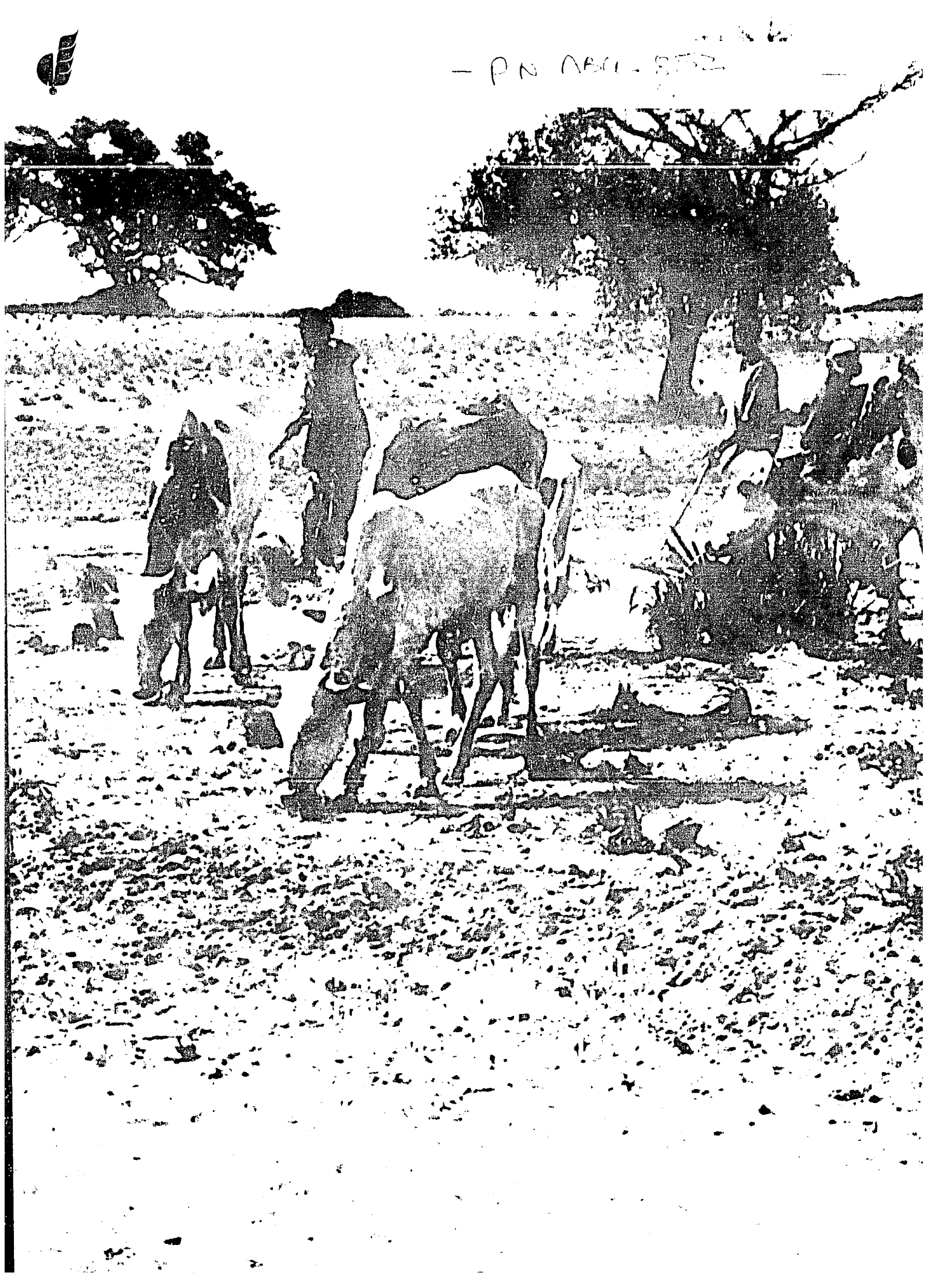

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Papers Presented at the International Planning Workshop for a Desert Margins Initiative

Communications présentées lors de l'Atelier international de planification pour l'Action dans les zones limitrophes du désert

23–26 Jan/*janv.* 1995, Nairobi, Kenya

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1995

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Foreword

In August 1994, at the invitation of the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR), ICRISAT submitted a draft proposal for an ecoregional research initiative for the arid and semi-arid tropics of sub-Saharan Africa. It was entitled 'Sustainable Natural Resource Management Options to Arrest Land Degradation in the Desert Margins of Sub-Saharan Africa'.

The goal of the Initiative is to address problems of food security, poverty, and the sustainable management of natural resources on behalf of 400 million poor people who inhabit 1.3 billion hectares in Africa, whose livelihoods are endangered by environmental degradation.

This proposal for the Initiative was submitted by ICRISAT on behalf of the United Nations Environment Programme (UNEP) and a consortium of the following six CGIAR centers:

- International Center for Agricultural Research in the Dry Areas (ICARDA);
- International Centre for Research in Agroforestry (ICRAF);
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT);
- International Food Policy Research Institute (IFPRI);
- International Livestock Centre for Africa (ILCA): now the International Livestock Research Institute (ILRI);
- International Plant Genetic Resources Institute (IPGRI);

and other international, regional, and national organizations.

In order to facilitate an effective dialog between interested participants, ICRISAT proposed to hold an International Planning Workshop for a Desert Margins Initiative in January 1995.

This volume provides, for early publication, the full texts of papers presented in facsimile form in the original English or French. The companion volume, *Combating Land Degradation in Sub-Saharan Africa*, describes the background, organization, and outcomes of the Workshop, including summaries of development constraints in desert margin areas of Botswana, Burkina Faso, Kenya, Mali, Namibia, and Niger.

At the end of the Workshop, participants agreed to nominate candidates for an Interim Steering Committee. And, to maintain the impetus developed during the meeting, over 30 representatives of organizations with relevant expertise to offer, recorded their interest in one or several of the nine agreed objectives of the Initiative. This will form the basis of the next steps in the process of articulating and implementing the Initiative.

J G Ryan
Director General, ICRISAT

March 1995

Avant-propos

En août 1994, l'ICRISAT a soumis une proposition 'Options durables de l'exploitation des ressources naturelles pour lutter contre la dégradation des sols dans les zones limitrophes du désert en Afrique au sud du Sahara'. Cette proposition visant à une action écorégionale concertée contre la désertification a été soumise à la demande du Comité technique consultatif (TAC) du Groupe consultatif pour la recherche agricole internationale (GCRAI).

La dégradation environnementale touche à peu près 400 millions d'individus habitant de 1,3 milliards d'hectares en Afrique sub-saharienne. L'objectif de l'Action est donc de parer aux problèmes de la sécurité alimentaire, la pauvreté, et l'exploitation durable des ressources naturelles de cette zone sinistrée.

L'ICRISAT a présenté la proposition au nom d'un consortium réunissant le Programme des Nations Unies pour l'environnement (UNEP) et les six centres suivants du GCRAI:

- *Centre international de recherche agricole dans les zones arides (ICARDA);*
- *Centre international de recherche en agroforesterie (ICRAF);*
- *Institut international de recherche sur les cultures des zones tropicales semi-arides (ICRISAT);*
- *Institut international de recherche sur les politiques alimentaires (IFPRI);*
- *Centre international pour l'élevage en Afrique (ILCA), maintenant Institut international de recherche sur l'élevage (ILRI);*
- *Institut international des ressources phytogénétiques (IPGRI);*

ainsi que d'autres organisations internationales, régionales et nationales.

Afin de promouvoir un dialogue efficace entre les participants concernés, l'ICRISAT a tenu, en janvier 1995, un Atelier international de planification pour l'action dans les zones limitrophes du désert.

On a regroupé dans ce volume le texte intégral des communications, en anglais ou en français, dans leur présentation originale afin d'en accélerer la publication. Le volume complémentaire, 'Lutte contre la dégradation des sols en Afrique au sud du Sahara', présente l'historique, l'organisation et les résultats de cet Atelier ainsi que les comptes rendus des communications sur les contraintes au développement dans les zones limitrophes du désert au Botswana, au Burkina Faso, au Kenya, au Mali, en Namibie et au Niger.

A la fin de l'Atelier, les participants ont décidé de désigner des candidats pour un Comité intérimaire de direction. Plus de 30 représentants d'organisations de compétences diverses ont montré leur intérêt dans un ou plusieurs objectifs de l'Action. Ceci permettra non seulement de garder l'impulsion développée au cours de l'Atelier, mais aussi de suivre le processus d'articulation et de réalisation de l'Action.

J G Ryan
Directeur Général, ICRISAT

Mars 1995

Opening Session/*Session d'ouverture*

Systemwide ecoregional initiatives of the CGIAR: role of the Desert Margins Initiative

J G Ryan

Director General

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

Introduction

In recent years the Consultative Group on International Agricultural Research (CGIAR) has been engaged in a major reassessment of its strategies and priorities to ensure they more adequately reflect contemporary concerns about the sustainable management of natural resources. At the same time the CGIAR's commitment to the protection of food security and the alleviation of poverty has been reaffirmed. In this process it has become evident that there is a nexus between sustainability, poverty alleviation, and food security. The three are complementary goals.

Endeavoring to address these three challenges against the background of a substantial reduction in the level of support for international and national agricultural research has required some lateral thinking about how to improve the cost-effectiveness of the global agricultural system, of which the CGIAR is but a small part. Out of this has emerged the notion of ecoregional approaches to the conduct of research, aimed at addressing the three challenges referred to above.

In this paper the genesis of these ecoregional approaches is first described, including an elaboration of the concept and its rationale, followed by a discussion of organization and management issues. The influence of the negotiation process leading up to the successful conclusion of the Desertification Convention on the articulation of the proposed Desert Margins Initiative is then discussed. This is followed by a section on the genesis of the Desert Margins Initiative, including a summary of the background document prepared for this Workshop which details the objectives of, and proposed activities in the Initiative. The possible linkages which a Desert Margins Initiative could develop with an emerging Systemwide Initiative on Soil, Water, and Nutrient Management Research are also discussed. The paper concludes with a listing of issues about which the participants in the Workshop would need to come to some conclusions if the proposed Initiative is to become a reality. Assuming the decision is in the affirmative, the next steps are then described.

