahel, d'une part l'énergie hydroélectrique par la mise en place de grands barrages, d'autre part l'énergie d'origine solaire.

De très nombreux sites possibles de barrage ont été inventoriés sur les grands fleuves qui traversent le Sahel et les régions soudanaises adjacentes. Certains de ces barrages sont en place comme celui de Sansanding, de Markala et de Sotuba, au Mali, ou en avant-projet comme ceux situés sur le Fleuve Sénégal, à Manantali et sur le Delta.

Mais de nombreuses autres possibilités existent. Ainsi en Haute-Volta, tous les sites reconnus ne sont pas exploités malgré l'existence d'une centaine de petits barrages de 7 à 8 mètres de hauteur. Des aménagements plus importants sont possibles sur le Sourou, un affluent de la Volta Noire, et également en plusieurs localisations de ce dernier fleuve, à Dedougou en particulier.

Sur le fleuve Niger et ses affluents, plusieurs possibilités ont été envisagées, suite aux travaux des hydrologues. Citons les sites de Kandadji, de Tossaye à la sortie du delta central ceux situés dans la région du W, ainsi que ceux sur la Mekrou, à Oyodonga, et sur le Niandan, à Baro.

Au Tchad, diverses solutions sont possibles pour la régularisation du haut Logone, l'aménagement des lacs Toubouris ainsi que pour l'utilisation de sites sur le Mayo Kebi.

En définitive, l'inventaire des possibilités d'utilisation des eaux de surface montre que l'on peut envisager quelques grands barrages aux possibilités hydroélectriques relativement importantes, et de très nombreux sites de petits barrages à vocation hydroagricole ou d'adduction d'eau pour des communautés locales. Les données recueillies par les hydrologues sont suffisantes dans la plupart des cas pour mettre au point les avant-projets.

Les ressources hydroélectriques que peuvent fournir les grands barrages présentent une importance particulière car elles permettent d'envisager, dans certains cas, la mise en place d'usines d'engrais, dans d'autres, la mise en valeur de gisements miniers actuellement inexploités (cas du Mali). Cependant elles ont l'inconvénient d'être localisées en quelques points particuliers Dans le reste du Sahel l'énergie solaire pourrait être une solution avantageuse.

En effet, les conditions climatiques sont particulièrement favorables. L'ensoleillement varie de 2 200 à 3 400 heures par an et l'intensité moyenne de la radiation solaire est de 0,8 kw/Sq m/h. L'énergie solaire peut permettre une dispersion des sources d'énergie dans tout le Sahel, en particulier pour l'exhaure de l'eau souterraine des puits et des forages. C'est par ce moyen que l'on peut espérer organiser rationnellement l'élevage dans les régions sahéliennes et sahelo-soudaniennes et éviter qu'il y ait, autour de grands barrages, des zones particulièrement favorisées et partout ailleurs des régions délaissées de plus en plus marginales sur le plan économique. Il faut d'ailleurs ajouter que l'utilisation de l'énergie solaire pour la réalisation des travaux de cuisine pourrait sauver annuellement 20 millions de tonnes de bois et limiter l'intense déforestation qui se développe actuellement tout autour des grandes villes. C'est en combinant ces diverses solutions énergétiques et en tenant compte des contingences socio-économiques locales que l'on pourra mettre en place les conditions d'une économie stable dans le Sahel.

Appendix VI

The Sudano-Sahelian Zone

by

L. K. Opeke

Introduction:-

The Sudano-Sahelian problem has accumulated gradually. The drought of 1972/73 only triggered off an already potentially explosive situation. The Sahelian zone can be roughly divided into two agricultural (economic, social and developmental) belts. (a) The most northern part which is characterised by pastoral economy. Here the pastoral people (nomads) have achieved a delicate balance by utilizing the barest minimum of pastoral resources to raise cattle and other classes of livestock at extremely low cost. These nomads obviously live under precarious conditions, but all the same, they maintain a delicate balance with the environment. The people occupy roughly the area between Isohyetes 100 to 300mm.. Practically no crop production activities exist except in valleys and fadamas. There is the barest minimum of irrigation. (b) South of the nomadic belt, a small-grain (Sorghum, millet, jero etc.) producing belt. This belt enjoys (irregularly) 300 to 600mm. rainfall per year. This is the crop economy zone. Although divided into two for descriptive purposes, there is considerable overlap of these two belts.

Thus, the basic problems of stable life in the zone are well known. These problems consist in increasing productivity, improving social services, furthering the welfare of the people - all resulting in guaranteeing the inhabitants of the zone an above--average standard of life. Apart from drought compounding the problems, the task is not an easy one. The drought disaster has, however, demonstrated the urgency of attending to the problems of the zone. Roughly, one may forecast that complete rehabilitation of every inhabitant is not possible, but the efforts will only achieve success if fewer people are made to live the present precarious life, while more and more are settled either to mixed farming activities or other employment. Those remaining may then have improved grazing opportunities and more steady livestock production prospects.

This change will involve not only the agricultural (pastoral) activities of the people, but the totality of their outlook and ways of life.

The objective of this outline, is to focus attention on a few areas needing attention both for short-term and longer-term development of the Sudano-Sahelian zone.

The outline will attempt to define:-

(a) Priority areas

(b) Programmes and projects

and (c) to spotlight inherent problems that call for interdisciplinary/ multidisciplinary approach. These are mostly institutional problems.

Priority areas:-

Basic problems of development in the Sahelian zone are well known. The people and the Governments of the zone have continiously made attempts at development. The objectives are increased productivity, security of production, improving the social and economic status and improving some aspects of the outlook and beliefs of the people eg. keeping their wealth and/or savings on the hoof instead of in banks.

(a) Relief: The current disaster calls for immediate relief action. Many world authorities have responded to this need. These operations, especially the food aid, cannot and should not be allowed to become a permanent feature because of the likely long-term effects on the attitude of the people concerning self-reliance.

(b) Repairs:- In parts, the governments in the zone had installed small scale irrigation, pumping stations, dug wells, watering points etc. for animals. Most of these installations are either in very bad states or in ruins. In the short-term, repairs are essential.

(c) Health Services:- There is much loss of vigour both in men and their livestock. Medical and veterinary services need expansion both on the short and longer-terms.

The above and other simple steps are necessary in the short term.

(d) Improvement of Communication - land and air.

Longer term approach:- Consideration of any longer term approach to solving the Sahel problems must take into consideration a number of basic issues. A few of these are outlined.

(a) The environment:- The balance between the inhabitants of the zone and the environment is delicate. This biological balance is easily tipped off by even a small change in the

regular pattern of climate. Most of the area has been overcultivated/overgrazed. The original sparse vegetation has, through activity of man, been turned to man-made desert or potential desert. This obviously raises the question: Could the Sahel further support man and his animal? This question will be attempted later. Note also needs to be taken of the obvious spread of the Sahara southwards. Can this be arrested or prevented?

(b) Life of the people: The nomads and the planters have necessarily lived a mutually benefitting co-existence. This balance has been disturbed by the drought. Not only that: when the environmental - inhabitant delicate balance was maintained, the population of both men and animals increased. The carrying capacity of the Sahel was possibly taxed to breaking point. Intra-communal competition sets in, this resulting in intra-communal bitterness, jealously and potential strife. Maybe the catastrophe of the last few years had restored things to normal. The future: where is this stable balance? Locating the balance, how can the Status quo be maintained?

(c) Climatic Cycles: Very little is known about the climatic cycles in the zone. This lack of knowledge makes long term planning very difficult.

(d) The people: This is the most difficult aspect of the Sahel problem. They are used to a way of life. Are they prepared for a change? Their attitude to life, food habits, nomadic life, etc. etc. These are psychological problems which are basic to any longer term planning.

(e) Food habits: Major food supplies are the small grains. It is claimed that vegetables are not grown. Maybe vegetables are not cherished: the meal of milk and grains sufficing. Can this be changed?

(f) Financial resources: No problem to development (short or longer term). Better endowed people (in other parts of) the world are prepared to help.

(g) Mineral resources: Underground water, petroleum, metallic ores etc. - knowledge very little - survey is the answer.

Approach to the Problem.

Listing the problems will not solve them. Approach to the solution of the Sahel problem must be biological, social,

psychological and institutional.

To begin with:-

(a) a better knowledge of the ecosystem is necessary.

(b) need to ascertain the potential carrying capacity of the environment, optimum man and/or animal density per sq. km..

(c) psychological and institutional study of the people.

(e) a better knowledge of the natural resources - water (surface and underground), mineral etc. etc..

All the above call for immediate but intensive study if a meaningful longer term development of the zone is envisaged.

It is obvious from this short outline, that more knowledge of the area is a must. Short duration study visits appear to me not the answer. A permanent study group (a multipurpose research institution) appears the answer to the current lack of knowledge. Such an Institute has to be MULTIPURPOSE, (Biological - Psychological - Economics anthropological - Home economics - even Religion).

The main assignment of such an International Multipurpose Study/research centre could include:-

1. Agricultural (fishery, forestry etc. etc.) and pastoral studies.
2. Institutional Studies.
3. Development of backyard gardens-based on household waste waters - vegetables for family consumption.
4. Economic studies Trade, banking, marketing, etc. etc..
5. Crash Education programme.
6. Relegious Studies - to determine the magnitude of the effects of religion on the behaviour of the people; and the possibility of rapid change.
7. Communication and transportation system improvement.
8. Introduction of intermediate technology - wheel barrows, motor-cycle drawn trailers etc. etc..
9. Investigate the possibility of gradual concentration of the population on the southern part of the Sahel.

and 10. The likely impact of improving agricultural (food) production in southern - neighbouring countries for consumption in the Sahel - (this involves political etc. issues).

The agricultural and pastoral activity of such an institute must differ from those of the traditional institutes. The programme must be <u>absolutely</u> problem-<u>solving</u>. It must include a very strong team of plant breeders who will rapidly assemble crop and vegetable

types of short season growth duration from all parts of the world, test them rapidly, select, and with the assistance of the other specialists introduce them to the system. Introduction of new crops like Soybean, guar etc. to the staple foods of the people could be resisted. The probable answer is for such an institute to have a strong food technology programme (concentrating on food processing research, integration of new foodstuffs into locally favoured diets etc.).

The operations that need to be undertaken in the Sudano-Sahelian zone can be grouped into three.

1. Immediate relief operations which are in progress.
2. Medium range operations such as road constructions, seed supply, water conservations, livestock restocking (needing medium range study). The medium range studies could be done through visiting experts or organisations such as the Association for the Advancement of Agricultural Sciences in Africa (AAASA): Association for Social Work Education in Africa (ASWEA) and/or Economic Commission for Africa (ECA).
3. Longer term operations such as agroecological surveys including carrying capacity of the land, most of the assignments listed for the multipurpose institure. Here too organisations such as the AAASA, ASWEA and ECA should actively participate.

The above is strictly sketchy. It is hoped that the main issue would emerge through discussions.

16/10/74

Appendix VII

Research Group on the Least-Developed Nations
Program on International Development and Social Change
Clark University

DISTINCTIVE ENVIRONMENTAL PROBLEMS OF THE WEST-AFRICAN SAHELIAN-SUDANIC LEAST-DEVELOPED COUNTRIES
A Note

As part of its collaborative research effort on the relationship between environment and development, six distinctive groups of 34 of the poorest nations have been identified for further study and analysis. Four of these groups are primarily African states: West-African Sahelian-Sudanic (plus North Yemen), West-African Coastal (plus Haiti), East-African Coastal, and Landlocked States in Eastern and Southern Africa. We have intensively studied one of these groups, the West-African Sahelian-Sudanic group, in an effort to identify problems related to environment and development distinctive to this set of countries and not necessarily shared with other groups of least-developed nations.

Our inquiry has focussed on the import of three environmental characteristics: ecological stability, land-lockedness, and the non-agricultural resource base and on the long-term environmental impact of technology and development activity in the region and of the current drought. For each, we have tried in this brief note to succinctly state the problem, offer an observation as to the prevailing wisdom or speculations, identify a central question for research, and an indicated approach for development activity.

Ecological Stability

The Sahelian-Sudanic zone is an ecological system marked by low productivity, sharp and significant fluctuations in areal potential, and long cycles of resource exploitation and regeneration. Successful human use of such a region has always been characterized by mixed strategies: extensive exploitation of low-productivity resources, intensive exploitation of widely dispersed and small but favored environmental opportunities for agriculture, high mobility of

peoples and long-term storage of resources in the form of animals.

The prevailing sentiment is to characterize the area as ecologically fragile. Except for the highly-localized problem of sand deposition from late pleistocene sediments, the ecological system of the Sahel is exceptionally robust, or in Holling's terms resilient--plants and animals well-adapted to extreme variation are highly capable of survival and recovery, albeit accompanied by extreme short-term fluctuations in numbers and areal occupation. The managerial implications of focussing on resilience rather than instability as the central characteristic need to be explored. The attention on the stability of the Sahel diminishes attention on what may be truly fragile--the Sudanic zone where cattle and crops mix to the possible sustained detriment of the environment. The few detailed studies from Eastern Africa indicate the highest erosion rates for such areas.

The central research question is how to adapt the traditional, mobile, multiple resource exploitation strategy to the realities of the severe changes in scale of movement which have taken place. On the one hand, pastoral mobility has been restricted, and there is a decrease in land available for multiple pasture and agricultural use. Conversely, an increase in opportunity for both market and migration have produced net outflows of energy and wealth from the area.

Indicated approaches to development activity favor the modernization of pastoralism rather than sedentarization of pastoralists, intensifying with water the use for agriculture scattered areas of environmental opportunity, and facilitating opportunistic shifts between animals and crops within households and between groups.

Land-Lockedness and Isolation

All of the countries but one of this group are landlocked; all are isolated.

Within countries, population densities are low, central places few and far between, exacerbating problems of providing services, marketing crops and animals, exploiting mineral deposits.

Much current concern focuses on improved communication with the metropole, wealthier neighbors to the South or ports to overseas. But in a special sense, the isolation of these land-locked ~~states~~ is of recent origin, externally imposed by the orientation of trade and aid to Europe. In historic time, an internal, within African, trade turned currently isolated nations into important centers. And to this time, long existing reciprocal linkages of the folk-trading society persist.

A central research question is how to encourage self-sufficiency in human and social services dealing with health, education, nutrition and the like for severely isolated regions and nations.

Indicated approaches to development activity to decrease isolation lie in expansion of appropriate East-West rather than North-South communications, trying to phase movements of services to people or goods to market with the considerable normal movements of people and animals, substitution of animal and water transport for increasingly higher cost motor transport, and encouraging local paraprofessional human and social services.

Non-Agricultural Resource Base

Major non-agricultural resources of mineral and forest can serve, if properly developed, as important aids to development activity. The poorest countries are generally marked by an absence of these opportunities. The Sahel-Sudan without forests is also with one or two exceptions without current sources of mineral revenue.

Current wisdom ranges from viewing the region as a poor prospect for mineral occurrence, or conversely viewing the area as a good prospect with

significant finds awaiting economic opportunity and concealed in cloaks of corporate or governmental secrecy, or unknown, the least-developed being the least explored.

Given such uncertainty, a major research need is to consider how to link mineral resource survey, exploration, and exploitation with rural development activity. Mineral survey should be broadened to provide needed information for agricultural and water resource development and areas for survey need to be related to the potential for other development activity.

Indicated development activity would be to explore the alternative of moderate subsidizing of extraction of known resources to compensate for isolation and distance, to consider linking surveys of ground water with mineral survey, and to have a high-level review of known geologic data.

Impact of Technology and Development Activity

By other nations' standards, the introduction of technology and development activity has not been excessive, much development aid has gone to support ongoing administration. Nevertheless, veterinary services have increased, deep wells have been drilled, cash crops introduced, and a few major irrigation efforts undertaken. What has been the impact of technology and related development activity?

A much publicized view has been that of attributing to the introduction of technologies and development activity perverse effects, exacerbating the impact of the current drought and enlarging ecological instability. Some effects of such activity are well-known, e.g. the deterioration in vegetation around new wells or the reduction in food surplus with cash cropping. What is not known is the overall impact of such activity on human systems. In a region where the effect of development of all kinds has been slight, it may be more proper to observe the failure of activity to ameliorate rather than to exacerbate current

problems.

A central research need is to develop a methodology for both analysis and implementation of appropriate technology. The controversy between capital-intensive and labor-intensive, between high and intermediate technology and between technological fixes and social engineering heighten the issues but are inadequate for solutions. A focus on technology appropriate to social systems and purpose can lead to many mixes of capital and labor, high and intermediate technology, and technology utilization and institution building.

Indicated approaches to development should be one of caution insofar as a new technology or development activity makes excessive demands on the skills of the region, monopolizing them in a narrow fashion; or requires monitoring and evaluation that cannot be assured. The best starting points for technological inputs are the river basins and the lake shores where some of the pitfalls of technology in Africa are reasonably well studied and where the opportunities for development are large.

Impact of the Drought on Long-Term Development

Six years of drought may or may not have ended with the current rains. What is the impact for long-term reconstruction and development?

The impact of drought or any disaster is most unequal, victims and families pay the ultimate price, others even profit. Inequality in the face of drought or flood extends to nations. In general, developing countries suffer relative losses 10 times greater than developed countries. It is widely feared that the drought's impact on the Sahel are long-lasting, creating a long term economic and ecological disaster for the area by increasing desertification, destroying nomads' pastoralism, accelerating migration to urban places within the region and of the young to other countries, overloading the fragile institutions, and diverting scarce funds and people to high-cost relief and disaster efforts. At

the same time, the drought is seen as opportunity for new attention to the area, new effort at regional integration, new opportunities for river basin development or improvement of food supply.

If studies of disaster reconstruction are indicative, and these are too few to be predictive, then neither of these views may be realized. The trend of the evidence to date is that drought or other natural disaster accelerates bot does not change on-going trends in a fundamental way and that much of the opportunity posed by coping with environmental stress is frequently unrealized.

A central research question is how to reduce the human cost of drought occurrence in the face of the atrophy of traditional measures of coping with drought and sharing losses and the weakness of the new institutions needed for drought prevention, relief and reconstruction.

Indicated development activity should assume the recurrence of drought in the area, provide institutions for increasing, storing and distributing regional food supplies, and carefully examine economic policies and development activities for their inadvertent effects of increasing drought loss vulnerability.

October 3, 1974

Appendix VIII

"Building to Strengths"

Presented at Conference on
INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

by
Michael M. Horowitz

The greatest resources for development in the Sahel are its enormously knowledgeable, hardworking population of herdsmen and farmers, who have developed productive strategies adapted to the demands of this marginal environment. A program of interventions should reinforce their abilities to sustain themselves in dignity and to expand the contributions which they make to the larger society. Accordingly, we propose that parallel with and in anticipation of the more spectacular high technology capital intensive programs elsewhere recommended in this document there be the widest possible distribution of low risk, modest technology, high local participation programs to increase, without environmental degradation, the outputs from pastoral dairying and rainfall-fed small-scale agriculture. The point is to increase the amount of food people have to eat with some reasonably assured surplus for commercialization, and to facilitate the creation of a marketing system which provides them with a better return for their labors. This action, geared to the needs of the poorest and least powerful segments of society, should serve also as a brake on the rural exodus, since increased yields and incomes, and increased investments in the countryside, will make rural living both more feasible and more attractive.

Appendix IX

"Issues in Sahel Development over the Long Term"

Presented at Conference on
INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

by
Samuel C. Adams, Jr., Assistant Administrator
Bureau for Africa, Agency for International Development

How do we see the Sahel as of October 24, 1974? How do the region's people view their situation? With what satisfaction or disappointment have they regarded the massive interventions of external donors of food and non-food aid, emergency relief, the numerous visitations of the controllers of drought relief, and the wave upon wave of planners and programmers of medium-term recovery and regular external assistance? How do the six states differ now from what they were when they became disaster areas?

A discussion of main issues in Sahel development planning must begin with an updating of our perceptions about the Sahel and a clarification of what we believe to be true about the Sahel as of October 24, 1974. The Sahel clearly has not been in suspense since the crisis of drought caught public attention, nor presumably can anyone now "blueprint" it into a different system by the year 2000. However, processes can be set in motion now which will give it extended options and new capacities.

The Current Situation

The October 21 - 22 Washington, D.C. visit by representatives of the OMVS states is illustrative of a current event relevant for dis-

cussion of main issues in Sahel development over the long term.

The representatives of the OMVS came to the U.S. seeking a U.S. commitment or pledge of a specific funding for their program of long-term development of the Senegal River Basin. While they recognize the generosity of U.S. food and non-food aid, they understand little of the processes required to bring this about. For example, Section 639 B of the U.S. Foreign Assistance Act directs the Executive Branch to consult and plan along with all interested countries and international organizations a comprehensive long-term Sahel development program. Multidonor support of considerable magnitude will be a necessary condition for addressing the longer term problems which the drought has exacerbated. Our hopes to maintain significant levels of U.S. aid as well as that from the donors depends upon:

. institutionalization of donor interest in the Sahel, and

. demonstration to the international community, the U.S. public, and the U.S. Congress of the ability to implement programs effectively in spite of operational difficulties.

The "impatience" felt by the three states with "getting on" with the execution of a program of long-term development becomes a fact of considerable substance in discussion of Sahel long-term development issues. The feeling that programs of development must clearly be managed by them and must be their own is of paramount importance.

What should be the organizational characteristics for cooperation among donors? What mechanism exists for conciliation or identification by donors of their special areas of interest, and the ways in which they propose to provide aid?

The task of furthering substantive movement towards greater progress in international external donor and host country efforts toward long-term development is, in my view, more pressing than emergency relief and rehabilitation or additional planning for medium-term programs. How should the approach to the problem be organized and what might be the process used to maximize not only soundness of programs, growth in absorptive capacity, but to offer greatest assurance that the programs be manageable by the people and are their own.

Longer term development objectives must materially alter and extend the options that the habitat provides for human survival and at the same time substantially improve the quality of human capacities for managing their well being. Can the aspects of these tasks which belong properly to longer term development objectives be differentiated now from some of the large ongoing projects being planned or underway, e.g., the new road from Bamako to the Ivory Coast border, or the $40 million being provided by the U.S. for livestock, seed multiplication, national cereal production programs in Mali, Upper Volta, and Niger respectively?

The preceeding remarks aim principally to suggest that in pursuit of our conference objectives, our discussions cannot have their own melody or result in a statement of postulates about the Sahel planning problem as though the region has been "frozen" in time or that it is prepared to accept externally directed concepts and solutions to its problems. There is a need to address the long-term development problems of the Sahel and the bordering areas as reflected currently in a world of fluctuating commodity prices, food pressures, and potential economic and political instability. The approach must be understood to be responsive to humanitarian instincts of developed nations and their worldwide ecological and food production concerns.

This meeting can offer a timely opportunity for clarifying which perceptions about the Sahel require updating. Issues of longer term development planning have greater urgency for discussion now to avoid risks that publics may conclude that the Sahel problem is intractable. We are all ready for a different threshold of activity. Mass famine has been made wholly unlikely for the present yet costs of maintaining this capacity makes it largely dependent upon external support systems. Each year costs for emergency aid will be increasingly greater for donors and recipients without substantial amelioration in the processes which render the area unable to feed itself, even without consequences of an exacerbating drought. The numbers, nature, and distribution of distressed populations have been changing. Throughout all, the Sahel has greater capacity and experience in managing the disaster. An important point to bear in mind during this conference discussion is that portions of the area feel they already have a strategy and an integrated program of long-term development.

For example, amounts above $200 million have been pledged by donors towards realization of the OMVS long-term development program. Additional levels of investment, much higher than heretofore available to any of the countries, have been committed in the current calendar/ fiscal year or will be committed in the next year under headings of emergency R & R activities, medium-term or regular programs. Yet at the same time, the lessons of the past concerning the ecological implications of river basin development cannot be ignored.

Sahel Longer Term Development Requisites

Greater progress has occurred to date among external donors and host countries in managing the arrangement of food availabilities,

delivery/distribution, than in defining longer term development requirements. Most consultation/coordination that has evolved relates specifically to the food problem and to matters of programming non-food emergency, relief and rehabilitation or medium-term activities.

In the face of meeting the emergency, substantive progress has lagged in reaching agreement on definitions of longer term objectives toward which international donor effort ought to be oriented. Moreover, no effective institutional arrangement for donor coordination on long-term program has been established to lay out a program upon which long-term commitment to the region can be sought, e.g., the World Bank's/WHO role in program/project development for Control of River Blindness in West Africa.

Issues Arising out of Longer Term Development Planning

What are the essential propositions about the Sahel relevant for longer term development planning starts upon which all can agree? How much data, i.e., in what minimum scale can a data bank be fashioned to allow for meaningful further progress in fiscal year or calendar year '75 and beyond to hasten sequential programming of longer term development planning decisions? What are the modalities to be considered for making greater progress toward responsibly organizing action and commitment toward longer term development by the international donor country and the host country under some institutionalized arrangement?

Some Propositions which Would Appear Relevant to Sahel Longer Term Development Planning

Long-term development must anticipate that people and their lands can acquire new or modified careers. Major inputs of infrastructure

and trained personnel must be counted upon. The region's capacity to absorb aid and to create its own growth patterns must be urgently assisted.

The region's past misery and even its current crises are partly due to imbalances in the interaction between man and land and vagaries of weather. Often overlooked as an element in the area's present problems has been its continued existence as a colonial economy, i.e., its dependence on a limited number of export crops.

The vitality of any efforts to substantively achieve breakthroughs in rendering the area more agriculturally productive, in enabling it to provide employment for the population, and to fashion and support institutional bases relevant for survival, e.g., schools that educate--will depend in large measure upon policy decisions made outside the Sahel which bear upon possibilities for change in nexus of relationships of the region and major world economies. Substantive extension of options for the human beings of the area will not meaningfully occur otherwise over the long term. A very fundamental issue for long-term development must involve assessment of the feasibility of a realistic modification in interaction between the region and other parts of Africa, and most importantly the relationships with the major developed economies.

Appendix X

"Improving Capabilities for Food and Livestock Production"

Presented at Conference on
INTERNATIONAL DEVELOPMENT PROBLEMS IN THE SAHEL

by
Samuel C. Adams, Jr., Assistant Administrator
Bureau for Africa, Agency for International Development

Within the harsh and demanding Sahel environment people, largely through a folk tradition, perpetuated an experience which insured their survival and the continuity of generations at tolerable levels in spite of the vagaries of weather. On balance, though many died each year and subsistence was at low levels, their adaptive systems showed an extraordinary skill and genius for keeping men and animals alive largely without external help. The drought decimated most of these traditional capacities. The agricultural support systems and animals upon which food and livestock production depended were subjected to great losses. Traditional skills were rendered largely irrelevant and an erosion in zest occurred.