Genesis of Ecoregional Concepts in the CGIAR

The ecoregional concept was first made explicit by the Technical Advisory Committee (TAC) of the CGIAR in their *Expansion Paper* written in 1990. Although concerns about the conduct of research on natural resources was evident much earlier in the history of the CGIAR, it was only in the *Expansion Paper* that TAC coined the word "ecoregion". The ecoregion was characterized as a regionally defined agroecological zone.

TAC proposed an ecoregional approach to the conduct of research on sustainable increases in agricultural production and the conservation of natural resources in order to help focus and coordinate the research expertise of CGIAR centers on these twin goals.

Because the approach encourages research to alleviate constraints at various levels that include the field, farm, community, watershed, and region, TAC also considered it important to undertake ecoregional research initiatives with a strong sense of partnership amongst collaborating institutions at local, national, regional, and international levels.

The detailed articulation of the ecoregional concept is described in the paper entitled, "The Ecoregional Approach to Research in the CGIAR: Report of the TAC/Center Directors Working Group" (TAC 1993). This paper was discussed at length during the CGIAR Mid-

Term Meeting in May 1993 in Puerto Rico. In addition to donors and international centers, the meeting in Puerto Rico included representatives from national agricultural research systems (NARS) and nongovernmental organizations (NGOs). The paper was also discussed at the meeting of the Special Program for African Agricultural Research (SPAAR) held in April of 1993. Let me draw from this paper and others from TAC to describe the ecoregional concept in some detail.

The Ecoregional Approach

In the early days of the CGIAR, "Food First" was the primary objective. This was against the background of the famines that were prevalent in many developing countries, especially those in Asia, during the early to mid-1960s. Today it is well recognized that, whilst the challenges of ensuring future food security loom as large now as they did then, future food productivity increases will have to be achieved while at the same time conserving and enhancing the natural resource base on which they depend. Hence, future commodity improvement research must be balanced by an increased effort on natural resource management research. This will require a new spirit of partnership amongst all groups engaged in these research issues. There must be a closer integration across local, country, regional, and international levels to ensure that the global research system is both more efficient and more coherent.

The concern about widespread land degradation in recent years has centered around such issues as the loss of genetic diversity, depletion and pollution of water sources, soil erosion, salinization, waterlogging, deforestation, desertification, and general environmental pollution. These are seen as threats to the sustainability of the agricultural resource base. The CGIAR defined sustainable agriculture as: "The successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources" (TAC 1990).

Because the ecoregion, as defined by TAC, combines physical, biological, and socioeconomic dimensions of agricultural production environments, TAC saw it as a logical component of a hierarchial system that would enable international agricultural research centers (IARCs) to deal more effectively with resource management challenges, than would a concern only with the farm level. Research at broader levels of the hierarchy such as the catchment area, the community, and the agroecological zone was seen as enabling more equal and explicit partnerships with the policy formulation that is so necessary to promote technological change. Ecoregional mechanisms and initiatives were seen as a way to help IARCs understand and coordinate the needs of NARS within the IARCs' mandate regions to ensure that IARC interactions are better tailored to NARS capacities, and to reduce duplication among IARCs in their relationships with NARS.

TAC envisaged the ecoregional approach to research as having three ingredients:

- Applied and strategic research on the foundations of sustainable production systems in the ecoregions;
- Improvement of productivity in the ecoregion by drawing on appropriate global research activities; and
- Strengthening cooperation with national partners and the development of transnational mechanisms of collaboration.

Hence the ecoregional approach was seen as a way of enabling novel approaches to future collaboration with various stakeholders in the R&D continuum, in order to achieve sustainable

increases in food and agricultural productivity in the years ahead. The CGIAR acknowledged that the complexity of the challenges ahead will require a much greater range of expertise than presently exists in the IARCs, and that new partnerships on an agreed research agenda will be necessary. Ecoregional mechanisms involving consortia of institutions was seen as one potential mechanism to achieve this. The ecoregional approach was seen as not only providing a vehicle for enhancing collaboration between NARS and IARCs, but also as an important way to strengthen cooperation and reduce duplication amongst IARCs operating within ecoregions. It was recognized that overlapping mandates and competition among IARCs have created an additional burden on NARS that has sometimes impeded their capacity to be responsive as equal partners.

Ecoregional Organization and Management Issues

It is recognized that there is currently no panacea for the implementation of ecoregional approaches to the conduct of research that has both sustainability and productivity dimensions. In articulating the ecoregional approach, TAC called for the development of a new paradigm and recognized that this itself is a topic for experimentation amongst actors in the R&D continuum. TAC envisaged, however, that ecoregional research will require multidisciplinary teams to ensure that:

- Proper integration of resource management and productivity concerns will occur;
- Human and technical dimensions will come together;
- A systems approach will apply; and
- Policy formulation will be explicitly linked to technology design and exchange.

Similarly, because of the diversity of the capabilities of NARS, the differing mandates of IARCs, and the location-specificity of food security and natural resource management challenges, TAC did not believe that there would be a single organizational mode that would serve the needs of all ecoregions.

TAC in its Priorities and Strategies Paper (1993), suggested a set of pragmatic guidelines that might be used to assist the CGIAR system to move forward in this area. These guidelines included recognition of the need to:

- Operate on a regional basis;
- Focus on important agroecological zones with potential or actual sustainablity problems;
- Combine natural resources management and productivity objectives;
- Employ a multidisciplinary approach;
- Include natural and social sciences;
- Involve national research institutions and other partners in a synergistic way;
- Adopt flexible systems of governance and priority setting;
- Ensure global coherence in system strategies; and
- Utilize flexible funding mechanisms.

The formation of research consortia catalyzed and supported by a convening institution, possibly an IARC, was seen by TAC as perhaps the most logical way to begin ecoregional initiatives. A consortium was defined as "a partnership of diverse institutions to accumulate critical mass, and to jointly plan and implement an integrated research program of common interest in an ecoregion". The convening role may, or may not, lead to subsequent agreement for an IARC to become a research leader in one or more elements of the agreed research agenda of the ecoregional consortium.

The ecoregional initiatives will no doubt adopt organizational forms appropriate to specific ecoregions and to the strength of collaborating national, local, and regional institutions within that ecoregion. Clearly, each initiative will only be able to conduct research at a limited number of sites, and these should be carefully chosen to ensure that they are both replicable and can be extrapolated to other parts of the ecoregion.

Diagnostic research to understand the mechanical, chemical biological, and socioeconomic determinants of natural resource degradation was seen as an essential first step in ecoregional research. Following upon the diagnostic phase, research on options that could be used to address the problems would need to be evaluated by a number of criteria, including their:

- Potential to restore and enhance the natural resource base;
- Potential to increase productivity;
- Comparability with existing production systems; and
- Amenability to influence by community institutions and policy decisions.

TAC selected the warm, arid, and semi-arid tropics and subtropics with summer rainfall in sub-Saharan Africa and Asia as two priority ecoregions for the implementation of this new paradigm. These ecoregions consist of Agro-Ecological Zones (AEZ) 1 and 5 in the TAC and FAO nomenclature. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was nominated as the Convening Center for initiatives in these two ecoregions. The Desert Margins Initiative is proposed as the focal point for ecoregional activities in the warm, arid and semi-arid tropics with summer rainfall in sub-Saharan Africa.

We recognize that the research paradigm and the accompanying organization and management arrangements for this ecoregional initiative will have to evolve over time, and that TAC has no panacea to meet this need. At least three principles were suggested to help CGIAR Centers implement the ecoregional approach, and to guide their interactions with collaborating institutions in the global agricultural research system.

Improved efficiency in the CGIAR and the wider global system. By reducing duplication among global system partners through effecting greater complementarity of research efforts, and by efficient task allocation based on the principle of institutional comparative advantage, the CGIAR and the global system will stimulate greater spillover of benefits.

Greater participation and transparency in decision-making. Equal partnerships will reduce perceptions of conflicts of interest held by NARS and NGOs, and stimulate their commitment to collaborative programs.

Mobilization of additional resources. Open and flexible organizational mechanisms to identify, attract, focus, and facilitate the efforts of collaborators to work together on jointly defined problems will increase donor confidence and open up new sources of funds.

The ecoregional initiatives will emphasize mechanisms rather than Centers, and will stimulate dynamic and equitable partnerships to design novel research models for sustainable improvements in productivity and in natural resource management. These models will be based on the exploitation of scientific synergies amongst actors in the global agricultural research system.

At present some 12 ecoregional initiatives have either been implemented or are under active development in the CGIAR. A recent paper by Duiker and Goldsworthy (1994) of the International Service for National Agricultural Research (ISNAR) describes some of these initiatives, and they are listed in Table 1. ICRISAT is convenor of the Desert Margins Initiative and the Rice-Wheat Consortium in the Indo-Gangetic Plains of South Asia.

Desertification Convention impetus. Together with the introduction of the ecoregional approach in the CGIAR, the recent negotiation of the Desertification Convention provided an added stimulus to the development of the Desert Margins Initiative to its present stage. ICRISAT represented the CGIAR during the intergovernmental negotiating process which led up to the signing ceremony in October 1994 in Paris, France.

Table 1. Current and planned ecological initiatives of the CGIAR.

Ecoregional Initiative	Geographic scope	Convening/Lead Center
African Highlands (AH)	Sub-Saharan Africa	ICRAF
Alternatives to Slash and Burn (ASB)	Global	ICRAF
Sustainable management of natural resources in the High Andes (CONDESAN)[1]	South America	CIP
Desert Margins (DM)	Sub-Saharan Africa	ICRISAT
Rainfed Lowland Rice Research Consortium (RLRRC)	Asia	IRRI
Inland Valley Agro-Ecosystems (IVAE)	Sub-Saharan Africa	WARDA
Sustainable Mountain Agricultural Development (SMAD)[1]	Global	CIP
Rice-Wheat Based Cropping Systems (RWBCS)	South Asia	ICRISAT
Northern Margins of the Sahara (NMS)	West Asia/ North Africa	ICARDA
American Lowland Tropics (ALT)	Latin America	CIAT
Warm Humid and Sub-Humid Tropics (WHSHT)	Sub-Saharan Africa	IITA
Warm Humid/Sub-Humid Tropics and Subtropics of Asia (WHSHTSA)	Asia	IRRI

Source: Duiker and Goldsworthy (1994); TAC (1994). [1]CONDESAN and SMAD are being combined.