For these peoples who are to continue their careers on the land, restoration of their capacities to be food and livestock producers will require not only the providing of seeds, fertilizers, and animals, but more importantly new skills. Fundamental among new skills to be developed must be a better understanding of the interaction between man and his environment in the production of plants and animals. Extensions of

capabilities in these domains obviously will call for earliest attention to the providing of means of production, a substantial modification of the habitat to reverse degenerative trends, and accelerated means for large scale implementation of extraordinarily innovative approaches at developing new survival skills within the population. The new survival skills, to fully extend capacities for food and livestock production, must go beyond new skills in agricultural production and animal husbandry techniques. They must include particularly extension of capacities for understanding land management and conservation processes. Among additional skills needed to extend capacities of people, there must be consideration to problems of nutrition and health if human zest and vitality are to be restored.

Appendix XI

FIFTH MEETING OF THE ADVISORY PANEL ON SUB-SAHARAN AFRICA

Washington, D.C., 18 December 1974

National Academy of Sciences, Main Building, Room 180

Panel

JOHN J. MCKELVEY, JR., Associate Director, Agricultural Sciences, Rockefeller Foundation, Chairman

THADIS W. BOX, Dean, College of Natural Resources, Utah State University

GUY C. CAMUS, Director General, Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), Paris

HAROLD E. DREGNE, Department of Agronomy, Texas Tech University

ROBERT KATES, Department of Geography, Clark University

GEORGE I. LYTHCOTT, Associate Vice-Chancellor and Professor of Pediatrics, Center for Health Sciences, University of Wisconsin

THOMAS F. MALONE, Director, Holcomb Research Institute, Butler University

PETER F. M. MCLOUGHLIN, President, Peter McLoughlin Associates Ltd., Comox, British Columbia, Canada

DEAN F. PETERSON, JR., Vice President for Research, Utah State University

LEE M. TALBOT, Council on Environmental Quality, Washington, D.C.

GEORGE M. VAN DYNE, Professor of Biology, Natural Resource Ecology Laboratory, Colorado State University

AID

I. COKER, Deputy Director, Central West Africa Regional Office

LOIS HOBSON, Special Assistant to the Administrator, Africa Bureau

PRINCETON LYMAN, Director, Office of Development Services

NAS

M. G. C. MCDONALD DOW, BOSTID

JAY DAVENPORT, BOSTID

JULIEN ENGEL, BOSTID

JUDITH PORTER, BOSTID

Dr. McKelvey welcomed participants and introduced Dr. Camus to the meeting, it being his first.

Special Reports on the Sahel

MIT Report

Dr. Van Dyne. The draft MIT report was a massive effort well-funded which was difficult to critique since the conclusions and recommendations had not been included in the draft. Thus, it was only possible to infer the conclusions and to critique the methodology and approach. The twelve volumes of the draft report were perhaps not as well coordinated as they might be in the final form, and there was a certain amount of duplication of information in a number of sections. A variety of analytical techniques were used. Some of the subreports were graduate student thesis topics. For example, linear programming analysis was applied to the analysis of the industrial sector and simulation modelling techniques to the village

in the Sahel. The draft study concentrated mainly on three interacting loops, or vicious circles, and procedures by which these might be broken. While the recommendations were not included, many of the inferred conclusions were sound.

Dr. Lyman. Our general impression is that the study would be more useful to people not very well acquainted with the situation. There are new ways of looking at the problem. The conceptualization of the vicious circles is useful and has already been picked up by an United Nations report. The methodology of the agricultural section is well developed, and this is perhaps the strongest section. We are now working with MIT to publish an overall summary volume capturing the essence of the study and the agricultural section, which is the most elaborately worked out in terms of agricultural alternatives. That may be of more use to the governments than ways of looking at planning. The section of water systems was not far enough developed to be of great help to people who had been working on these problems for some time, such as the Office de la Mise en Valeur du fleuve Senegale (OMVS). The section on socio-political aspects, while having some useful ideas, is not well enough refined to stand on its own.

Dr. Peterson. I reviewed the water resource volume, which came in two parts, as well as the summary. The background part concerning water resources needs a lot of work if it is to be published--legible maps, tables, other visual aids, and correction of some inconsistencies and gross errors. The authors had included the drought alternative in design of water resource management, which was essential for the study, since until greater political management systems in the countries is possible, it is better not to plan for other than the "worst case."

Much of the section is fuzzy; there did not seem to be enough water for irrigation and many of the figures quoted seem impossible. The resource allocation model could have some general value as a preliminary approach, but it needs a great deal of work. The problem is whether the numbers are correct. I have prepared written comments to pass on to AID and MIT.

Dr. Dregne. I have reviewed the agricultural section and agree with Dr. Lyman that the section was the strongest.

I was pleased with the emphasis on having local governments place high priority on this development. The approach might be useful in many countries, not only the Sahel, and it might have general applicability.

Dr. Lyman. I find it useful to hear what elements of the draft have most promise or could be most usefully developed, and would be glad to hear comments on other parts, perhaps less useful, which might be improved. Although only two volumes are to be published and distributed, elements of the other parts which may be useful will be picked up.

More Water for Arid Lands: Promising Technologies and Research Opportunities

Dr. McKelvey. Can we comment on this report, on its utility, particularly for the Sahel situation?

Dr. Van Dyne. I have read this with great interest. It is well put together and the photographs and text excite the imagination. I was impressed with the scope of the work, including particularly the small and local techniques, the variety of ingenious techniques. It seems to me that it might be useful to undertake an assessment of the opportunities for small and local developments of water, such as the variety of techniques shown here, in contrast to the larger "damn big" big dam projects. I've worked in arid lands, but I might say that I was amazed at the variety of ways and ingenious methods to conserve and utilize water.

Dr. McKelvey. I might say that we are beginning to get requests in the Rockefeller Foundation from people who would like to do just that sort of thing in the Sahel and who are interested in very small projects where with one well or with one slight modification of a water system you can get more water yield. They marshall in defence of their ideas and their projects some of the things they have read in the draft MIT report, so there is beginning to be a bit of payoff with that particular study.

Dr. Van Dyne. I think this particular approach would lend itself well to the kind of comments that Michael Horowitz puts forward in terms of getting improvements to the grass roots level and involving the people on a small local scale. I think it would be tremendously difficult to manage or evaluate, but I think it would have much more permeating effect on a broad region. We're talking about, of course, an area two thirds the size of the United States, and to talk about one, two, or three major dams is rather miniscule compared to the area and all the local opportunities for conserving water and utilizing it more wisely on a small scale.

Mr. Coker. You may be aware the Administrator Parker has just returned from the Sahel and he noticed that there were several things we could do in the immediate term rather than the long term, projects such as mentioned in the report More Water for Arid Lands. We've just returned from a seminar in Niamey with AID staff in the region, and we felt there that we want to look at some of the small-scale possibilities outside the long-term dam projects, so that this would be most useful to us in suggesting some of the kinds of systems which might be useful for our geographic area.

Dr. Lyman. While we were out there, one of our health specialists expressed great concern that these techniques should be engineered in a way that would not provide conditions for mosquito development or other kinds of waterborne diseases. I don't see any mention of that in here, and I wonder if these factors were built in? I feel very sensitive about it.

Dr. Peterson. There's a companion volume on mosquito control* which is very good, so I guess you need to take both together.

Dr. Camus. I think it is a beautiful report, a very useful one, very clear and precise. Of course many of these techniques are not actually being used in the Sahel, and I think it would be very important to test them for usefulness. I was quite impressed.

Dr. Talbot. I would just like to amplify what George said, that I particularly welcome this because it adds impetus to thinking small rather than thinking big. For a long time now in development activities it has not been academically acceptable and diplomatically stylish to think small, and yet you don't accomplish very much in this kind of a situation unless you do this sort of thing. I think that this report and this kind of an approach are perhaps the most important directions that we can take in our thinking here and can actually bring about some real changes on the ground.

Dr. Peterson. I was chairman of this committee and was glad to hear all these wonderful comments about it. When I undertook the job, I began to wonder what we could really do. I still don't believe that this is a substitute for large-scale capital development activities. These techniques can probably conserve a lot of water, but when one

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*Mosquito Control: Some Perspectives for Developing Countries; Special Report No. 9, Commission on International Resources, National Academy of Sciences

begins to evaluate this approach against demands for food and so on, it will fall short of closing the gap, even in water resource activity.

Dr. McLoughlin. I too enjoyed this document very much; I would just like to add that there has been a lot of experimentation with these kinds of techniques in recent years. I've seen some of this in the Sudan--UNDP was working there with a Greek firm--in Iran also, and I think there is a lot of experience now with some of these methods which could be brought to bear on the Sahel.

Dr. McKelvey. Obviously, we really applaud your efforts here.

Dr. Peterson. Could I say just one more thing. You know, obviously, if you increase irrigation efficiency by about 5 percent in agriculture throughout the world, this would do more than almost massive implementation of the report's recommendations to conserve water. We purposely didn't put on-farm water management in this report because we figured it was already well covered. But on-farm management of irrigation water is a place where you can make tremendous gains.

Dr. Malone. I was struck by the potential interaction between the sort of research opportunities proposed in this report and the idea of a regional institute which was discussed at Bellagio. If you add to the institute the equivalent of the agricultural extension agent so that there would be a link between the exploration of these water-conserving techniques in the area (as you point out, some are applicable in one region but not in another) and over a long period of time, not only could you explore the benefits of these techniques, but you have a way of getting them out to the country. I think our own experience in this country with the experiment station and the agricultural agent--here is an agenda for the institute to discuss for the next five years.

Bellagio Background Paper

Dr. McKelvey. George, you're scheduled for a review report on the Bellagio conference. What would you like to say?

Dr. Van Dyne. I'd like to say it very informally. I was asked to prepare and review some information regarding development plans from a great variety of sources, and I had great cooperation from AID people in tracing down such documents and from the Academy panel, particularly Mike Dow's office, in getting some of these unavailable documents. What I tried to do was to go through those reports in the context of an outline that this panel had developed some months earlier and capture that in a first draft pass through the literature in a report that was distributed at the time of the Bellagio conference to the participants. Certainly the MIT reports were helpful background documents, but I had some 200 plus reports to go on, and the major thing that I tried to condense out from them was a concensus of viewpoints and critique these from an outsiders point of view, never having worked in the Sahel itself, and come up with some conclusions that seemed to be justified.

I think that what the MIT group calls "vicious circles" are apparent in a great number of the documents as what I would call "feedback loops," and I think it is worth mentioning these three factors, which if correct, condition any development planning. Briefly stated the first one is based on the physical features of the area; it is subject to recurrent droughts. There is argument as to whether the area is getting wetter or drier, colder or hotter, or man is changing it or not, but whether he is changing it or isn't, there have been droughts there for millenia and they are bound to recur. The second is that the social behavior of the people has built

up patterns for building up reserves of cattle or other livestock for these times of drought and also it is ingrained in the measures of wealth of the population, so their tendencies are to build up numbers of cattle. A third factor that is in part related, not entirely, is the introduction of a large number of permanent water points that were not there historically which has allowed people and livestock to stay in these areas longer than previously.

Also, the social factors, recently introduced technology, population growth due to a reduction of infant mortality, to some degree have allowed populations of people to build up; this in turn has induced populations of livestock to build up. Then the drought hit. With the increased human population it influenced not only the grazing agriculture, but also the cultivated agriculture where historically there was a great deal of fallowing of fields as a means of recharge of nutrients allowing decomposition of materials and nutrients to feedback into the system. The increased human population and animal population densities have decreased the number of fields that lay fallow and increased the number that are cropped every year in a row, and this in turn has decreased fertility and lowered some yields. Increased human populations affect the area in another way; these people are largely dependent on wood for fuel, and this has led to deforestation. The deforestation and increased grazing have led to destruction of the plant communities and increased erosion. The erosion is not a movement of the Sahara as an uniform front marching to the south amounting according to some figures to thirty miles a year, but it would appear to be more a generalized dispersion of eroded and destroyed vegetation throughout the region. Once the vegetation breaks

down, then the animals have more effect, so it is a positive feedback. That's one factor on the resource side. Another is related to the economics; that is, the low production capacity of the region, low output and subsistence living conditions which have led to a mass-elite gap. Prices aren't necessarily tied in well with world markets. There are not opportunities for saving and credit and investment in the usual sense and the employment opportunities are limited. This has led to seasonal out-migration of people and a somewhat secular migration. Add to this the basic nature of a very large region--about two thirds the area of the United States and about one tenth the population--inadequate health-care facilities, educational systems, and other social amenities; so the only way the people have been able to overcome this is through cattle, their source of wealth. Therefore, they have tried to increase cattle numbers, and that exacerbates the problem of destruction of vegetation, of drought and erosion. So that's a second complication. The third one is migration of people from the traditional sector in the rural areas into the modern sector and the urban areas due to population growth and the weakening of the resource base in the rural area. The numbers that have migrated to the urban areas have increased the size of the urban areas greater than the rate of employment increase due to industrialization; and combined with minimum wage laws and overvalued currency and low level of worker skills, this has not helped the competitive situation of these countries in the international market. Furthermore, suggestions are that the great increase in the number of people coming to the cities, like many other cities around the world, has led to inadequate housing, poor sanitation, poor water systems, poor health care, nutrition, and thus a general lowered quality of life among the bulk of the city dwellers. That's the background to the Sahel.