Background and Negotiation Process

The background to the negotiation of the Desertification Convention was the concern about the increasing pace of land degradation in arid, semi-arid, and dry subhumid tropical areas resulting from climatic variations and human activities.

Back in 1974, the United Nations General Assembly approved concerted efforts to combat desertification. These efforts culminated in the United Nations Conference on Desertification (UNCOD) held in 1977 in Nairobi. UNCOD produced 27 detailed recommendations on ways to combat desertification in a 20-year proposed Action Plan. The United Nations Environment Programme (UNEP) recently reviewed the UNCCD Action Plan and reiterated that desertification continues to afflict many millions of people. The UNEP review also revealed that UNCOD's Action Plan had achieved minimal impact for the following reasons:

- Lack of prioritization of desertification action plans by both donors and recipients;
- Lack of emphasis on the socioeconomic and political mechanisms required to solve the problems; and
- Inability of affected countries to cope with the problems without additional external support.

This problem was recognized by United Nations Conference on Environment Development (UNCED) at Rio in 1992, and accepted as a major program area in 'Agenda 21'. However, the first call for a Convention came during the UNCED preparatory process. During the elaboration of UNCED's Agenda 21 Chapter 12, that deals with combating desertification and drought, the African Group, especially the Sudano-Sahelian countries, promoted the concept of a Convention to Combat Desertification as a critical mechanism for strengthening local, national, regional, and international cooperation. Such a Convention would provide for commitments from all nations, an element that was lacking in the UNCOD Action Plan. The Rio conference accepted the suggestion recognized desertification as a global environmental/developmental problem, and recommended that the 47th UN General Assembly "establish an Inter-governmental Negotiating Committee to elaborate a United Nations International Convention to Combat Desertification (UNICCD) in those countries experiencing serious drought and/or desertification, particularly in Africa".

The UN General Assembly adopted this recommendation by resolution 47/188 of December 1992. This set in motion the negotiation process for the Convention, which was to be concluded by June 1994. The rationale for negotiating UNICCD could be summarized as a concerted worldwide effort to:

- Support millions of affected populations alleviate their suffering, and replace land degradation with sustainable development;
- Support other efforts in reversing global climate change; and
- Support other efforts in the conservation of biodiversity.

The UNICCD Secretariat indicated in the early stages of the process that:

> "The overall objective of the Convention is to marshall effective and specific commitments, actions and cooperation at local, national, regional, and global levels to implement a new integrated systems approach to combating desertification and mitigating drought by promoting sustainable development

at the local community level according to the real needs local people perceive. This implies long-term focus on both improving living conditions and the quality of life at the community level and simultaneously managing land resources sustainably to maximize dryland productivity".

Perhaps the most important accomplishment of the UNICCD process has been the international attention that has been focused on the problem of desertification. Many have argued that, regardless of the specificities in the final Convention, the process itself has been a success in providing a networking forum for those affected by desertification. This forum involves donors, affected developing countries, UN agencies, intergovernmental organizations, and NGOs, and has provided numerous contacts that have already laid the groundwork for future partnership arrangements to combat desertification.

Other critical achievements are the acceptance by many governments of the importance of the participatory approach in the development of the national action programs, and the recognition that this participation is a precondition to successful results.

NGOs were extremely positive about the openness of the negotiating process and the extent to which they were able to influence decision-making, especially around such issues as national desertification trust funds and NGO participation in the development of national action programs. At the first UNICCD session (UNICCD-1) held in Nairobi in May-June 1993 only 15 NGOs were represented. By UNICCD-5 held in Paris in June 1994 there were over 50 NGOs actively participating, with over 230 accredited. The impact these NGOs had on the Convention and the role they are preparing to play in its implementation have set an important precedent for their role in R&D generally.

There has also been an important change in the attitude of policy-makers to the socioeconomic dimensions of the desertification problem, and to the need to incorporate these factors into action programs.

The negotiation process has stimulated a new awareness of the need to coordinate action and aid programs. There has been a heightened awareness of national and regional resource management problems and of the need to build on the successes and to avoid replication of the failures of the 1977 Action Plan.

Relevance of the Desertification Convention to the Desert Margins Initiative

The following Articles in the Convention are of relevance to the proposed Desert Margins Initiative.

Article 16	Information collection, analysis and, exchange
Article 17	Research and development
Article 18	Transfer, acquisition, adaptation, and development of technology
Article 19	Capacity building, education, and public awareness
Article 24	Committee on science and technology
Article 25	Networking and existing institutions, agencies, and bodies.

Space does not permit me to reproduce all these Articles here. I would encourage Workshop participants to obtain a copy of the Convention, as it makes for interesting reading. However, I will reproduce **Article 17, Research and development.**

"1. The Parties undertake, according to their respective capabilities, to promote technical and scientific cooperation in the fields of combating desertification and mitigating the effects of drought through appropriate national, subregional, regional and international institutions. To this end, they shall support research activities that:

(a) contribute to increased knowledge of the processes leading to desertification and drought and the impact of, and distinction between, causal factors, both natural and human, with a view to combatting desertification and mitigating the effects of drought, and achieving improved productivity as well as sustainable use and management of resources;

(b) respond to well defined objectives, address the specific needs of local populations and lead to the identification and implementation of solutions that improve the living standards of people in affected areas;

(c) protect, integrate, enhance and validate traditional and local knowledge, know-how and practices, ensuring, subject to their respective national legislation and/or policies, that the owners of that knowledge will directly benefit on an equitable basis and on mutually agreed terms from any commercial utilization of it or from any technological development derived from that knowledge;

(d) develop and strengthen national, subregional and regional research capacities in affected developing country parties, particularly in Africa, including the development of local skills and the strengthening of appropriate capacities, especially in countries with a weak research base, giving particular attention to multidisciplinary and participative socioeconomic research;

(e) take into account, where relevant, the relationship between poverty, migration caused by environmental factors, and desertification;

(f) promote the conduct of joint research programmes between national, subregional, regional, and international research organizations, in both the public and private sectors, for the development of improved, affordable, and accessible technologies for sustainable development through effective participation of local populations and communities; and

(g) enhance the availability of water resources in affected areas, by means of, inter alia, cloud-seeding.

Research priorities for particular regions and subregions, reflecting different local conditions, should be included in action programmes. The Conference of the Parties shall review research priorities periodically on the advice of the Committee on Science and Technology."

It can be seen that the rationale for the ecoregional approach in the CGIAR has much in common with research activities proposed under the Desertification Convention. Both of them emphasize strategic, applied, and adaptive research on the processes leading to desertification and drought, and obtaining a better understanding of the causal factors involved, with the aim

of designing appropriate strategies to alleviate their effects. Participatory methods are encouraged, with a view to distilling indigenous knowledge that can assist in solving the problems of desertification and drought. Both productivity and sustainability are alluded to, as is the need for collaborative research programs at national, subregional, regional, and international levels.

A number of action programs are proposed under the Convention, and the one for Africa is well articulated. This is probably as a result of the Convention's placing special emphasis on the problems of desertification and drought in Africa.

Funding Issues

It was clear during the negotiation process leading to the Desertification Convention signing in October 1994, that donors did not envisage there would be a significant increase in funding available for implementation. This was obviously a great disappointment to the developing countries who participated in the negotiations.

At one stage it was hoped that a new global desertification fund would be created to facilitate the mobilization of additional funds for action programs under the Convention. This now seems unlikely, as does funding under the Global Environment Facility (GEF). The GEF has indicated that problems of land degradation and desertification will not be included as explicit project activities under the GEF. However, if projects focusing on these issues include components that relate to biodiversity, global climate change, international waters, and the ozone layer, these components may be considered for possible support. Land degradation per se is not eligible for GEF funding.

It would seem that if we conclude at this Workshop that there is merit in proceeding with a Desert Margins Initiative it may be preferable to develop modules that could be used to make submissions to different donors, rather than to develop a single project for submission to a single donor. This would result in not only a research consortium, but also a donor consortium. This is a topic that will undoubtedly be revisited during this Workshop.

Genesis of the Proposed Desert Margin Initiative

The momentum for the development of a Desert Margins Initiative came from a number of sources. The first was the initiation of the intergovernmental negotiating process for a Convention on Desertification which began in early 1993, following the UNCED deliberations. At that time, the International Centre for Research in Agroforestry (ICRAF) and ICRISAT began discussions and drafted a joint background document proposing a possible research agenda for an ecoregional initiative focusing on the problems of arid and semi-arid regions. This draft document built upon ICRAF's experience in initiating the Alternatives to Slash and Burn Consortium, and with a similar one for the Eastern African Highlands.

Later in 1993 UNEP was approached to see if they could lend assistance in carrying the process forward in a way that allowed more explicit involvement of NARS and regional organizations in sub-Saharan Africa. This resulted in their supporting a Canadian consultant, Dr Wolfgang Baier, who traveled around Africa to discuss the draft background document with potential collaborators in NARS, regional organizations, and IARCs. His discussions

helped to produce a detailed document which provided more elaboration of the possible research agenda, and the likely contributions of potential collaborators.

After ICRISAT was formally designated by TAC as the Convening Center for ecoregional initiatives in the warm, arid, and semi-arid tropics of sub-Saharan Africa, further interactions occurred with other IARCs who had an interest in the emerging research agenda for the proposed Desert Margins Initiative. Their suggestions, along with those of NARS and regional institutions, were incorporated into succeeding drafts of the Baier document. The background document which was attached to the letters of invitation to this Workshop is an abstract of the latest draft of this Baier document.