The major conclusion I drew from a number of the reports, which I I feel is justified, is that one segment of the country or the economy cannot be isolated and dealt with at a time. I would be concerned at taking a focus on water, unless water is used as an entry point to the whole scene. To isolate water or health or roads or mining or fertilizer or grazing--any one point in these interacting feedback problems--would be counter-productive. The idea was to look at what might be done if a systems view was needed--taking a holistic view of the whole complex society which is still relatively simple in terms of developed nations. This led to the idea that to do such a thing, an organization or group or agency inside or outside the region is needed. I believe the MIT report infers that the systems analysis might be carried out in Massachusetts and transferred to decision-makers overseas. Other commentary led to the idea of an institute or group working in the Sahel which would be based in one of the countries. It would serve the needs of the countries collectively, or some at least because of the commonality of their problems, and would have more acceptance. Such an institute or group would provide more long-term development capabilities for the peoples, even subject to the limitations of technical personnel and facilities that are available in any of the countries at the present time. Each of the areas of communication, transportation, dryland crop production, irrigated crop production, livestock and rangeland production, technological and industrial development, socio-cultural and health developments, institutional policy and economic structures would be examined in concert with one another. Ideas were put forward regarding a generalized structure of such an institute and its relationship to national governments and international donor agencies.

A second conclusion was that development of self-sufficiency during a short period of time would require a great increase in the technological capabilities of the population to capitalize on the resources available. This development required a staged training program moving more towards the university level and the pre-university level from the local level. A three-pronged attack would be needed. The Horowitz viewpoint is one phase--build on the ground starting with bush schools trying to get a massive involvement and contact with people, an extension approach but a type of self-involvement, self-help approach. A second major phase is to increase as far as possible and feasible the number of technically trained personnel in a variety of fields and to develop an institutional framework in which these personnel could be deployed more effectively than at present. A third phase is a more pervasive and widespread reform of the educational system over the long run. This was part of a time-phased program which pinpointed the logical development of industrial, agricultural-industrial, agriculture separated into grazing sector, irrigated sector, and so on.

A third major conclusion was that, at least at present, one of the larger resources is the grazing land resource. One of the major products which is moving into international trade is meat. Since there are massive areas of arid land and there are vegetation resources which can only be harvested through animals in many of the regions, the idea of using grazing as an entry point and developing a more efficient north/south shift system of animal movement is feasible. This is an historical pattern, but improvements can be made in rangeland utilization and management, in the road system and development, in industrialization,

in the dryland and irrigated crop systems, and in introduction of new land use or new major land use schemes in an integrated manner that would facilitate the movement of animals from the northern regions through to the southern regions with utilization of the northern regions largely as rearing units for raising young animals through the middle part of the zone to the southern part, going to a finishing pasture-fattening of animals and transporting them on the hoof to the south. The slaughtering and movement of the finished product through to the coastal market zones would follow. This cycle would be complemented by a movement back to the north of certain supplies and facilities, and would then have an involvement of the people in the northern regions in cooperation with the southern regions. Rather major changes would be required in institutional structures in terms of developing cooperatives, perhaps, which would involve land holdings or land systems from north to south; major changes and improvements in the transportation network; differences in the credit facilities and banking procedures; integration with development in the irrigated agriculture which is proposed to be used more for human food production than for animal food production; and utilization particularly of the waste-products of some of the industrial crops that are being grown and could be grown in greater degree. It would eventually be tied to such features as mining in terms of agricultural fertilizers, perhaps petroleum industries in some of the countries. This is the basic thrust, the review of what seemed to me to be the critical works and interpretation of them. It is a system that can be looked at as a whole and must be looked at as a whole in order to make sound long-term improvement and thus leads to a more clear identification of the inter-

action and coupling of the parts of the system. At present there probably is an inadequate supply of manpower and technology and organization in which they can work. The idea of an institute that is international in nature, both from the standpoint of the donor and participating governments as well as the recipient governments, is necessary and needs to be addressed.

Dr. Box. The interesting thing about all of these studies is that they all come to the same conclusions--just where do we go from here?

Mr. Coker. It seems that one thing we should not overlook is what George mentioned--don't concentrate on one thing, thereby overlooking some of the other problems that maybe resulted from what happened in the past. For example, as a result of the migration of people from rural to urban situation, as in Mali, we have discovered that they have a vast wealth of technical know-how. They have put together a 5-year scheme for achieving self-sufficiency in food production, which also includes cattle; there is a great attempt which will be involved in this scheme to get people back to the rural areas from the urban areas. They are looking very seriously at how this can be achieved in Mali, cities such as Bamako, where one can see the results of the mass migration from the rural areas. A scheme has been embarked upon to make certain they come up with something that is first of all appealing and knowledgeable to the people who have come from the rural areas. When this is completed, they hope the reverse of the migration would be achieved and, consequently, the economic impact on the city would be the reverse situation. At the same time the need to make certain changes in pricing structure and other factors is recognized. Based on George Van Dyne's

findings after looking at many, many documents (being able to pull them together has been a difficult task and I admire what he has done) and reporting on them here, we have seen at least one of the governments recognizes and moves in the right direction. Their educational training institutions are also being built up to maximize the number of skilled people in a number of areas, so that in these areas where assistance is desired, the practical experience can be achieved and the necessary backup provided. Here we find some of the conclusions in Dr. Van Dyne's report and some of the approaches in trying to rectify the problems. We see them in one country. Hopefully they can be spread to other countries.

Dr. McLoughlin. I think it is easy to see the Sahel in isolation. There is a lot of experience elsewhere in fairly similar regions which also can be used to help us with the Sahel. I am thinking particularly of the fact that in the Middle East and North Africa and, indeed, sub-Saharan Africa there have been millions of pastoralists who have historically moved from pastoralism into a mixed farming-herding situation or into cities or on to irrigation schemes and other kinds of more settled existence. As a matter of priority as researchers and planners, we might want to look at this historical experience. What have the circumstances been under which animal owners have historically moved from being pastoralists and nomads or semi-nomads into other types of economic and social milieu? I'm really making two observations--one is that there is an incredible wealth of experience on people changing their life styles and their economic patterns and their social situation in similar areas, and indeed in the Sahel itself; secondly, there is a lot of experience outside the Sahel on drought-proofing or trying to get a more steady economy, which I think we could bring into the Sahel.

Dr. McKelvey. Your comments impinge on a question that we will later want to bear down on a little harder; that is, "Why are we here? Why do we have a committee on the Sahel?" Because if you proliferate too far into the general area of drought-proofing over the world as a whole, then you have to ask the question "Why?". This will probably come up later as our discussions move ahead.

Dr. Dregne. I am uncertain after having heard various comments about this livestock situation relative to the possibility of bringing the nomads into the cash economy and market system being proposed for the arid regions and grazing land for bringing the cattle into the cropping areas and then finally into the feeding program. I had the impression that the nomads looked upon livestock as a source of wealth and are in the cash economy now to only a very slight degree because they are not interested in it. Following on from that it seems as though developing a crop livestock union improvement situation would be very difficult. The base is the nomadic grazing, and the nomads are not interested in the cash economy nor in feeding their livestock; they want numbers to protect them in the periods of drought and disaster. Peter McLoughlin said or implied that nomads are prepared to change their semi-nomadic existence for a sedentary existence over time. That being the case and in view of the lack of ownership of the land areas in the more arid regions, I would think that the potential for improving livestock would begin with the mixed farming area on the edge of the arid grazing area. This is where emphasis should be put for getting the livestock that will be tried for production if improved or if some sedentary farmers become pastoralists--pastoralists for whom livestock

health services can be provided, and for whom breeding programs are supplied. This experience should then be brought into the projects for supplying meat to the neighboring countries.

I have been tempted for some time to throw this out, but I have been afraid to do so because it sounds so callous. I have wondered whether it was not a waste of time to worry about the nomads?

Dr. McKelvey. We discussed this at great length at the Bellagio conference. The alternative philosophies have been discussed at many other places, but I think we came down quite positively on the point that it was not a waste of time to deal with the nomads. Though the population in nomadic areas is very sparse and the resources are meager, nevertheless the population is very sensitively geared to the ecological conditions in order to provide themselves with a livelihood, and there may be no better way of using that type of area. In fact, there may be many ways of improving that type of existence.

Dr. Dregne. I have no quarrel with the idea that there is no other way to use the area. I think that is correct whether you use domestic livestock or wild animals; this is the way to use it. But I understand that the national governments look upon the nomads as a nuisance anyway; they do not like to have the nomads around, that the political pressure within the nation lies in the urban area, that the movement of rural to urban areas is an international phenomenon and that the reversion to overexploitation of the grazing areas should not occur or there will be no improvement over the present situation.

Dr. McKelvey. Yes, but the Sahel does not necessarily need to be identified as an area where all those factors operate. Places in the United States can be identified where the same sort of situation exists,

where the urban areas are in a sense exploiting the populations in the hinterland, or many other parts of Africa where the concentration of urban populations don't care about the hinterland and exploit it. This seems to be a general phenomenon which has to be dealt with.

Dr. Box. May I speak to that as coming from one of these exploited areas? John McKelvey made the point very well that the situation in the Sahel is not greatly different from that in Utah. There we live in an arid land; we can only use our land by nomadic grazing; we truck the sheep from the mountains to the deserts. I think the problem is one, but still people in Washington would like to have our land. The problem is one of sophisticating the nomadism rather than ignoring it or doing away with it. As George Van Dyne says, it's a matter of becoming more sophisticated or more efficient. Let's not stamp out Utah or the Tuareg either.

Dr. Peterson. I thought Harold was saying that the instrument is the sedentary farmer at the margin of the desert. Here is where whatever the market the nomad is interested in might be created. Either some market interest would have to exist that would cause the farmer to take the right kinds of animals and to finish them in the right way, or else regulation would be necessary. The United States experienced regulation, and you know how difficult that was; the Navahos would never quite accept it. I don't see how one gets at the problem. The use of the range must be limited, whether or not one approves of nomadism. Nomadism is an efficient way to use the land, probably the only way to use it; but what kind of institutional arrangement will achieve the desired end?

Dr. Van Dyne. I think I may have given a wrong impression in my report or maybe Harold has misinterpreted it, but I don't think that my only focus was with the nomads. I think the concept I suggested was that the livestock resource is one which ties together the north and middle and southern regions; it is the major export product in many of the countries and provides an entry point that is integrative. It has in it a nomadic/semi-nomadic, sedentary/partial-sedentary, irrigated/high-intensity/low-intensity agricultural complex, and that it does not say that it is going to maintain a nomadic system alone or disregard the others. In fact, some of the most interesting schemes are really highly technological development of introducing grazing lands in the southern region and that I don't have enough competence on. The idea of clearing large areas of the woody vegetation to prevent the tsetse fly, introduction of pasture plant species in the higher rainfall areas that will provide high quality grazing will be the final link in the finishing of animals. All the way through from the north to south there is grazing resource and cultivation. In the very arid areas there are opportunities through wise use of water development for introducing cultivated crops and in the middle zone in the shifting cultivation areas in which the rainfall is sometimes more limiting and the fertility more limiting and then clear to the southern region with the higher rainfall. My impression in reading through the materials (and this may be contrary to Rockefeller Foundation philosophy) is that there is far more gain to be made utilizing commonly existing genetic resources of plants and animals rather than worrying about a detailed and improved breeding program. I think it may also be antagonistic to AID which is investing a sizeable amount of money

into a crop breeding program in the Sahel countries. The amount of gain that can be made through organization, dissemination, and utilization of existing knowledge and existing genetic resources is far greater and can be achieved much faster than the improvements to be made through breeding tick resistant varieties of goats and cattle or new varieties of sorghums and so forth. I'll throw that out as a challenge to the Rockefeller Foundation and AID that have had notable successes in other areas.

Dr. McKelvey. I think that maybe there may be some misunderstanding of our program because basically we would agree with you. But it isn't one way or the other way; there should be a dual approach. Intensive breeding for crop improvement in intensive areas can lead to tremendous yields needed to feed massive populations. On the other hand, you're absolutely right; there needs to be a great deal more effort in the small increments that you can make in some of the harsh ecological areas in the movement of existing germ plasm or selections. There's no disagreement with what you have to say.

Dr. Van Dyne. We've got to have all sorts of approaches. If we look at the world by the year 2000, the world will have seven billion people at a fairly conservative estimate. That's a doubling of the world population from today in 25 years time. Africa has a much higher growth rate than the average, and so it isn't just a matter of big dams vs small local developments, or massive increase in technology and utilization of existing resources vs development of new genetic resources. It's really a matter of survival and combination of all the skills and energy to produce for double the population on a worldwide basis. Even if one accepts the most optimistic estimates of nations moving to zero population growth (the United States is expected to achieve this by 1980,

and we're moving much faster than many of the LDC's towards that goal) even if we all moved to zero population growth, there is a timelag in demography that affects a very great segment of the population--we are affected by the postwar baby boom in the employment market in this country, and there is a timelag that is going to tax all the resources of the world. I'm not describing a picture of doom, just saying that the problem is not only in the Sahel but in the world, and it is so significant in the next 25 years that we can't rely on one approach alone. It has to be a combination of approaches.