A further impetus to the evolution of the Desert Margins Initiative was the report of the Stein Bie Task Force on the CGIAR response to UNCED and Agenda 21, which was finally endorsed at the Mid-Term Meeting of the CGIAR held in New Delhi in May 1994. ICRISAT was designated as a lead institution within the CGIAR on the issue of marginal soils outlined in Chapter 12 of Agenda 21.

As stated earlier, the background document you have all received is already the result of considerable interactions with many of the organizations represented at this Workshop. However, ICRISAT does not pretend that it represents the final word on the needs and opportunities for research on the problems of food security and natural resource management in the desert margins of sub-Saharan Africa. We put it before you this week so that it will help to focus our deliberations and enable us, through the scheduled Target-Oriented Project Planning (TOPP) exercises, to agree to a research program on which we can embark together in the years ahead. The background document will be elaborated by others in the early part of this Workshop, and I encourage everybody to critically review the suggested agenda in these various presentations and to feel free to modify, add or delete, as appropriate.

To facilitate this process let me summarize the major elements of the draft background document for you.

Objectives of Proposed Desert Margins Initiative

The overall objective of this Initiative is to:

> Arrest land degradation by promoting improved and innovative technologies that integrate effective nutrient management strategies with improved soil and water conservation techniques that are ecologically sound, economically viable, and socially acceptable to farmers in the dryland areas of sub-Saharan Africa.

The specific objectives are to:

- Develop a better understanding of the extent of land degradation through water and wind erosion and through mining of soil nutrients in the traditional crop and livestock production systems in the desert margins, and of the impact of, and distinction between causal factors, both natural and human, with a view to combating land degradation and achieving improved productivity together with sustainable use and management of soil resources.

- Evaluate with the participation of farmers, NGOs, and NARS, past and current indigenous and improved soil management programs for arresting land degradation, to identify the causes of misuse, and to design effective strategies for, and elaborate activities to test options that enhance soil resilience in the desert margins.

- Overcome negative nutrient balances and to increase biomass at the farm level by developing integrated systems of nutrient management incorporating use of locally available agrominerals, combined with: recycling of manure/urine from livestock, crop residues, and city wastes; the use of farmer-acceptable agroforestry systems; and crop rotations that involve the use of legumes to improve biological nitrogen fixation.

- Combine improved, farmer-acceptable soil and water conservation techniques such as stone bunds, windbreaks, hedgerows, field ridges etc., with integrated nutrient management systems in order to enhance soil resilience.

- Evaluate the role of livestock in the ecological and economic linkages between arid and semi-arid zones in order to control land degradation and loss of vegetation biodiversity in the arid zone.

- Identify, evaluate, and assist in the design of policies that will enhance the adoption of improved soil-management options for arresting land degradation.

- Enhance the institutional capacity of countries participating in the project for land degradation research and extension of the improved technologies, with particular attention to multidisciplinary and participative socioeconomic research.

Activities in Proposed Desert Margins Initiative

Activities include:

- Characterization and analysis of land use systems;

- Household and community resource management and investment decisions, and the impact of policy;

- Ecological and economic linkages between arid/semi-arid zones: the role of livestock;

- Development of management techniques to enhance soil resilience and arrest land degradation;

- Selection of multipurpose forages, legumes, and tree species;

- Strategic research on component interactions;

- Development and evaluation of improved technologies; and

- Institution-building and enhancement of human resource capacity.

Objectives of Workshop

- Assemble those institutions and individuals interested in collaboration in a Desert Margins Initiative.

- More precisely define and characterize the "desert margins" for the purpose of the Initiative.

- Design an effective experimental approach and research agenda tailored to the target agroecological zones of the desert margins, and to the socio-economic conditions of the participating countries.

- Discuss the proposed Initiative and develop effective collaborative arrangements that include interested NARS, NGOs, regional institutions, IARCs, and other institutions;

- Formulate workplans leading to specific project proposals that can be used to solicit appropriate funding.

- Establish a governing mechanism to provide policy guidelines and to set priorities.

- Identify the training needs and support required for the enhancement of human resource and institutional capacity in the NARS.

Special Role of NGOs

I am particularly keen to ensure that we have direct and extensive involvement of nongovernmental organizations in the proposed research consortium. NGOs offer the advantage of being closer to the beneficiaries, and hence able to engage people in participation in the development process by creating new social organizations for coordinated action and empowerment. Cernea (1991) maintains that creating social organizations is equivalent to creating new social capital, which is a strategic resource for development. Because NGO's also have special concern for the poor and the environment, they have increasing influence on development policy, programs, and projects.

In a review of the Ford Foundation's association with the Intensive Agricultural Districts Programme (IADP) in India, Staples (1992) found that all-India solutions to development challenges are not appropriate. It was concluded that sustainable development is crucially related to the participatory nature of the process. People will conserve forests, maintain irrigation systems, and innovate in farming systems if they are actively involved in, and have full rights to, the product of their energies.

To quote from Staples: "the first two decades of development in India showed that national approaches like the IADP, or indeed most centralized, national-wide development schemes run into difficulties as they confront specific problems of local populations. NGOs often can demonstrate how best to organize people and deploy funds for poverty alleviation and resource management in the complexity and diversity of the Indian countryside."

It would seem desirable for national and international R&D agencies to more explicitly involve themselves with NGOs in their future natural resource management research. This view was shared by the participants in an International Development Research Centre (IDRC) Workshop entitled "Listening to the People: Social Aspects of Dryland Management" held in Nairobi in December 1994.

However, there is growing unease in some quarters about the replicability and sustainability of some NGO-sponsored activities, and about their limited scientific and technical capabilities. The proliferation of NGOs in recent years is of concern, as are the difficulties in appropriate accountability. The dependency of NGOs on government support, and in turn of the poor on NGOs for their livelihoods, is also cited as leading to dependency which may not be sustainable.

It would seem there are strong mutual advantages in terms of replicability, accountability, and sustainability for NGOs to come alongside IARCs, NARS, and regional institutions as full collaborative partners as we move ahead on the proposed research agenda of the Desert Margins Initiative. Indigenous knowledge and empowerment of people are necessary, but not sufficient, ingredients for success in the challenge of ensuring future food security and the sustainability of the natural resource base in the desert margins. Modern science must complement these, as the pressure of population on natural resources is unprecedented.

Systemwide Soil, Water, and Nutrient Management Research Initiative

Table 1 listed 12 ecoregional initiatives which are either under way or planned for the future. TAC recognized that, especially at the most strategic end of the research continuum, there will be a number of generic research themes that cut across these various ecoregional initiatives. This offers opportunities for research spillovers to be exploited within and among agroecological zones, and will result in further economies in research investments. Research in different ecoregions will increase our understanding of climate, soil, water, and biological interactions and will contribute to a global research model. The Alternatives to Slash and Burn Initiative led by ICRAF provides a good example of how these scientific synergies can be identified and promoted.

TAC listed the following examples of strategic research areas where scientific synergies might be relevant :

- Land resources and land use;
- Soil fertility and management;
- Soil and water conservation;
- Pest biology and ecology;
- Social science; and
- Biodiversity.

A recent paper by Greenland et al. (1994) commissioned by the International Board for Soil Research and Management (IBSRAM), made a strong case for a global soil, water, and nutrient management research initiative aimed at exploiting the complementarities that exist between current or planned ecoregional initiatives and strategic research issues in the soil, water, and nutrient continuum. After a meeting at Zschortau, Germany, and discussions at International Centers' Week 1994 followed by a meeting held recently in Rome, it was

concluded that there are at least six major research themes which cut across the various ecoregional initiatives currently underway or planned in the CGIAR. Table 2 contains a list of the suggested generic research themes, possible initial target zones, and potential co-convenors. The suggestion is that the co-convenors would represent mechanisms for ensuring that a global synthesis of research and knowledge on the themes was made available to all ecoregional players and others who were interested.

As can be seen from Table 2, all six proposed research themes would be of some relevance to the proposed Desert Margins Initiative. Hence it is anticipated that collaborating institutions in the Desert Margins Initiatives would be able to benefit significantly from the cross-cutting research knowledge and synthesis that would be undertaken in the proposed SSWNMRI.

Table 2. Initial targets for research theme consortia in the Systemwide Soil, Water, and Nutrient Management Research Initiative (SSWNMRI)

Research themes	Initial target zones	Suggested co-convenors
Nutrient depletion/ replenishment	Sub-Saharan Africa	IFDC, TSBF, KARI
Optimizing soil water use	Sub-Saharan Africa	ICRISAT, IER
Managing acid soils	Latin America	CIAT, EMBRAPA
Controlling soil erosion	Southeast Asia	IBSRAM, PCARRD
Carbon sequestration	Southeast Asia	IRRI, CAAS
Soil-quality indicators	Southeast Asia	CIFOR, ??

Proposed Research Theme Agenda

Nutrient depletion/replenishment
- Organic matter management
- Nutrient replenishment and inorganic fertilizer
- Nutrient balance
- Policy interventions

Optimizing soil water use
- Soil surface management
- Water harvesting
- Soil amendments
- Identification of crops adapted to environmental constraints
- Soil management including rooting studies.

Managing acid soils
- Liming

- Use of adapted crop varieties
- Organic matter management with special attention to phosphorus fertilization

Controlling soil erosion
- Biological soil conservation methods, including promoting vegetative coverage of the soil, crop residue management and mulching, and use of vegetation barriers
- Physical soil conservation measures, including tillage, contour bunding, and terracing
- Socioeconomic and policy research

Enhancing carbon sequestration
- Natural and managed systems (rainfed and submerged)
- Rate of carbon dioxide and other emissions and their impact on global climate change
- Modeling

Soil-quality indicators
- Diagnostic studies
- Monitoring biodiversity through measured or surrogate biological, physical and chemical indicators
- Minimum attribute sets
- Evaluation of sustainability
- Compilation of databases

One issue which I would like to raise for consideration by the participants in this Workshop, is whether they agree with the initial priorities for the proposed SSWNMRI and, if so, how the Desert Margins Initiative might be linked to this proposed systemwide initiative? A related issue is whether proposed collaborators in the Desert Margins Initiative would have any interest in being co-convenors of one or more of the research themes in Table 2. Before we disperse I would request that the Workshop agree to formally nominate convenors or co-convenors of the SSWNMRI Research theme 'Optimizing soil water use'. The initial suggestion was that ICRISAT and IER, Mali, play this role on behalf of the Desert Margins Initiative, but there may be other suggestions.