Dr. Talbot. I read the earlier version of the notes of the Bellagio meeting, and one thing that didn't seem evident to me was the recognition that we really aren't talking about using essentially the same livestock from north to south. There was a good deal of discussion about integrated programs and moving animals from dryland to finishing areas, but the problem of requirements for developing meat producing animals in the south for export of meat is vastly different than the ecological requirements and adaptations of the animal from those in the really nomadic areas. This is where programs in East Africa and other parts of the world have fallen down--a high yielding, heavy-bodied animal that is a good export meat animal which puts on meat quickly, finishes well, and is able to live under truly nomadic conditions efficiently is not available. Consequently, I hope that there was more emphasis in the discussions that I have read, or in the final report, of this point--that we need to have a whole spectrum of strains of livestock, each best suited for a particular area. Another aspect of this that I haven't seen in any of the MIT materials is that there are strains of the local livestock that have adaptations to drought--nitrogen-recycling and that sort of thing--that

the imported ones don't have. In many cases in other parts of Africa, failure to recognize that, either in the selection of the types of livestock or in the methods of range management, has led to many of the problems, some of which we saw in the Sahelian Zone. For example, the nitrogen recycling system that some of these animals have is short-circuited by provision of water; therefore, if the animals are provided with too much water in the dry season, they are automatically starved, which is diametrically opposed to most of our American range management technology that is exported. This is an ecological, physiological side-effect that I haven't seen in the literature we've been looking at.

Dr. McKelvey. Are you saying that rainfall zones cannot be crossed, let's say from north to south, by the same animal and still be a good beef animal? In other words, start the animal in a dry area and go progressively to wetter areas with the season.

Dr. Talbot. There are two factors. Under some conditions with proper management this can be done; it is done in the western United States. The animal that does best in the northern, truly arid zones is adapted to that type of a situation. The digestive tract is not adapted to the kinds of food that are found in a southern finishing area, and it simply is not ecologically sound or efficient to try to use exactly the same animal all the way through the process. This doesn't mean that there is no degree of flexibility; a good deal of flexibility is possible, but whatever is done requires the kind of control that one doesn't hear talked about. That's why I worry so much about things such as the tsetse clearance schemes; these are fine as long as there is adequate control over livestock numbers and management of the area.

Dr. McKelvey. I share your concern about that, as you might imagine. That is very important and useful information for us.

Dr. McLoughlin. I'd just like to take George Van Dyne's comments a step further or add to them. One of the things which greatly distressed me when I was going through a fairly similar exercise to George's was the tremendous focus on the marketing of animals. Almost every document or project or activity suggested by CILSS, World Bank, etc., was one aspect or another of marketing. And as I know Horowitz would second, I'm concerned that we won't leave enough animals for the people to live on. The structure of herds, the kinds of animals and their age, etc., the balance which must exist for marketing in a suitably modified operation are all quite different from those which will keep a family alive. Here we are basing all these activities by taking off certain kinds of animals and, I think, completely fracturing the historical means for them to stay alive.

Another point I'd like to address to George (and I had some correspondence with Hugh Bunting after Bellagio in which this was discussed) is how is a system built that is fairly reliable for planning purposes in view of the vagaries and unpredictability of the climate? In view of this quite unpredictable element, at least so far certainly over a two, three, or four year period, how can we use a systems analysis for planning?

Dr. Van Dyne. I think the systems approach says "take that into consideration as a feature that drives the system." The characteristics of the climate, magnitude of fluctuations, potential spacing of droughts and their duration, intensity and locality of droughts must be recognized.

There are at least a dozen strategies that are incorporated in some of the plans in response to this. One of the ideas that has been discussed is partial feed reserves; this seems to have limited applicability. Another is the idea of cooperatives and mobility--increasing the mobility of animals so they can be moved from drought areas and still moved into other areas without high death losses; another is the development of types of land that have multipurpose multiple opportunity, of taking stress off one area and into another. There is the idea of adjusting the economy and banking to allow some insurance features; yet another is to build up the industrial sector in order to cause less dependence on a sector that is very sensitive to climatic fluctuation. I think your point is well taken. In any development scheme that which drives the system must be looked at and the characteristics of those driving variables must be recognized explicitly so that the strategies for drought-proofing are taken into consideration. That's the short answer.

Dr. Talbot. One further point in follow-up to Peter McLoughlin's extremely well-taken one. Different breeds or strains of livestock are needed for subsistence than are needed for marketing. Quite often overlooked and very rarely touched upon in the literature I've seen so far is the fact that the more nomadic the people in the Sahelian Zone become the further to the north, the higher is their reliance on milk from the livestock; this includes the whole spectrum of livestock. The more important is the milk and the less important is the meat, and of course, the marketing strategies require exactly the reverse. A second point is that a certain number of animals is necessary to support a certain number of people, a family, or village unit. Referring to the

northern edge, again, the mix of the animals depends on how far they have to move and what the characteristics of the range are throughout the year. They are, of course, concerned with maintaining a hedge against drought; therefore, depending on where the people are, they're going to need a certain percentage more of animals than they need to survive because they know some will die in the drought. This is a sociological or behavioral factor that must be taken into account, even if a management system that would avoid these losses could be developed. The point is that marketing is not what drives them now. Unless a very significant change in their way of life occurs, one must recognize that not one kind of animal is to be dealt with, but animals that are adapted to different kinds of environment and to providing different kinds of yields and services to the people.

Dr. McKelvey. Yes. There's a very interesting FAO document about livestock production in the Middle East. It is possible to just about identify the amount of rainfall an area receives by the proportion of camels, goats, or cattle that are kept in the area by the nomads. I think your point is very well taken. There is a very sensitive relationship between the livestock in the area and what that area can produce in terms of vegetable matter.

Dr. Box. I think the key to getting this movement of livestock products south and into the market is security for the nomads because the kinds of animals that are used in both areas (north and south) are mostly geared to security; as you said earlier, the animal that is evolved for survival is not necessarily the best market animal. So a compromise must be made. If the same animal is to be able to go through

all these zones, a compromise must be made somewhere. If a market is looked for down the line, there must be feedback to the nomad in other kinds of goods and services to give him security. Unless that is done, the nomad will go right back to the goats, camels, or whatever will give him the most security. That's the key--getting security for the nomad and then getting the flow of products.

Dr. Van Dyne. A brief comment in looking through the two or three reports that recognize this problem of genetic diversity and so on, which I tried to summarize in my report on page 31. I would challenge you, Lee, that the problem of variation in genetic material of the livestock is not for nutritional efficiency but for disease and health resistance. The disease problem for the animal in the south is drastically different from the problem for the animal in the north. The nutritional efficiency in dealing with low nitrogen diets, high urea rate in the saliva, and recycling of nitrogen by the animal occurs in the southern regions as well as in the northern regions because they go through a period of very leached-out low quality roughage. The north actually has higher quality roughage but much less of it and much more dispersed, so I think the genetic differences are required more in the disease resistance.

I think we are again in the trap of the focus on the nomads and the Sahel vs the Sahelian countries--since the countries have the Sahel Zone, Sudan Zone, and Guinean Zone. I think if the focus is on the Sahel Zone or the nomadic people, there is one answer; if the focus is on the countries of that region, there is another answer.

Another point is in a long-term historical and systems analysis view, in order to deal with the situation highly variable in terms of time and magnitude of driving variables, the resulting strategies imposed are

flexibility, mobility, and storage or reserve; so the strategies evolved in those countries with climate driving the system are flexibility, mobility, and reserves.

Bellagio Conference and Report

Dr. McKelvey's Summary of the Bellagio Conference

The international conference on development problems in the Sahel was organized by the NAS with the Rockefeller Foundation to gather the ideas and wisdom of a very broad spectrum of people. Much had been said before and in other places about various aspects of the many problems which are drought-related; the Bellagio conference was an effort to focus upon those problems and their interrelationships. This we accomplished.

. First was an excellent presentation by Dr. Michel Doo Kingue on the need for institutional development in the Sahel. The participants recognized this important need and, in the end, the Bellagio conference strongly supported the ideas presented by Dr. Doo Kingue.

. Dr. Thomas Malone gave an excellent presentation of the climatic situation. He was supported in his views by Dr. Hugh Bunting, who also turned in a fine background paper on weather and climate in the Sahel.

Our discussion led us to the conclusion that one must accept the fact of long-term climatic fluctuations over which man has no control. In the short term, however, we can improve our predictive tools and methodologies and spread vital, practical information to the farmers and herdsmen to help them react to a drought-prone situation more adequately.

I believe we also exploded a series of myths regarding massive programs of climatic improvement and tampering with the weather in a variety of ways.

. Dr. Samuel Adams and others strongly favored programs for improved food production, both animal and plant. This is basically the argument of improved food security for survival and certainly is agreed to by all.

. The Bellagio group discussed in detail the questions of pastoralism and the nomadism of some peoples of the Sahel. We discussed the nomads and their needs and came to more or less the same conclusions as were reached here earlier today. The system can be helped; it must be understood, perhaps much more thoroughly than it is understood now.

Dr. George Van Dyne spoke about the special situation of animal production in the Sahel; Dr. Jean Pagot (of the International Livestock Center for Africa) contributed greatly to our understanding of this aspect of the problem.

. We also concentrated on human resources. I, frankly, did not anticipate the emphasis that was given to the need for a very fundamental shake-up in the educational system in that area. Dr. Cheikh Hamidou Kane of Senegal, and now Vice President of the IDRC in Canada, spoke eloquently about the need for broad and fundamental changes in the educational system. He was concerned with education in the schools and in the non-formal sense. How does one reach the pastoral people? How does one teach very practical skills, for example, business skills, to the nomads? How does one take best advantage of the oral tradition in non-formal education? These questions were not just postulated; Dr. Kane had specific suggestions and these remarks spurred-on our discussions in Bellagio.

Recognition of higher level training and university education was also discussed. It is important to realize that no one is suggesting non-formal education to the exclusion of more traditional kinds of education.

. The matter of health came before the Bellagio group. Infectious diseases were of most concern--trypanosomiasis in cattle and human beings, onchorocerciasis (river blindness), malaria, and schistosomiasis. The context in which these four diseases were considered was with respect to development of water resources.

. There was a great deal of discussion about infrastructure--drainage basin development, transport, communications, economic systems changes.

Five great drainage systems were identified and discussed in some detail in the context of development strategies. The Niger, Senegal, Volta, and Gambia rivers plus the Lake Chad basin were identified as potential resources not only for improved water management in agriculture, but for transport, power generation, industrial needs, human settlement, etc.

. Finally, there was again the question of institutional development, including the need for a Sahelian institute.

You have the notes of the conference; these are for the committee's use only. They present what I believe to be a fairly accurate account of the Bellagio discussions. They are a building block for the Bellagio conference report.

We had hoped to have a finished draft of the Bellagio conference before you today, however, it is not yet completed. More work is

required. There is an urgency because interest in the Sahel as a specific disaster area is waning. But we need a very good report rather than a rush towards an arbitrary deadline.

The Bellagio conference report will be issued as a Rockefeller Foundation document. We are using the background notes plus background documents prepared for Bellagio by Drs. Van Dyne, Bunting, Opeke, and others. We are far enough along to think we could complete the report by January 1, 1975.

You will note in your package of papers for this meeting there is a preliminary draft of a Bellagio report. Please take that preliminary draft for criticism purposes only; the organization may not stay the same, the substance will be greatly expanded, etc. The draft report shows we have been working; we are most desirous of your criticism.

In addition to the Bellagio report, the NAS has a reporting requirement for AID. The NAS report must include the Bellagio document as a central element, but their report will deal also with meetings of this panel.

Now we need to ask ourselves what the total value of our Bellagio conference will be, aside from the immediate information and experience it provided our panel about the Sahel.

I can see the Bellagio conference report serving the needs of donor agencies as a very useful document. This will be true of the Rockefeller Foundation, the UNDP and, we hope, of USAID. I am not sure that the Bellagio conference will have a great impact over the entire African community that is involved with Sahelian development. I do think, however, that the Bellagio report will have an impact upon the CILSS. Dr. Konate

(Executive Secretary, CILSS) was invited to Bellagio. Although he was unable to be there, he will receive the minutes of the meeting, the draft report, and be kept fully informed. Time will tell whether my expectations are realized.

With those comments I now turn to you, asking that the panelists who attended the Bellagio conference (Drs. Malone, Van Dyne, and Kates) speak first.

Open Discussion

Dr. Malone. The draft report is a fine preliminary document; it seems to pull together the points we have in the draft minutes. It stresses the need to develop the whole infrastructure (for Sahelian development), including the educational system. It seems to be balanced. I am biased in favor of a Sahelian institute as developed in George Van Dyne's report, perhaps not exactly as he has outlined it, but certainly in that direction. Also, I like many elements of what M. Doo Kingue has said.

The institute also offers a possibility of strengthening the unity in this desperate region. It gives an apolitical focal point which could have an impact upon the political machinery of the area. I would not expect the institute to solve all the problems, but it would contribute toward solutions.

I still am very concerned about food storage problems. This reflects a doubt in the minds of many people, including myself, that the region could produce food surpluses at all. We are aware that periodic droughts occur. The "ever normal granery concept" has to be developed either

in the Sahel or elsewhere. That point seems essential. I am persuaded we will meet food problems with increasing severity and frequency in one or another area of the world over the coming several decades. The experience of the recent drought in the Sahel is a "cloud on the horizon" of episodes elsewhere. This we did not discuss in detail at Bellagio.