Terms of Reference for Research Theme Convenors

- Articulate fully a conceptual framework for the research theme;
- Prepare an inventory of present and past research conducted on the research theme. Such an inventory will concern not only the initial target zones, but also other potential research areas within the theme;
- Identify gaps and areas that require strengthening;
- Develop a liaison with ecoregional programs and other research themes; and
- Plan research activities through the organization of ad hoc planning workshops, if possible in conjunction with ecoregional program meetings.

Issues for Decision at the Workshop

Assuming that there is general agreement with the need for a Desert Margins Initiative, I thought that it might be helpful if I listed (not necessarily in order of priority) the issues which need to be deliberated before the end of the Workshop. There may of course be others.

- Decide on the value and desirability of a Desert Margins Initiative which emphasizes research and related activities;
- Establish priorities and the research agenda;
- Decide on notional resource allocations for the various activities, and potential collaborating institutions;
- Identify roles and responsibilities of participants including those for convenors. leaders, coordinators, and reporters;
- Establish decision-making mechanisms;
- Develop a plan to gain the commitment of stakeholders, especially of the senior management of the institutions represented at the Workshop;
- Establish a governance mechanism and the accompanying organization and management arrangements. Some guidance on this is available from on-going Initiatives including the Alternatives to Slash and Burn, the Rice-Wheat Consortium in South Asia, and from the meeting held in Rome which discussed the management of systemwide and ecoregional initiatives;
- Draft a project document which can be used to further the process of dialog and negotiations with potential funding agencies and TAC;
- Agree on a clear articulation of goals, milestones, methodologies, activities, and timetable for components of the Initiative that can be used to guide further development and assist in monitoring and evaluation after the project begins;
- Decide whether the Initiative is best described as a single ecoregional initiative, or whether it is best structured as an ecoglobal project similar to the Alternatives to Slash and Burn Initiative, that encompasses several ecoregional elements linked together by a global set of working groups and an associated mechanism;
- Decide on accountability for program areas and financial aspects;
- Define responsibilities for mobilizing funding and for representation;
- Decide on the value and desirability of linkages between the Desert Margins Initiative and the proposed SSWNMRI.

If endorsed, nominees for convenor roles would be sought.

The Next Steps

ICRISAT, has an obligation to report on the outcome of this Workshop to TAC at their meeting to be held in March 1995 in Lima, Peru. In particular ICRISAT is expected to indicate the extent of commitment of collaborators to the Initiative, to provide a description of the proposed project milestones, to indicate which institutions have responsibility for the various proposed activities, and to submit an indicative budget. What we require is that a sufficient degree of commitment be evident by the end of this Workshop for us to propose to TAC the next steps in the process, in order to gain their approval for releasing funds to move the process forward. This is the reason why we decided to invite two consultants who are familiar with TOPP techniques. They have been asked to assist us to develop a draft project document which we could use as the basis of our submission to TAC, and subsequently to donors.

Acknowledgments

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Acronyms

AEZ	Agro-Ecological Zone
CAAS	Chinese Academy of Agricultural Sciences
CIAT	International Center for Tropical Agriculture (CIAT)
CIFOR	Center for International Forestry Research (Indonesia)
CGIAR	Consultative Group on International Agricultural Research
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria (Brazil)
GEF	Global Environment Facility
IADP	Intensive Agricultural District Programme
IARC	international agricultural research center
IBSRAM	International Board for Soil Research and Management (Thailand)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics (India)
ICRAF	International Centre for Research in Agroforestry (Kenya)
IDRC	International Development Research Centre (Canada)
IER	Institut d'économie rurale (Mali)
IFDC	International Fertilizer Development Center (USA)
IRRI	International Rice Research Institute (Philippines)
ISNAR	International Service for National Agricultural Research (Netherlands)
KARI	Kenya Agricultural Research Institute
NARS	national agricultural research sytem(s)
NGO	nongovernmental organization
PCARRD	Philippine Council for Agriculture and Resources Research and Development
SPAAR	Special Program on African Agricultural Research
SSWNMRI	Systemwide Soil, Water, and Nutrient Management Research Initiative
TAC	Technical Advisory Committee (CGIAR)
TOPP	Targeted-Oriented Project Planning
TSBF	Tropical Soil Biology and Fertility Programme (UNESCO)
UNCED	United Nations Conference on Environment and Development
UNCOD	United Nations Conference on Desertification
UNEP	United Nations Environment Programme
UNICCD	United Nations International Convention to Combat Desertification

Session 1: Research Needs and Opportunities for Resource Management Programs to Arrest Land Degradation: National and Regional Perspectives

Session 1: Besoins et options de recherche des programmes d'exploitation des ressources dans la lutte contre la dégradation des sols: perspectives nationales et régionales

Les ressources naturelles au Niger: situation et besoins en recherche

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I. INTRODUCTION

le Niger est un vaste territoire de 1,27 million de km² situé entre le 12° et 14° latitude nord en plein coeur de l'Afrique de l'Ouest. De part sa localisation, le pays est soumis à un climat de type sahélien caractérisé par une alternance entre une saison des pluies de courte durée et une longue saison sèche où les températures sont particulièrement élevées. Sur la base des précipitaions annuelles, le Niger peut se subdiviser en 4 zones agro-écologiques (tableau 1-1)

ZONE ECOLOGIQUE	Pluviométrie en mm	Superficie million ha	Pourcentage % du total	Potentialité
Saharienne	< 200	82.35	65.0	Nul à faiblement pastoral
Saharo-sahelienne	200-300	15.40	12.2	Pastoral
Sahelo-soudanienne	300-600	27.71	21.9	Agro-psatoral au Nord et Agricole au Sud
Soudanienne	>600	1.24	0.9	Agricole
TOTAL		126.7	100.0	

Les régions où les précipitations sont favorables aux activités agricoles et pastorales ne représente qu'un peu plus du 1/3 de la superficie totale du niger; les effets de la température et du vent y ont également des incidences déterminantes sur les ressources naturelles. Les températures présentent des variations mensuelles importantes avec une moyenne de 35°C en Avril et de 20°C en Janvier. Le régime éolien se caractérise par les flux d'harmattan en saison sèche et de de mousson en saison des pluies. Ces vents participent a l'érosion et au modelage du relief.

Afin d'appréhender la problématique des ressources naturelles, le Niger a été subdivisé en 13 systèmes agraires (fig.1) différents par leurs caractéristiques environnementales, des conditions socio-économiques. Chacun des agro-systèmes connaît une ou plusieurs des grandes contraintes relatives à la préservation des ressources naturelles : ensablement, la baisse de fertilité des sols, l'érosion hydrique, les défrichements et la dégradation des ressources ligneuses, la reduction des ressources pastorales.

II. CARACTERISTIQUES DES RESSOURCES NATURELLES ET AGRICOLES

2.1. La dégradation des Sols et l'érosion

Les types de sol les plus répandus sont les sols bruns minéraux sans valeur agronomique de

la frange saharienne et les sols ferrigineux tropicaux de la frange méridionale du pays. La plupart des sols cultivables ont une teneur en matière organique très faible (0.1 à 0.2%) et sont souvent carencés en phosphore. Le Niger ne possède que 150,000 km2 cultivables dont environ le 1/4 est actuellement cultivées. Il y aurait 90,000 km2 de jachères et 6000 km2 de forêts.

Le capital sol est actuellement soumis à une forte dégradation du fait de l'érosion, de la baisse de la fertilité due a une pression foncière en rapide augmentation liée à un croissance démographique importante. Dans la zone agricole, la mise en culture des terres marginales et la dimunition des jachères entraînent rapidement une chute de fertilité et l'apparition de phénomènes érosifs comme l'érosion en nappe et la remobilisation des sols stabilisés. Dans le domaine sylvo-pastoral, la disparition et la dégradation de la couverture herbacée et arbustives des sols se traduit rapidement par une érosion qui prend des formes différentes suivant la nature des sols. Les conséquences de cette évolution sont multiples:

- formation de glacis ou croûtes de battance sur les bas-versants, empêchant toute infiltration de l'eau et par conséquent toute végétation
- ravinement dans les vallées, ce qui se traduit par des pertes de terre cultivables de bonne qualité, réduction et disparition des épandages, envasement de la vallée du fleuve
- remobilisation des dunes résultant de la mise en mouvement de dépôts éoliens stabilisés, souvent riches en végétation naturelle herbacée ou arbustive.

2.2. La dégradation du couvert végétal

Le domaine sahélien qui couvre une grande partie de la zone agricole est caracterisé par une végétation de type steppique à *Acacia*. D'une manière générale, les ressources ligneuses sont utilisées comme source d'énergie, bois de service ou à des usages divers.

Le bois-énergie représente 87% de la satisfaction des besoins énergétiques du pays. La consommation en bois de feu serait de 0.6 à 0.8 Kg/J/personne. Le bois de service est prélevé principalement dans les formation naturelles de rôniers (*Borassus aethiopium*) et de doumiers (*Hyphaenae tabaica*). Les arbres à usage multiple fournissent divers produits: gomme arabique, feuilles et fruits divers pour l'alimentation humaine, chaume pour les toitures, fibres pour le tissage. Les arbres constituent une source non négligeable pour l'alimentation du bétail; Ils fournissent 25 à 30% de la ration annuelle du bétail en matière sèche.

La baisse importante de la pluviométrie enregistrée les années antérieures a entrainé une forte mortalité des formations arbustives et arborées du pays. Dans les formations à combrétacées aux alentours de Niamey (500 mm/an) on a enregistré jusqu'à 278 Kg/ha/an de bois mort et 8 à 24 % de mortalité par essence. Cette dégradation liée à la baisse de la pluviométrie est plus importante dans les zones moins arrosées (300 mm/an); elle peut atteindre 50% de la population des ligneux. Par ailleurs il a été constaté un changement dans la composition des aires de parcours, passée d'espèces vivaces à un plus grand nombre de plantes annuelles, et à l'expansion vers le sud d'espèces sahariennes comme le *Leptadenia pyrotechnica*.

La seconde cause de la déforestation tient à l'extension des défrichements agricoles due à la baisse de rendement au nord et à un croit démographique dans la frange sud. Cela se traduit par:

- le remplacement de la végétation naturelle des terres cultivées par une végétation éparse d'espèces appréciées pour leurs produits: *Acacia albida, Acacia senegal, Adansonia digitata, Balanites aegyptica, Ficus spp., Parkia biglobosa, Tamarindus indica...*
- l'apparition d'une végétation caractéristique des friches avec notammenet *Guiera senegalensis* et *Pilostigma reticulatum*
- la surexploitation des formations forestières déjà peu productives (0.5 m3/ha/an) dans les environs des centres urbains et sur les grands axes routiers.

La destruction du couvert ligneux sous l'effet conjugué de la sécheresse, des coupes excessives, du surpâturage, de l'extension des terres agricoles se ferait sur 80,000 a 100,000 ha/an.

2.3. Les ressources pastorales et animales

L'élévage occupe 20% de la population et procure 18% du PIB et environ 16% des recettes d'exportation. Les estimations faites en 1990 donnent 2.7 millions de bovins, 9.2 millions de petits ruminants et environ 1 million pour les camelins, équins et asins.

Au Niger on distingue fondamentalement deux types d'élevage: l'élevage pastoral dans la zone Nord, extensif dont l'objectif est la reproduction; l'élevage sédentaire pratiqué dans la partie sud du pays Il est aussi extensif pour l'essentiel et plus ou moins intégéré à l'Agriculture, on estime que 63% du cheptel sont concentrés dans le zone sud.

Les principales contraintes du développement des productions animales sont d'ordre alimentaire, sanitaire et socio-économique. Au stade actuel, le principal goulot d'étranglement du secteur élévage reste l'organisation intégrée de l'espace, des ressources fourragères, des animaux et des hommes, assurant des spécialisation régionales conformes aux potentialité.. Beaucoup d'éléments de connaissance font encore défaut pour élaborer des mesures appropriées et disposer d'outils et de méthodes efficaces tenant compte des caractères physiques et sociaux de cet élévage.

2.4. Les productions agricoles pluviales

Les principales espèces cultivées en saison des pluies sont le mil, le sorgho et le maïs pour les céréales, le niébé et l'arachide pour les légumineuses. Elles occupent plus de 95% des superficies totales cultivées. Les surfaces consacrées aux cultures pluviales s'accroissent dans les mêmes proportions que la population soit environ 3,5% par an. En fait, c'est par l'accroissement des superficies que se réalise l'augmentation de la production. Les rendements obtenus dans les systèmes traditionnels de production sont très faibles et très fluctuants: 400 kg/ha pour le mil, 500 Kg/ha pour le sorgho, 650 kg/ha pour le Maïs, 250 Kg/ha pour le Niébé et 650 Kg/ha pour l'arachide.

A côté de ces productions majeures, les paysans cultivent d'autres espèces: sésame, Voandzou, Oseille, Souchet, Gombo et Manioc de saison des pluies. Ces cultures sont généralement pratiquées sur des petites surfaces par les femmes. Elles ont fait l'objet de peu d'attention de la part des services de développement et de la Recherche, malgré le rôle non négligeable qu'elles jouent dans l'alimentation humaine et comme source de revenu pour les ménages ruraux.

Les contraintes à la production agricole sont bien connues. Elles sont d'ordre climatique (Pluviométie, Vents de sable fréquents gênant l'établissement des cultures), édaphique (Faible fertilité des sols) techniques(Travail du sol insuffisant, absence de fertilisation, Variétés non adaptées et peu performantes) et socio-économique (problème foncier, revenu faible, organisation insuffisante).

IV. LES PRINCIPAUX AXES DE RECHERCHE

4.1. Justification des choix

L'économie est largement dominée par les activités du secteur agricole qui assure l'emploi de 87% de la population active du pays (92% si l'on tient compte des actifs de 15-64 ans en âge de travailler). Cependant, ce secteur connaît depuis 1970 une situation de crise marquée par un profond déséquilibre entre besoins des populations d'une part et ressources naturelles et systèmes de production. Cette situation déstabilise les systèmes de production existant.
Pour faire face à cette crise qui se traduit au niveau du monde rural par l'accroissement de la pauvreté, de la malnutrition et de la dénutrition, le Niger a défini en 1992 des "Principes Directeur de Développement Rural". La gestion des ressources naturelles, l'organisation du monde rural, la sécurité alimentaire et l'intensification et la diversifications des productions en sont les axes prioritaires. Aussi, depuis 3 ans, l'INRAN s'est-il engagé dans un processus de redéfinition de ses programmes de recherche en vue d'être en conformité avec les nouvelles orientations en matière de développement rural.

4.2 Les axes principaux de recherche sur la gestion des ressources naturelles

Les différents axes de recherche devant permettre de répondre efficacement aux problèmes posés par la dégradation de l'environnement ont été définis de concert avec les services de vulgarisation et les paysans à travers divers ateliers régionaux.

Lutte contre les effets climatiques (sécheresse, érosion)

- Evaluation de l'impact des paramètres climatiques sur la productivité des espèces cultivées en saison des pluies
- Sélection de variétés à cycle court et ayant un bon établissement en début de saison
- Mise au point de technique de valorisation de l'eau des pluies (travaux du sol,

récupération et conservation de l'eau)

- Amélioration des techniques de cultures des plantes secondaires pouvant contribuer à l'amélioration du revenu des paysans et à la sécurité alimentaire (Manioc, Souchet, Sésame, Gombo, Oseille...)

Lutte contre la dégradation des terres

- Mise au point de technique de régénération des sols dégradés (glacis, plateaux dégradés et terres dunaires surexploitées
- Détermination des conditions d'utilisation des biofertilisants et des phosphates naturels
- Mise au point de ststème de gestion intégrée de la fertilité des sols et de la conservation de l'eau
- Détermination d'espèces forestières locales utilisables comme brise-vent en vue de lutter contre l'érosion éolienne

Lutte contre la dégradation du couvert végétal

- Conservation des ressources phytogénétiques forestières et herbacées en voie de disparition
- Détermination des techniques sylvicoles d'espèces forestières en vue de leur utilisation comme bois de feu ou de service ou en agro-foresterie
- Identification d'espèces ligneuses à croissance rapide et à forte production de biomasse foliaire en vue de palier au déficit fourrager durant la saison sèche
- Amélioration de la digestibilité des résidus de récolte en vue d'améliorer l'alimentation du bétail et assurer une meilleure intégration agriculture-élévage et réduire le surpâturage dans certaines zones

Amélioration des productions agricoles et animales

- Identification de variétés à rendement acceptable et stable
- Mise au point de méthodes de lutte intégrée contre les principaux ennemis des cultures
- Mise au point de technologie post-récolte en vue de valoriser les produits locaux
- Détermination des paramètres zootechniques des diverses races ruminants

Gestion des Ressources naturelles et amélioration des systèmes de production

- Appréhender les contraintes et les potentialités des terroirs cibles
- Avoir une meilleure connaissance des systèmes de production, leur évolution du fait de la dégradation de l'environnement et les possibilités de leur amélioration
- Suivre l'évolution des Ressources naturelles et des systèmes de production
- Vérifier à grande échelle l'applicabilité des innovations et leur impact sur l'environnement physique et socio-économique du terroir
- Identifier des contraintes devant faire l'objet de travaux de recherche

V. CONCLUSION

L'observation de l'évolution des ressources naturelles à l'échelle du terroir est sans aucun doute le projet le plus ambitieux que l'INRAN est sur le point de mettre en place. Il s'agira de procéder à des audits écologiques et socio-économiques périodiques dans des terroirs-tests des principaux agrosystèmes. Ce vaste projet de gestion des terroirs et d'aménagement de l'espace rural devra être intégré au Programme National de Gestion des Ressources Naturelles et devra impliquer nécessairement les agriculteurs, les éléveurs les ONG intervenant dans le monde rural et les différentes institutions de recherche oeuvrant sur le territoire national.

D'ores et déjà l'INRAN est entrain de réaliser des enquêtes préliminaires de caractérisation de deux des treize agrosystèmes repertoriés en vue du choix des terroirs-tests. Plusieurs chercheurs de l'Institut interviennent directement à plein temps ou à temps partiel dans divers opérations des projets régionaux de développement rural ou d'aménagement des terroirs (Tahoua, Aguié) et de certaines ONG. Cependant, pour jouer pleinement son rôle dans la coordination des activités de recherche et la constitution d'une véritable banque de données évolutive sur les ressources naturelles, l'Institut devra continuer à développer ses propres capacités de recherche et de gestion de l'information par une politique conséquente de développement de ses ressources humaines, à s'ouvrir d'avantage vers les autres composantes du SNRA, les CIRA, les ONG et les Projets.

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La recherche sur la gestion des ressources naturelles: perspectives pour les zones arides du Burkina Faso

F Lompo

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I. INTRODUCTION

La prise de conscience collective sur la nécessité de gérer de façon durable les ressources naturelles se développe en cette fin du XXème siècle.

Les conclusions du Sommet de Rio (juin 1992), les dispositions de la Convention Internationale sur la désertification (1994) de même que les conséquences souvent catastrophiques de la dégradation du milieu mettent en évidence la notion de gestion durable des ressources de la Terre ; cela, de façon à répondre selon IRONK et MAHBUBUL HAQ (1992) "aux besoins des générations futures à satisfaire les leurs".

L'élaboration d'un Programme National de Recherche sur la gestion des ressources naturelles et les systèmes de production au Burkina Faso a pour but de permettre une meilleure connaissance du milieu et de rechercher les techniques et méthodes de gestion les plus durables des sols, des eaux, de la végétation et de la faune.