Dr. McKelvey. I have the impression that the "idea" of an institute in the Sahel is just that--an "idea," but no more. In concept many people are thinking that an institute would meet very generalized needs. A task force, formed by UNDP, would identify what a Sahelian institute could and should do, taking into consideration research institutes that already exist in the seven Sahelian countries (and elsewhere).

If that is the case, should this panel have any further input? Is it important that we do? Perhaps it doesn't really matter.

Secondly, is this task force the best way to build an institute? Again, this may not be any of our business. Perhaps UNDP and CILSS are also asking themselves this question.

Another question--are there some very specific tasks, or programs, that a Sahelian institute needs to do. Does anyone know?

Dr. Malone. I believe we agreed (at Bellagio) that a feasibility study is needed. A Sahelian institute is a fuzzy concept at the moment. I envision our Bellagio report as a stimulus toward creating a feasibility study. For that reason I feel we are on the right track (in the preliminary draft before us). Endorsement of the concept, I think, would help move a feasibility study along.

Similarly, I feel the NAS report More Water for Arid Lands gives some specific suggestions that a Sahelian institute might experiment with in the region. This is an example of a rather specific task in

water management research and development. Such specific tasks might be much more acceptable to potential donors than a grand scheme.

Dr. Peterson. I have had a couple of experiences with institutes that have dealt with social management as part of their realm of interest.

The first of these was a center for soil and water management under the auspices of the Organization of American States (OAS). The guidelines were drafted by a group of North American experts. These were referred to the cooperating countries and the entire concept (of a soil and water management center) headed for disaster--fast. Then the question was turned around and the countries were asked to draft the mission of the institute. This put the project back into progress.

A second experience was a feasibility study for a regional institute for agricultural water resources management. This was thought of in terms of the international institutes pattern such as CIMMYT, IRRI, etc. Social delivery systems within a country seemed to be the key elements--credit, fertilizer, and other incentives. I looked into the feasibility of such an institute in Southeast Asia for IDRC. The only means of effectiveness would be to have the Ministers of Agriculture from each country involved feel as though they "owned" the institute.

My conclusion is that specific objectives of a Sahelian institute are important, but one should not go too far without thinking about a strategy of local participation (at a policy level) to arrive at those objectives. How this is done in the Sahel is something I do not know.

Dr. McLoughlin. Mr. Chairman, when we talk about an institute for the Sahel, do we mean a center or an organization which deals with

(a) drought-prone areas, (b) the Sahelian countries as such, or (c) the Sahelian Zone defined ecologically. I ask this because the drought affected countries go much further south than the geographic limits of the Sahelian countries themselves.

Dr. McKelvey. At the Bellagio conference we agreed to discuss seven countries (Gambia, Mauritania, Mali, Chad, Niger, Upper Volta, and Senegal) which have, by their own initiative (treaty), banded together to fight the drought and to work toward regional development.

This does not exclude research and development beyond the strict geographic limits of those seven countries. Everyone recognizes that the drought-prone areas (in West Africa) are the focus, but the agreement to work together at this time is by the seven nations (CILSS organization).

Dr. Malone. I agree with all that Dean Peterson has said. The proposed Sahelian institute was not conceived in Bellagio but by CILSS. We are endorsing their initiative; that fact is far more important than if the situation were reversed.

Dr. McKelvey. I do not see how we as a group (an NAS panel) can go farther unless we are asked (by CILSS or UNDP) as a group or as individuals to do more.

Dr. Malone. I would, however, suggest more emphasis in our report on the extension function.

Dr. McKelvey. Yes, I agree that the report can make suggestions of programs that might be taken into consideration. To do anything more active would not be proper.

Dr. Van Dyne. Coming to the idea of the institute, I can say it was in a number of the documents I reviewed for my report (Long-Term Development Strategies in Relation to Environmental Management in the Sahel). If the institute idea is endorsed now by the committee, we might point out by way of illustration institutes of this genre that exist in other parts of the world and the lessons that have been learned from them. Dean Peterson gave us ideas.

Secondly, from the ideas put forth, what can we think are a priori shortcomings when examined one by one? Can we strengthen the idea (of the institute) by attacking some of the weaknesses?

They may not be part of the task of the panel, but they also were not done at Bellagio.

Dr. McKelvey. As I assess the proposal described to us at Bellagio and as I compare it with other institutes, this institute would differ from others because it would not be specifically a research institute but a research and development institute. That is a much broader task.

There is a parallel to WARDA (West African Rice Development Association) which hasn't yet been too effective, but shows promise of becoming so. Its role is rice development in fourteen West African nations.

Dr. McLoughlin. Would our committee make itself available for technical assistance (to the Sahelian institute)? We are multidisciplinary and multinational.

Dr. McKelvey. Would it be presumptuous to state something of that sort? It would, perhaps, be better to assume that we would be called upon if needed, particularly in our individual capacities.

Dr. Dregne. I have some difficulty with a strictly research function for a proposed Sahelian institute. There certainly is a great need for

an information function, extension function, training, workshops, etc. I understand that a number of specialized research institutions already exist.

Dr. Camus. It is true that much relevant research has been done in the seven countries and in nearby countries, but there are gaps which have not been completely identified. The fact that resources have been limited must be recognized. Therefore, I would be in favor of retaining research as one important function.

Dr. Dregne. What about strengthening the institutes that already exist so that more research can be done?

Dr. Camus. Yes, of course! But let us take, for example, some of the techniques suggested in More Water for Arid Lands. To put together the kind of team needed to do some of the applied research suggested from the human resources in the area now would be very difficult. People could be more easily assembled if some specialists from outside were obtained. There would be a long wait to train teams drawn only from within the area.

The seven Sahelian countries do believe in regional development relationships. There is, for example, an interstate organization dealing with health matters, and it works very well.

Now a question, if I may. Mr. Chairman, will you explain about the two reports. I believe I did not hear clearly and will trouble you to explain it to me again.

Dr. McKelvey. The two reports are not alternatives, merely two directions. One report would be a specific Bellagio conference report, published as a Rockefeller Foundation working paper with NAS approval.

The second direction would be a report giving the totality of this committee's work since its inception, including a section on the Bellagio conference. The reason for two documents is to achieve wider circulation and impact for the conference and the committee's work.

Dr. Camus. It would be my suggestion to do one document, and I believe it should be the second which you described.

Dr. Kates. I have only scanned the draft (report) document. The Bellagio conference was a much more interesting meeting than this document reflects; even the minutes reflect greater interest than the draft report. Something happened in the process of transposition from minutes to report.

Firstly, that quality of the meeting which dealt with shattering of myths became modulated. Secondly, the document became a list of all possible things to do. Thus, it lacks focus; it is bland. In fact I don't recall discussing "health" or "moving toward a market economy" at Bellagio. Do we not want to select a few items on which we think Bellagio had something unique to say, rather than seek completeness?

There was a suggestion by Dr. Mensah at Bellagio (see Minutes, Monday, 28 October, page 6) to emphasize: (a) food security, (b) infrastructure (basically, roads and water development), (c) improved participation of local people, and (d) long-term development. My short summary of the meeting paralleled those thoughts of Dr. Mensah.

In my own case, I believe the most important question is the one that Dr. Malone has asked, "What will happen when the rains fail again?" That is the central question rather than the matter of long-term development. I feel that this was the central theme upon which there was real agreement at Bellagio. The myth of climatic change was dealt with very

well by Dr. Bunting when his data showed five major droughts in the last 70 years. Therefore, the question around which much of our discussion was focused was, "Will the Sahel be better prepared next time?"

Then there were four (corollary) points.

. Food production, including food security, marketing, the "granery," storage systems, fine tuning the marketing system, even sacrificing marketing efficiency for the sake of some greater food security.

. How can the productivity of animal raising be improved without destroying the essential adaptiveness of the system? This goes to the heart of what our colleague Dr. Horowitz was advocating. There is wide recognition that animal raising by the nomadic peoples is enormously adaptive. At the same time the MIT report, from my reading of the fine print, suggests that in the best of their proposals 40 percent of the nomads must become more sedentary in their agriculture; in the worst case 60 percent would be removed from agriculture. There is the question of improving a system that fits both the people and the ecology without destruction of that system.

. River basin planning coupled with human resource integration in the process requires an exposition of sequence and timing of dams based upon what has been learned elsewhere in Africa.

. Human participation, the need for modification of the educational system, is perhaps best dealt with in the draft report, but even there is a lack of emphasis upon mass communications (radio, vernacular languages, etc.).

The critical question, transcending the matter of one or two reports, is whether this committee wants to emphasize those unique insights which we have developed over and above what others have said about the Sahel.

Dr. McKelvey. Very good. We will take your comments very seriously.

Dr. Van Dyne. I'm sorry, but I'm still not clear what the two reports being proposed are.

Dr. McKelvey. One would be a report specifically dealing with the Bellagio conference; the other would deal with the entire work of this committee (which includes the Bellagio conference).

Dr. Van Dyne. I would suggest that the major work of the committee was captured at the Bellagio conference in its preparation, discussions, and follow up. The great part of what the committee has to say is there. Perhaps one could add a chapter entitled "Bellagio on Reflection," but I'm not sure what could be added in a separate report.

Now the NAS annual report is different--stating who did what, how funds were spent, other administrative matters, etc.

Dr. Dregne. I wanted to raise the question of priorities.

Dr. McKelvey. I agree with you. A statement of priorities is missing, and they were established at Bellagio. They were as clear in our discussions at Bellagio as they are in this meeting, but they don't come through in the draft report. That's what we have to establish.

Dr. Dregne. A second item deals with river basin management. I do not sense that the associated problems were understood at Bellagio. Dean Peterson mentioned this. In addition to irrigation, power generation, etc., one has to be realistic about the time frame for establishing

river basin management. I would assume that if we started development today, ten years would pass before the process would be completed. What do we do in the interim?

Dr. McKelvey. Yes, that is another valid point. One must put more substance into the report; it must be reorganized and supported by additional information which shows why the conclusions were reached.

Dr. McLoughlin. Another thing, Mr. Chairman, neither the short-term nor long-term development of the Sahelian Zone as reflected in the draft report is implicitly geared to a similar development in the Sudan Zone. The economies are interrelated. The interrelationships are not emphasized as strongly as they should be.

Dr. McKelvey. Yes, and it was thoroughly discussed at the meeting.

Dr. Box. In scanning the draft, we should recall that we were originally brought together to advise AID and hopefully other international donors as well. When the questions are asked--what happens when a drought comes again and how does one help to improve the system without destroying it--then I do not see much in the draft to answer those questions.

Dr. McKelvey. Right. This substantiates some of our feelings. We need this type of discussion, and I thank you.

Dr. Van Dyne. Along that line (not having had a chance to read the draft before the meeting) I recall from Bellagio the idea that "three levels" of condensation were needed in a report: (a) a one or two page abstract for the busy person who will read only that much, (b) something of the length of this draft report (less than 20 pages), and (c) some back-up information.

In the second level of the document maps are needed. This would quickly help the reader differentiate between the Sahel, Sudan, and Guinean (ecological) zones, the Sahelian countries, and distribution of available resources. Illustrations would also improve the document.

Dr. Lyman. A report on the Bellagio conference itself would be valuable. It should include something of the flavor of the conference as well as the process by which the conclusions were reached. The Bellagio conference had significance by itself and a report of it deserves wide circulation.

Separately, the NAS may wish to report to AID because this committee may have things to say that were not said at Bellagio.

Mr. Chairman, is that consistent with your thinking?

Dr. McKelvey. Yes, it is consistent with my thinking and I hope with that of the committee. Do any of you have problems with such a procedure?

Dr. Camus. No, I for one do not.

Dr. McLoughlin. The basic question still left hanging over our head is, "What have we (as a committee) done that is new?" This has been bothering me since our September panel meeting.

Dr. McKelvey. We do have a contribution, but I'm not sure it should be labeled as new. By way of a digression one part of the draft report before you speaks of "new insights." That concept of "newness" bothers me. In what we say about climate, pastoralism, or animal production, what could one call "new"?

Dr. Camus. The integration idea, Mr. Chairman, is new.

Dr. McKelvey. Correct. In the perspective and the emphasis given to certain lines of research, we have much to say.

Dr. Van Dyne. I think that the idea of an institute (for the Sahel) was not new at Bellagio, but it was discussed and enlarged upon to a considerable extent. The idea of whether an institute would have simply an advisory function or a research function and how these functions would relate to other organizations (in the area) can be expanded upon.

When Harold Dregne asked whether the institute would do scientific research, I believe it must. Even if it is research in the armchair (in contrast to the field and laboratory), it is still valid research and very important to planning. In doing that function the institute must then have (independent) resources to instigate projects and/or modify what is being done elsewhere. This (Sahelian institute) would be unique in being international but having a regional systems planning viewpoint. This institute must be tied to the region, to governments, to other research institutes, to sources of development funds, etc. I think it is unique and should be elaborated upon in the conference report.

Dr. Camus. Yes, there is research on malaria that has no geographic boundaries. A Sahelian institute might aspire to the same kind of operation for that region.

Dr. Van Dyne. Cooperation between these (Sahelian) nations and the rest of the world is an important factor. It must be a "non-zero sum" game. A "zero sum" game is one which, if one side wins, the other side must lose. That strategy cannot be taken in the Sahel; none of the individual nations can "go-it-alone" in its development strategy. But if the group can play a "non-zero sum" game with the rest of the world, then progress for all is possible. One cannot look at the Sahelian

countries as isolated from the coastal countries. The seven countries and their interaction with the coastal zone, the rest of Africa, Europe, etc. can be studied. The time has come to get away from individual country, individual sector, individual project approaches.