Pour atteindre les objectifs escomptés, il a été nécessaire dans la définition de ce programme, de tenir compte de tous les facteurs physiques et sociaux. Pour ce faire :

- un bilan critique général de la recherche agricole a été effectué ;
- une détermination des contraintes du milieu et de l'attente des producteurs et des services de développement a été réalisée à partir de l'étude des caractéristiques des différentes régions agricoles ;

- une proposition de mécanismes de fonctionnement et d'organisation à la lumière des expériences déjà acquises dans ce domaine a été formulée.

1.1. Justification de la recherche sur la gestion des ressources naturelles et les systèmes de production

Le Burkina Faso possède des ressources naturelles importantes. Cependant, ces ressources connaissent une dégradation dont le niveau de sévérité est fonction des conditions éco-climatiques et de l'adéquation ou non des systèmes de production pratiqués.

Ainsi, la variabilité spatio-temporelle de la pluviométrie, le surpâturage, les défrichements et les cultures itinérantes, les feux de brousse, la suppression de la jachère, les coupes abusives de bois de chauffe, le braconnage etc. sont autant d'agressions anthropo-climatiques conduisant à une dégradation des sols, de la végétation et du potentiel faunique.

Dans ce contexte, les eaux de surface sont difficilement utilisables et les sols dénudés et appauvris entraînent la réduction des productions agricoles.

De nombreuses structures nationales et institutions internationales interviennent dans la recherche sur la GRN/SP.

Ainsi, au titre du système national de recherches agricoles, on peut citer :

l'**IN.E.R.A.** (Institut d'Etudes et de Recherches Agricoles), L'**.R.B.E.T.** (Institut de Recherches en Biologie et Ecologie Tropicale), l'Université de Ouagadougou à travers L'**I.D.R.** (Institut du Développement Rural), la **FAST** (Faculté des Sciences et Techniques) et le **C.N.S.F.** (Centre National des Semences Forestières)...

Les organismes de coopération scientifique sont entre autres : le CIRAD, l'ICRAF, l'ORSTOM, l'ICRISAT, l'ADRAO/WARDA...

Par ailleurs, plus de vingt cinq ONG intervenant dans le domaine de la GRN sont présentes. Ce nombre élevé d'intervenants pose des problèmes de deux ordres :

- le manque de programme cohérent de gestion à long terme des ressources naturelles dans le cadre d'un plan stratégique national de recherches agricoles ;

- le manque de coordination entre les différents intervenants dans le domaine de la GRN, et l'insuffisance de la prise en compte des populations au niveau de la Recherche.

L'analyse critique du bilan de la recherche a mis en évidence l'existence d'acquis importants sur la gestion des ressources naturelles au niveau de la parcelle.

Ces données restent à valoriser dans le cadre d'une approche participative à l'échelle des unités naturelles (bassins versants) et des terroirs. Cette approche constitue une priorité du Gouvernement dans le cadre du Programme d'Ajustement du Secteur Agricole (PASA).

Dans ce contexte, l'élaboration et la mise en oeuvre d'un programme national de recherche sur la Gestion des Ressources Naturelles (GRN) devient une impérieuse nécessité.

Un tel programme, fondé sur une base pluridisciplinaire et pluri-institutionnelle permettra au Burkina Faso d'assurer avec efficacité le leadership du pôle régional de recherches sur la Gestion des Ressources Naturelles (GRN).

1.2. Définition du concept Gestion des Ressources Naturelles et Système de Production (GRN/SP)

* La gestion des ressources naturelles est une notion complexe. Cependant, la définition suivante a été retenue : gérer les ressources naturelles : c'est

"prendre des décisions sur des activités à réaliser et à exécuter afin d'atteindre des objectifs précis dans les domaines suivants : sols, eaux de surface, faune, végétation".

* Le concept de système de production renvoi à l'utilisation des ressources, à l'organisation de l'espace. C'est la combinaison des ressources productives mises en oeuvre et les dosages opérés par les producteurs entre les principaux facteurs de production : ressources naturelles, travail, consommation intermédiaire et biens d'équipement.

1.3. Objectifs d'un programme national sur la GRN/SP

L'objectif principal est de rechercher, adapter et évaluer dans une approche participative :

- les systèmes de gestion durable des espaces ruraux,
- les stratégies de leur mise en oeuvre qui répondent à l'attente des exploitants ruraux et aux objectifs de développement rural du Gouvernement.

Ce programme permettra de :

- fournir aux institutions intéressées des indicateurs sur la dégradation du milieu ;
- proposer des innovations institutionnelles et organisationnelles pour une gestion des ressources naturelles au niveau terroir ;
- proposer des innovations techniques pour une gestion durable des ressources naturelles, tout en tenant compte de l'impact de ces innovations sur le capital ressources naturelles et sur l'environnement ;

- proposer des innovations techniques et socio-économiques pour la mise en oeuvre d'une agriculture durable et pour l'amélioration de l'efficacité des systèmes de production.

II. OPPORTUNITES DE RECHERCHE ET CHOIX STRATEGIQUE DU PROGRAMME NATIONAL DE RECHERCHE SUR LA GRN ET SYSTEMES DE PRODUCTION

2.1. Les opportunités de recherche

Compte tenu des attributions des structures de recherche du Centre National de la Recherche Scientifique et Technologique qui se résument en termes de "Conduite des recherches en vue de lever les contraintes du développement", les opportunités de recherche ont été dégagées de l'analyse de la demande des utilisateurs des productions de la recherche (structures étatiques de développement, ONG, Organisations paysannes et producteurs individuels) et de l'analyse des acquis de toutes les structures de recherche. Cette confrontation entre la "demande" et "l'offre" et l'analyse des contraintes et potentialités des différentes régions agro-écologiques, ont conduit à la définition de thèmes de recherche qui, en ce qui concerne les ressources naturelles sont relatifs :

- soit à la gestion de ces ressources naturelles
- soit à des recherches de type filière.

2.2. Les choix stratégiques en matières de recherche sur les ressources naturelles

Ces choix stratégiques découlent :

- de la nécessité d'un plan stratégique national de recherches agricoles ;

- du souci de rapprocher la recherche de ses partenaires, notamment à travers les cinq Centres Régionaux de Recherches Agricoles (CRRA) ;
- de la prise en conscience du rôle social de la recherche dans le processus de développement du pays.

En rapport avec les ressources naturelles, les choix stratégiques portent sur :

- la création d'entités de recherche suivantes :

  * la gestion des ressources naturelles et les systèmes de production (GRN/SP) ;
  * les productions animales (bovins, petits ruminants, volailles et porcins) ;
  * les production forestières (amélioration, protection et valorisation des produits forestiers) ;
  * les études filières et macro-économie (Impact des politiques économiques et agricoles sur la gestion des ressources naturelles) ;
- la prise en compte de l'approche "gestion des terroirs" dans les recherches sur la gestion des ressources naturelles. Cela implique la décentralisation des programmes de recherche au niveau des Centres Régionaux de Recherches Agricoles. Cette approche gestion des terroirs est basée sur des principes fondamentaux dont la participation et la responsabilisation des populations rurales tout au long du processus ; la pluridisciplinarité et la concertation entre les différents intervenants ;
- le choix du Burkina Faso comme pays hôte du pôle de recherche sur la gestion des ressources naturelles, dans le cadre de la coopération régionale au sein des pays membres du CILSS.

III. LES ZONES ARIDES DU BURKINA FASO : PRINCIPALES CARACTERISTIQUES

Sur la base du critère pluviométrique (100 mm <P<600 mm) la partie aride du Burkina Faso, comprend (carte 1) :

- le Sahel burkinabè avec les provinces du Séno, de l'Oudalan et du Soum. Le CRRA du Nord dont le siège est à Dori, avec une station de Recherches à KATCHARI, couvre cette région agro-écologique ;

- les zones Nord (Bahn - Kaïn - Solle dans la province du Yatenga) et Centre (Ouahigouya - Tikaré - Kongoussi dans la province du Bam) du CRRA du Nord-Ouest dont le siège est à Tougan, avec une station de recherches à DI ;

- la région Nord (province de la Gnagna) du CRRA de l'Est dont le siège est à Fada N'Gourma avec une station de recherche à KOUARE.

Au total les zones arides du Burkina Faso couvrent une superficie totale de 50 400 km^2 soit 18 % du territoire.