What we do have that is new is this integration idea.

Dr. Lyman. I believe the integration indicated by Dr. Van Dyne has been evolving over the past few years. Caution must be taken in how this is expressed. A better understanding of how things interrelate is beginning to emerge, and Bellagio certainly reflected this new appreciation of the problems. For example, there are (or were) some who looked upon river basin development as a drastic alternative to dryland agriculture or vice versa. There has been a lot of evolution; Bellagio overcame some of these opposition points of view. One does need to proceed on a variety of different, interrelated things in order to accomplish a series of tasks. Some are more immediate; some are more long range. Some affect long-term resource availabilities; some, short-term, etc. This is the integrated systems approach.

Now there is a danger in all this. It must be facilitative of moving ahead. It would not be constructive if it were put forward in a manner that no one could proceed on a certain phase until the entire system was in place. You will never get that perfect a state of coordination. I think we must be careful.

Dr. McKelvey. That is what has bothered me the most about the systems approach. It could become an impediment to action if one relies too heavily upon it. There are things that can be done immediately which fit into a systems development of the region.

Dr. Van Dyne. You fear that because one cannot do everything, there may be a temptation to do nothing.

Dr. McKelvey. Right. And you have stated it very well.

Ms. Hobson. I would say the involvement of the NAS in this development problem is all to the good. We have been "feeling our way"; now I think we can have a much more dynamic relationship. There is significance in having this kind of body working on these kinds of problems.

Dr. McLoughlin. In my own work in British Colombia there is an acceptance of the integrated approach concept. But there is also a perversion because some people say nothing should be done until the entire study, the whole plan, is complete. This is a very real tendency for governments.

We must, therefore, pull out two or three very real priorities (and highlight them). Hopefully, they will be the priorities of the policy makers of those countries.

Dr. McKelvey. I think we can present an holistic approach and then say these are the priorities, the place to begin.

Dr. Kates. For those who were not at Bellagio, I would like to illustrate the "flavor" of the conference.

An issue which we thought would be very difficult was participation of rural peoples in all stages of the development process. Dr. Hamidou Kane came out very strongly in favor of rural participation. This is stated well in the draft report.

On the other hand, the issues of water basin planning in terms of lessons that have been learned in Africa (Nile, Volta, etc.)--such as timing of construction, who benefits from irrigated land, where and how

products will be marketed, etc.--posed very difficult questions that were passed over lightly. We got very conventional replies. Perhaps our committee can say some of these things well and with the proper emphasis. (I do not mean a new, scholarly journal article.) It is perhaps in this area that we can play a critical role.

Dr. McLoughlin. There is a need for politicians to make critical decisions--grazing schemes, water development schemes, etc. No one says what size the farms should be or who will be farming the land. Thus, many other decisions cannot be made by planners. The truly difficult decisions are at that political level. The lack of decision could be one of the major stumbling blocks to the commitment of funds by the World Bank, for example. Are we (this committee) going to get this specific?

Dr. McKelvey. There are ways of handling these questions without becoming openly political. To confront the situation publicly is not helpful.

Dr. Dregne. Is there a national determination (in Sahelian countries) to proceed with the solution of real problems on the part of each of the governments involved. If that is not the case, there is little use in proceeding.

As an example, the commitment to proceed with agricultural development on the part of Israel was made. We all know the results.

Dr. McKelvey. I believe you can drive at (political) points through emphasis on policy. These become suggestions. Your illustration of Israel was correct until recently when the emphasis was switched to industrial development. When that became clear, then some international

donors felt they should not, indeed could not, devote their limited resources to the agricultural sector when the Israeli government was not inclined to give it first priority.

Gentlemen, I feel many points have been brought forward to help us turn out a good report. We shall now proceed with your suggestions.

This afternoon we turn to the question of the future role (if any) and mandate of this committee.

Dr. Lyman. Since I cannot be with you this afternoon, I would like to suggest the following:

. Regarding the scope of the committee's future work--should it be focused only on the Sahel or should it view aridity and development in the Sahel plus other regions of Africa, perhaps especially extending to East Africa (Kenya, Ethiopia, Tanzania).

. Regarding the question of a sharper programatic focus, the committee could suggest to AID what role and what things it feels it could do. This in turn would enable us to fit together with the committee those activities we are doing. It must be done better than we have done in the past. For example, perhaps the committee has been a bit too "ad hoc". Thus, the timing for certain things hasn't always worked to the best advantage of either group. Looking down the road two years, you and we might see some milestones ahead.

Future Work of the Committee

Dr. McKelvey. As a result of our discussions this morning, we are at the point where we may look forward to a definitive statement on the Sahel coming from this committee. The question now should be asked, "Has this committee completed its tasks? If so, what does the committee recommend? If not, what is left to be done and how should we organize ourselves to do it?"

The discussions with USAID representatives indicate their need for a group such as ours to carry on a continuing dialogue as an aid to help in the development of their program.

Since he has discussed the matter with Princeton Lyman, I will ask Dr. Michael Dow to elaborate on this.

Dr. Dow. I do not know that I can add much more than what Princeton Lyman said this morning.

Dr. Lyman feels AID does have a need for the overview, the perspective, that a group such as this has in terms of the Sahel, in terms of response to drought stress, integration of experience in drought-prone areas (Sahel, East Africa, perhaps northeast Brazil, Australia, etc.).

Now, everyone recognizes that there are problems. AID has brought questions to this committee in the past when it suited them (AID) rather than on a regular basis. I do not believe this has been a conscious policy on the part of AID; AID has had difficulties in organizing its responses to the drought-emergency in the Sahel. Should there be a continuation of this committee's efforts, the committee itself would want to set conditions (criteria) and program its activities more

definitively. AID agrees that a committee cannot and should not be asked to give quick responses to specific problems they face.

AID does feel that it has (major) decisions to take which would arise sufficiently in advance (i.e., the budget cycle) and to which this type of committee could provide valuable recommendations. A series of meetings, not necessarily of this group but perhaps of another group of a somewhat ad hoc nature, dealing with specific topics could be arranged.

This is "where we are." On the one hand, the interaction with AID should be on a somewhat broader basis than the Sahel itself and, on the other hand, the interaction ought to be better focused on topics which a committee feels can usefully be accomplished.

Dr. Kates. At Bellagio the U.S. panelists (Drs. McKelvey, Malone, Horowitz, Kates, and Van Dyne) asked themselves whether their task was finished. We reached the unanimous decision that we should not continue as a committee. We felt we had discharged our responsibility to AID to think about and to respond to questions of long-term development in the Sahelian Zone.

Now, various individuals can be usefully employed on specific tasks, but it is not clear that continuation of the entire committee would be useful. Also, some of us have a feeling that committees should be dissolved because there is a tendency for NAS committees to perpetuate themselves, to take on a life of their own.

Having said the above, I recognize at least two important tasks to be done: (a) a catalytic agent is needed to create, develop, and see established an international institute of the Sahel; and (b) the "experience" of this drought needs to be assembled for posterity.

On the first point, it is not necessary or desirable for this committee to undertake such an effort (to see a Sahelian institute from conception through to birth). It should be a truly international effort, perhaps with a different mix of talents than those existing here. There is, I recognize, a need for AID to have a group involved in such an effort on behalf of the United States; perhaps this committee or some other group assembled by the NAS should do this important task.

On the second point, we should recognize that a drought represents a major, natural, living experiment. That experience should be recorded so that the next occurrence will not catch us with a "lost memory." For example, I should like to ask Dr. Camus if there is a consistent effort to collect and record observations on drought experience of varieties of plants and animals. Similarly, we need to record the experience of the drought on water resources and water resource management systems. The drought was one of the most expensive relief operations in history; it isn't clear that this experience is being recorded. The drought also systematically affected the macro-economies of six or seven African states. A year from now we may not have an analysis of those effects as viewed by even one economist. The record of the experience of moving pastoral people from their rangelands to camps, etc., is not being systematically recorded. (Our colleague Michael Horowitz is trying to do something along this line.) Thus, the most obvious fact of trying to preserve the collective memory of the drought experience ought to be done systematically and relatively quickly; I do not know that it is, or will be done.

I am reluctant to recommend that the task of assembling the drought experience be done under NAS auspices. I was a member of the Committee on the Alaska Earthquake. It took nine years, nine volumes, and $20 million to record and to do the research for that study. I came away from the experience saying a committee should not be the mechanism for doing this type of task.

On the other hand, the only records of the drought in the Sahel that I have seen are a series of "picture book" brochures or reports put together independently by each group involved in the relief operations. These are superficial, often self-serving.

In my opinion there needs to be an effort organized in a cooperative, international way to get at the task (something between a brochure and a 9-year, 9-volume analysis). ORSTOM can contribute very significantly, as can other organizations. Perhaps the Swedish ecological group could do a quick study on recovery of areas which have undergone "desertification." Perhaps the UN in Dakar can do the study of the macro-economies. There is a need to bring all this together relatively cheaply and quickly (in a time frame of 2 to 3 years). Again, it isn't obvious to me that an NAS group such as this one should do that task, but I strongly feel the task needs to be done.

Dr. Talbot. I have been one of the most vocal critics about this committee's role vis-a-vis AID. One factor is that the committee itself has not been precise enough on its role. Far more important, however, is the functional question--this committee received information from AID rather late, often after they had made up their mind which way to go. We were called in, but for what purpose? From the perspective of the

African AID missions I feel AID/Washington was using this committee as a shield or way to provide legitimacy to actions AID/Washington intended to do all along. I do not question the intent of people in Washington; we were just a filter for them to do "business as usual."

Dr. McKelvey. Some have claimed that the situation you described is the typical, perhaps only use of a "consultant." (General laughter)

Dr. Talbot. But this is not an appropriate role for the NAS.

Now, I have been involved before in the organization of advisory groups for AID. One of the more successful, ultimately, was the Southeast Asia Development Advisory Group (SEADAG). This was one of AID's first attempts to get together with the U.S. academic community. For about two years it was painful because the two groups were speaking different languages without truly understanding one another. Gradually both sides learned a great deal; ultimately, there was a tremendous influence on AID projects in Southeast Asia from this association. The objective was not one of specific advice on specific problems. It was the AID avenue to academic input (in the best sense). This later resulted in a number of specific tasks which AID contracted with SEADAG. In any event, this is one type of AID interaction with academia.

Another kind of interaction is that of providing very specific advice about a very specific problem.

A third type is a review for AID of some specific proposal or whatever.

Yet another is the "early warning" or "targeting" function performed by a group such as ours. The group itself initiates interaction with AID on potential problems.

I see those potential kinds of interactions with AID using some of the better academic resources. This presumes AID will use (such a mechanism). But if an advisory committee is to exist, there must be a mandate representing which one, or which ones, of the kinds of interactions I have listed.

Dr. McKelvey. Good. Now I believe we are narrowing down to two questions: (a) Do we exist with a focus on the Sahel? (b) Can we be useful in a more general way following the outline given by Dr. Talbot?

I would like to pose the question, "Do we agree that there is no longer a vital need for this committee to exist as a Sahelian committee?"

Dr. McLoughlin. Are there, Mr. Chairman, important tasks vis-a-vis the drought in the Sahel which would not be done if this committee no longer existed?

Dr. McKelvey. I believe Dr. Kates raised that question and suggested several things which do not appear to be in the process of being accomplished by existing organizations. He has also raised the question of whether these tasks should be done by this committee. I don't know the answers.

Dr. Kates. I believe it is reasonable and natural for our committee to write to our parent body, the NAS Board on Science and Technology for International Development (BOSTID), urging BOSTID to take initiative to do certain things without the conclusion that this particular group be the one designated to do those things. Whatever else is done, one can imagine a different, perhaps better mix of people to do certain tasks if BOSTID were to decide NAS was the group to do the task.

Dr. Van Dyne. Let us look at the intersecting sets of opportunities of the panel, AID, and the Sahel.

Taking Dr. Talbot's list of specific tasks for the panel, I would reduce them to: (a) "brainstorming," (b) participation and/or organization of conferences and symposia, and (c) review, critique and response to particular questions. In my own view, a panel is not the best way to get a short-term (2 to 3 year) particular task done nor a long-term (8 to 9 year) research study. Secondly, I think the panel has done the brainstorming task. Whether a panel is needed to review and critique specific projects is something only AID can determine. Perhaps there is also a role for a conference or symposium on the drought experience in the Sahel. One could have a certain number of prepared papers and also "capture the dialogue" at the meeting in discussion sessions covering that drought experience.

With respect to this panel, I would suggest that we are finished with our brainstorming, there is a need for a follow-up conference, and, finally, I am ambivalent on the "response" to AID function. (For review and critique matters, AID has direct access to the same people that are available to NAS.)

Dr. Camus. There are lots of things which can be done even at the committee level, but some of these cannot be accomplished in a reasonable length of time. In this case there was a great pressure because of the disaster. The committee has considerable achievements, but I believe it has served its intended function. One should not overlook the fact that the situation (in the Sahel) has changed since this group was formed by the NAS at the specific request of AID.

Bellagio endorsed a proposal (for a Sahelian institute) which is being supported by UNDP. In the next few weeks a task force will go to the Sahel to study the situation. The report of that task force is due by May or June 1975. This panel, therefore, must produce its report by the end of April. We must recognize that decisions the (UNDP) task force must face are technical and political ones. This panel must not become involved in the political process.

Our report must be out very soon.

My feeling is that the NAS should respond positively to the AID need for assistance because there are other regions in the world outside the Sahel which will have (development-aridity) problems. There could be a group working with general problems of arid zones and then special groups associated with the parent body working on specific problems. This could, for example, eliminate the long time delays which were experienced in getting the Sahelian group underway.

Dr. McKelvey. That brings up a more fundamental question. If one focuses upon a class of problem (such as aridity and its development consequences), does one then need a geographic (a regional) committee?

Dr. Camus. In my opinion, no.

Dr. Dow. Do I understand Dr. Camus to be suggesting that the NAS undertake a review of the panel's work and other work in order to help prepare AID to respond to future problems of this kind in any part of the world?

Dr. Camus. I would not go that far. The collecting of the available data would not be the responsibility of the committee.

(Dr. Camus continued in French and this was translated as follows:

> It would be useful for everyone if the NAS were able to respond to the need for the long-term readiness for advice that would be available at the time drought disasters occur. What strikes me, for example, from the draft report and minutes of the Bellagio conference is the lack of statement of priorities.)

Dr. Box. I seem to hear that this committee should not exist just as a Sahelian group.

Secondly, I hear that AID needs advice from somebody. We may or may not be the right group to give the advice. Furthermore, I hear some of the things we ought not to do. Let UNEP and others do the regional tasks. Also, we should not be a technical review body.

What then do we (or someone else) do? We could serve as a collective memory to what has gone wrong in the past and as a "think tank" for what might happen in the future. If this is to be the role, AID must use such a committee at a very early stage of its (AID) deliberations--perhaps before planning is even done. I'm not sure that AID wants a "conscience" hanging around.

Dr. Talbot. Dr. Thadis Box has expressed what I had wanted us to get to. In view of the request of President Ford for the NAS to give the U.S. government generalized advice on food, we could recommend to our parent body a role for a panel on arid lands in terms of development problems, specifically food-population problems. This would be consistent with our (present) mandate. Where this fits relative to AID, I'm not sure. I also feel AID needs an advisory group on Sahelian Zone problems. However, this group has done its function--when it has presented our report to AID.

Upon presenting our report to our parent body we could leave to it (BOSTID) the possibility that the NAS serve an "occasional" advisory function, perhaps within a broader framework, to AID on arid lands and development.

Dr. Peterson. I have two comments. First, I want to reflect on George Van Dyne's "uneasiness" that we have been asked to respond "after the horse has already left the barn." I do not think we should shy away from giving scientific help to AID, under almost any honest set of circumstances. We will be "used" at times, but it is my observation that AID is losing its own experienced, scientific staff--through retirements and other forced circumstances. I feel we should stand ready on an *ad hoc* basis to help out. That *is* a proper function of the NAS. It may be a little more "risky" than we like; perhaps the NAS has been too conservative anyhow.

Dr. McKelvey. Agreed!

Dr. Peterson. Speaking to Robert Kates' point about "memory," I feel we should recommend to AID that it use its research funds to document the experience of the drought in the Sahel. We would not need to recommend that we do it or that the NAS do it. It can be done by contractors and with the participation of others such as UNDP.

Dr. Camus. Mr. Chairman, I agree with Dr. Kates (and others) that this panel need not do the studies, but it could be done by direct contract. The studies are needed.

Dr. Talbot. If a committee to advise AID is to continue, part of its function could (should?) be on such questions. The committee would not undertake *to do* studies but *to advise* that such studies be undertaken, and say why.

Dr. Van Dyne. Three points: (a) the "look-ahead" strategy group which would focus on aridity and development in general, (b) the Sahel "clean-up" (recording and analyzing the drought experience), (c) a general conference involving perhaps 75-150 scientists and technicians involved in the Sahelian drought experience (this conference would be quite different from our Bellagio conference in October 1974 and would "capture" relatively quickly the "collective wisdom" of those involved), and (d) monitoring the Sahel "follow-up" (birth and establishment of the institute).

I agree that scientists should always contribute to the cause of humanity (as in the Sahel). My concern is that this be done while preserving ones integrity.

Dr. Kates. I think the contribution to the institute of the Sahel deserves more emphasis. The kind of activities that occur in the next few months (feasibility study) will make a great difference as to whether something dynamic and meaningful or just another institution evolves. I am concerned that the thinking of the Bellagio group is factored into the process. Too often a feasibility study by the UNDP results in some compromise among FAO, WMO, UNESCO, etc. The result has "built-in" limitations. Perhaps an NAS initiative would help.

Dr. Camus. The preferable method would be informal contact because the NAS should not put itself into the political arena. Now the UNDP feasibility study must enter that political, decision-making stage.

Dr. Dregne. I would like to endorse two items. One is the "looking ahead" function as suggested by Dr. Lee Talbot. That would be challenging, very exciting.

The second is the drought experience as it affected the people. This is "a chance in a lifetime" opportunity for a fascinating study. Time is very short for such a study.

Dr. Kates. My assumption is that a great deal of information is readily available. Part is scattered around in various institutions that have been involved in the Sahel; part is in the minds of people. A study such as I envision would not strike out to do original research but to gather scattered evidence, encourage publication of recorded and/or unrecorded experience, etc. The task also requires categorizing as well as collecting. Having myself studied some ten major world disasters, I know that the systematic collection and publishing of the experience does not occur spontaneously.

Dr. Camus. I share the worries of Dr. Kates. A very specific recommendation for a conference to bring this experience into focus is a very important point. I can say that my organization is doing much in at least three of the seven Sahelian countries, but that probably isn't enough. Such a conference, held in the area, would help very much.

Dr. McKelvey. We will put such a recommendation down.

Dr. Box. Changing the subject, I would like to ask how one clears his conscience when he feels deeply some action has been ill-advised. I know many on this panel have discussed a specific case, but the panel has not put it bluntly or directly to AID. Are we doing our jobs if we don't go farther than discuss it among ourselves?

Dr. McKelvey. I don't share your pangs of conscience. The matter you refer to was a step taken by AID without first consulting this committee. It is a classic example of what Lee Talbot spoke about

previously. We will not get anywhere by specifically dragging the case out before AID. Let's build on what was good and go forward.

Dr. McLoughlin. I endorse the idea that there ought to be some committee to look down the road, to conceptualize on problems of arid and semi-arid areas. These areas are some of the most difficult in the world to achieve a sustained increase in food output. Often they have just about reached their level, given the technology of today. We now have heavy population and development pressures in these geographic areas. We know, also, that arid/semi-arid areas represent a large share of the world; thus, a long range committee could serve a very useful function.

Dr. McKelvey. Let us see what the mind of this group is--if a consensus exists. Can we agree that for the Sahel and for what this committee was set up to do:

. We have done our job;

. We see other tasks that some group needs to do that relate specifically to the Sahel;

. This committee, as presently constituted, is not in a position to do the needed tasks;

. We should recommend that the parent body (BOSTID) consider the tasks (and how they may best be done); and

. We have an indication from AID of a continuing need for the type of body we have been, whether on a Sahelian (Zone) basis or on a broader basis that remains to be further discussed.

Is this an accurate summation?

Dr. McLoughlin. With a footnote that in the report of this committee we should establish priorities.

Dr. McKelvey. Oh yes, we will do that--definitely, absolutely.

Dr. Van Dyne. Put in a slightly different way, this committee should

. vote itself out of existence, and

. specify a certain number ("n") of things for which there should be follow-up.

Dr. McKelvey. Correct. This committee should not take upon itself the task of giving itself a new lease on life. That is the responsibility of our parent organization (BOSTID, and ultimately the NAS) and AID.

Dr. Van Dyne. I would certainly agree that this committee should vote itself out of existence. I would agree that the committee should specify some follow-up tasks, and that some of those should impinge directly on the Sahel.

Dr. Talbot. I would hope that we should present as one option this much broader perspective (on world aridity and development).

Dr. Kates. I would also add there is a real case for having independent advisory groups to AID for something as big and important as the MIT study. Our role, which was an uncomfortable one and not even a very useful one, was that of occasional protagonist. In these instances a major contractor doing a study should not self-select its own advisory panel. We need to say something in our report about this situation and relate it to the more general question of the independent advisory role.

A second rather critical remark should be related to short-term projects. This kind of panel really cannot do that task. We are volunteers; we cannot meet often; we cannot usually make site visits; etc.

We should not, intentionally or otherwise, have a "rubber stamp" function. I do not feel AID was misusing us deliberately, but I also do not feel they fully understood the uses and/or limitations of an NAS panel.

Dr. Camus. As you know there is a movement among donor organizations to coordinate help for the Sahelian region. Whether or not the focus of this will be through CILSS, I do not think is too important for this discussion. The point is that AID, either through its own human resources or strengthened in some other way, would benefit from very sound scientific advice. Perhaps the panel should make a recommendation along this line. Either a contract could be let by AID for scientific assistance or a new panel organized under the auspices of the NAS, or some other method--but the point is that AID would surely benefit from good scientific counsel on questions of Sahelian Zone development.

Dr. Peterson. Yes, I feel AID does need the help of the NAS to identify the best talent available from within the scientific and academic communities. This need will increase with the increased development tempo in the Sahel and the simultaneous effort to cut back on AID (staff) personnel.

I agree that we should get into the act early, but at whatever stage, the advice can be very useful. The NAS, for example, reviewed for AID the East Pakistan (Bangladesh) water resources development plan of the World Bank. I think we had an impact in changing that--even at a fairly advanced stage.

Dr. McKelvey. I do not share the view of some that this panel had no impact on the MIT study. You will recall our discussion with MIT people some months back. In my own mind I am sure the MIT people paid attention to the points raised by members of the panel.

Dr. Dow. I recall in a discussion with AID people that the major points raised by this committee were factors in their decision making process. We may not claim a direct cause-effect relationship, but the input of this group was felt. The specific instances I can cite were large-scale grazing reserves and large-scale tsetse fly clearance.

Dr. Kates. There was also an educational function served. High level AID decision makers expressed, for example, the usefulness of Bellagio.

Finally, our informal advice and suggestions have affected the makeup of other advisory groups to AID on specific projects dealing with the Sahel.

Dr. Lythcott. I have been dealing with AID for a long, long time and am not really sanguine about our ability to get them to change traditional methods of operation.

I do agree that the committee should disband with the recommendation that there still remains work to be done, advice to be given. I am in complete accord with what has been said around this table this afternoon.

Dr. McKelvey. I agree that we have done our job; it is quite clear that we have accomplished our purpose.

Now another question arises. If there is advice to be given and work to be done for and with AID, should the structure of any new group be geographical or focus on the problem of arid lands.

Dr. Peterson. I don't think you can generalize on that point. It is both. One should be prepared to do both, depending upon the terms of reference.

Dr. McLoughlin. On reflection I believe I recognize a tendency to gear up to do a job associated with a disaster. Then a structure or a bureaucracy builds up to deal with a problem, and that bureaucracy tends to perpetuate itself. I see this as a problem that we should not be guilty of perpetuating.

Dr. Talbot. I would like to speak to the question of whether we should deal with arid lands in general or a geographic area in particular.

There are site specific problems which are more sociological than strictly ecological in nature (assuming one choses to rule sociology out of ecology). Having worked for a number of years in most of the world's arid zones, I feel there are more similarities than there are differences when we are dealing with development problems. Some of the more useful advances have come when there is cross fertilization, and this is in part because we are dealing with management of the problem.

Therefore, I would suggest that a useful organization is a parent committee dealing with arid lands. That committee could, on an ad hoc basis, enlist or establish a panel with particular expertise to deal with a specific problem. This could be done either on a geographical or a project basis.

Dr. Peterson. May I ask, Mr. Chairman, if we may put some other input into the Bellagio report?

Dr. McKelvey. Yes, but please do so in writing to me within the next few days.

I am assuming the committee, on the basis of the discussion today, will be willing to approve the Bellagio report.

Dr. Malone. Will there be a clear acknowledgment in the Bellagio report that the problems of the Sahel transcend the Sahel as a geographic region.

Dr. McKelvey. Yes, of course.

Dr. Malone. I also hope we will reference More Water for Arid Lands as an example of the kind of thing that a Sahelian institute might look into. This should be done not as a directive but as an example of research opportunities.

Dr. McKelvey. Definitely; absolutely.

Dr. Malone. Finally, there has to be attention to regional or global food "reserving." We must be prepared for contingencies in the Sahel.

Dr. McKelvey. Yes, we will look into that.

Dr. Malone. Before we leave, is there anything we should do as a committee about ordering priorities?

Dr. McKelvey. The priorities will be ordered. Whether the order will meet the desire or feeling of each of you, I cannot be sure at this moment. We will certainly try to meet a consensus of Bellagio and the discussion held here today.

Dr. Malone. I'm not apprehensive. The work is in good hands.

Dr. Van Dyne. We will have to respond to you by telephone. Will maps, etc., be included?

Dr. McKelvey. I would prefer a response by telephone, and maps will be included.

Dr. Kates. I believe I speak for everyone when I express appreciation for the remarkable patience and skill the chairman has exhibited over these many months. Our mutual frustration level at times was high,

but the chairman found the way around that--and we always felt a sense of accomplishment. Thank you, Mr. Chairman, for seeing us through.

Dr. Talbot. A task of this kind is dependent upon a chairman and his staff. I hope that we can express to them our appreciation of their efforts--depending, of course, upon whether we like the final report (laughter).

Dr. McKelvey. Thank you, each and everyone. This has been a delightful experience personally--and a very instructive one.