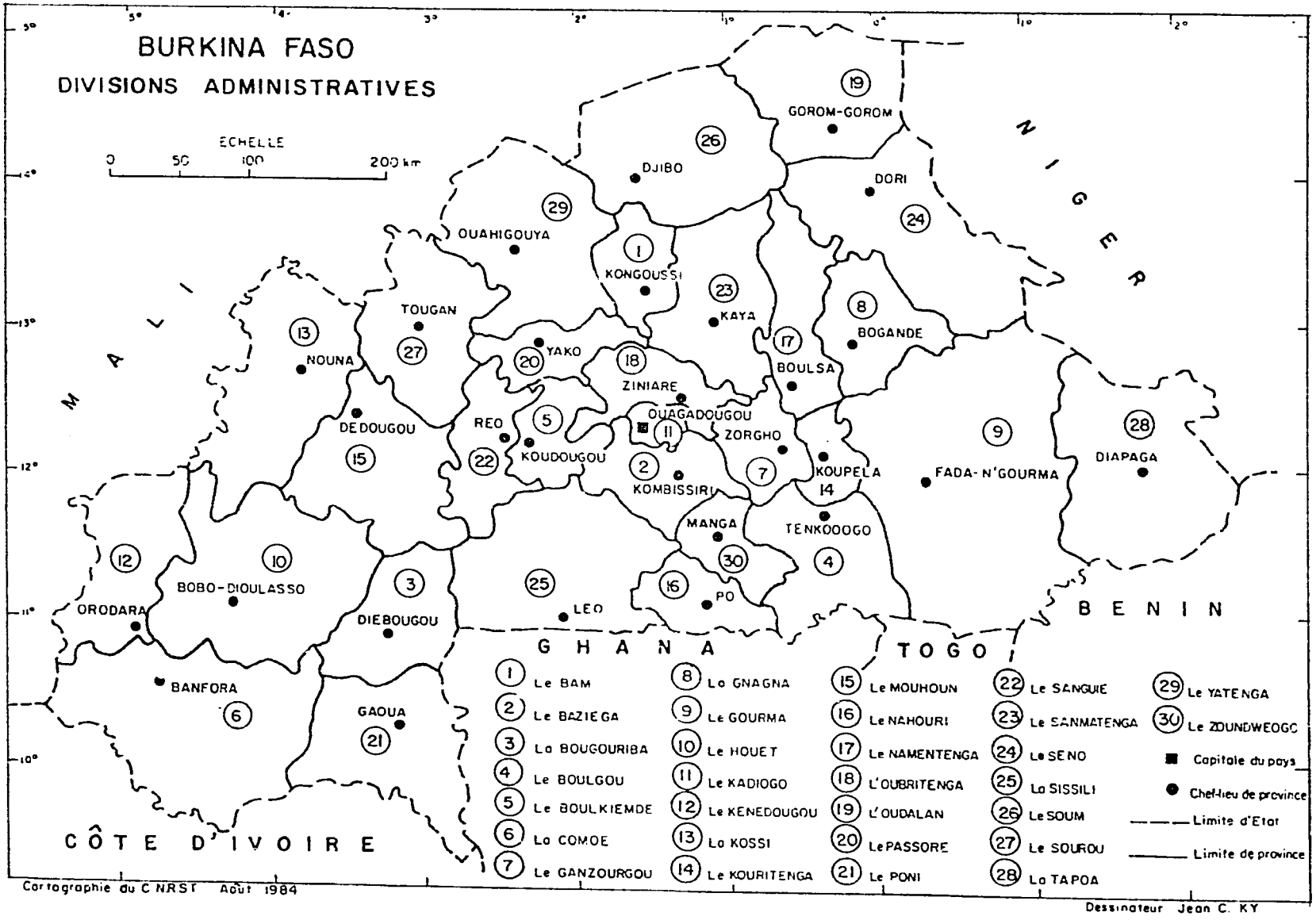
3.1. Le Sahel burkinabè

Avec une population de 521 911 habitants selon le recensement de 1985, le Sahel burkinabè couvre une superficie de 36 896 km^2, soit 13 % du territoire. La densité de population varie entre 10 et 17 habitants/km^2.

. Les ressources en eau et infrastructures hydrauliques

Le Sahel burkinabè présente des ressources en eau importantes mais peu exploitées. L'endoréisme a favorisé la formation de nombreuses mares. On y dénombre :

* 89 bas-fonds


BURKINA FASO
DIVISIONS ADMINISTRATIVES
ECHELLE
0 50 100 200 km
MALI
NIGER
BENIN
TOGO
GHANA
CÔTE D'IVOIRE
GOROM-GOROM
DJIBO
DORI
OUAHIGOUYA
KONGOUSSI
TOUGAN
KAYA
BOGANDE
NOUNA
YAKO
BOULSA
ZINIARE
DEDOUGOU
REO
OUAGADOUGOU
ZORGHO
KOUDOUGOU
KOMBISSIRI
KOUPELA
FADA-N'GOURMA
DIAPAGA
MANGA
TENKODOGO
ORODARA
BOBO-DIOULASSO
DIEBOUGOU
LEO
PO
BANFORA
GAOUA
1 Le BAM
2 Le BAZIEGA
3 Le BOUGOURIBA
4 Le BOULGOU
5 Le BOULKIEMDE
6 Le COMOE
7 Le GANZOURGOU
8 Le GNAGNA
9 Le GOURMA
10 Le HOUET
11 Le KADIOGO
12 Le KENEDOUGOU
13 Le KOSSI
14 Le KOURITENGA
15 Le MOUHOUN
16 Le NAHOURI
17 Le NAMENTENGA
18 L'OUBRITENGA
19 L'OUDALAN
20 Le PASSORE
21 Le PONI
22 Le SANGUIE
23 Le SANMATENGA
24 Le SENO
25 Le SISSILI
26 Le SOUM
27 Le SOUROU
28 Le TAPOA
29 Le YATENGA
30 Le ZOUNDWEOGO
Capitale du pays
Chef-lieu de province
Limite d'Etat
Limite de province
Cartographie du C.N.R.S.T. Août 1984
Dessinateur Jean C. KY

* 23 barrages et retenues d'eau fonctionnels
* 902 points d'eau (1 point d'eau pour 579 personnes)
* de nombreux puisards.

. L'occupation des sols

* 5,8 % des terres sont occupés par les jachères et les cultures, avec une plus forte concentration autour des bas-fonds;

* la végétation naturelle et les zones inondables et dénudées occupent le reste des terres ;
* Seulement 4 % de la superficie du Sahel burkinabè sont inaptes à l'activité pastorale (capacité de charge $\geq$ 7 ha/bovin.

En raison des faibles rendements dus à la dégradation des sols et à la pluviométrie erratique, on observe une concurrence de plus en plus âpre entre l agrioulture et l'élevage pour l'occupation des terres.

La végétation

Les steppes, les formations ripicoles et inondables constituent les principales unités de végétation du Sahel. On distingue cinq (5) unités de pâturages :

- les pâturages des dunes et ensablement constitués de steppes herbeuses et de quelques légumineuses. Leur production moyenne varie entre 1,5 et 2,5 T MS/ha avec une capacité de charge comprise entre 3 et 6 ha/UBT/ an ;
- les pâturages liés aux glacis, de production moyenne comprise entre 0,3 et 1 TMS/ha et dont la capacité de charge oscille entre 7 et 15 ha/UBT/an. Cette unité est constituée par une végétation arbustive dominée par Acacia et un tapis herbacé discontinu ;

- les pâturages des vallées et dépressions, composés de végétation dense arbustive, souvent arborée et d'un tapis herbacé riche en graminées annuelles. La production moyenne est de 1,8 T MS/ha avec une capacité de charge de 4 ha/UBT/ha ;

- les pâturages de mares, constitués de prairies aquatiques à base de graminées vivaces. Ce sont les meilleurs pâturages avec une production moyenne de 3,5 à 7 T MS/ha et une capacité de charge de 1 à 2 ha/UBT/an ;

- et enfin, les pâturages de jachère dont la production moyenne est comprise entre 2 et 2,5 T MS/ha et la capacité de charge entre 2,5 et 3,5 ha/UBT/ha.

. Les systèmes de production

- Le système de culture

Il se caractérise par une mise en valeur de l'espace disponible avec des moyens de production manuels. La superficie moyenne cultivée par habitant varie entre 0,15 et 1,98 ha.

Les principales cultures sont : le mil sur les sols légers, le sorgho et riz autour des bas-fonds et le maïs le plus souvent autour des cases. Les cultures irriguées sont peu développées, tandis que les cultures de rente (arachide, niébé, sésame, voandzou) sont insignifiantes. Les rendements sont faibles :

- Mil : 150 à 300 kg/ha
- Sorgho : 400 kg/ha
- Niébé : 200 kg/ha.

L'utilisation des engrais minéraux est quasi inexistante. On observe cependant un apport de déjections animales dont les quantités varient entre 0,5 et 4,5 T MS/ha sur le parcelles où il y a des contrats de parcage.

- Le système d'élevage

A partir de la nature et de la taille du troupeau, on distingue : les éleveurs itinérants, très mobiles ; les agro-pasteurs à faible mobilité et les éleveurs de petits ruminants, sédentaires. On distingue en réalité cinq (5) systèmes de production animale.

* le système "grand élevage peul" avec un élevage bovin de type extensif ;
* les "éleveurs - agriculteurs" ou élevage "peul confié" qui est une transformation du grand élevage peulh suite à la réduction des espaces pastoraux (conséquence de l'extension des superficies cultivées et de la sécheresse) et à l'introduction des productions végétales ;
* "les agriculteurs-éleveurs" ou petits éleveurs sédentaires qui exploitent des troupeaux de petits ruminants ;
* les "éleveurs absentéistes", propriétaires d'animaux, basés dans les centres urbains ;
* et l'élevage des femmes ou embouche de case.

. Le système agro-forestier

L'arbre est très bien accepté dans les systèmes sylvo-pastoraux pour son utilité (fourrages, pharmacopée, fruits etc.).

. Le régime foncier

il se caractérise dans le Sahel burkinabè par :

- la gestion du pouvoir et des ressources selon les lignages. La gestion de la terre relève de la compétence de chaque lignage et se limite aux terres qui lui appartiennent ;

- une distinction nette entre les terres de culture et celles réservées aux pâturages qui sont l'objet d'une exploitation inter-villageoise.

. Intérêts pour les projets :

Environ quatorze projets et ONG interviennent dans la zone dans les domaines de la santé, de l'élevage et de l'agriculture, de l'alphabétisation...

3.2. La zone aride du Nord-Ouest du Burkina

D'une superficie totale de 4 904 km^2, cette zone abrite une population de 154 033 habitants selon le dernier recensement de 1985, avec un taux d'accroissement moyen annuel de 1,9 % et une densité de population variant de 15 à plus de 50 habitants/km^2.

Dans la partie Nord de cette zone, les ressources naturelles en raison de l'endoréisme et de la faible densité, sont faiblement dégradées ; les ressources en eau sont faibles. Le système de production est caractérisé par un système d'élevage pastoral semi-transhumant dominant. Le déficit vivrier y est chronique.

Dans la partie centrale, à forte densité (> 50 habitants/km^2) les ressources naturelles sont fortement dégradées. La culture céréalière est dominante ; le mil et le sorgho, avec des rendements variant entre 250 et 800 kg/ha, occupent 80 à 90 % des surfaces cultivées. Les cultures maraîchères y sont bien développées. Le déficit vivrier est chronique et l'élevage des petits ruminants est très important. Le phénomène migratoire est important au centre (26,8 % dans le Yatenga, 4,3 % dans le Bam).

Plus d'une vingtaine de projets et ONG interviennent dans la zone dans les domaines de la lutte contre la désertification, l'élevage, la santé, l'agriculture...

3.3. La zone aride de l'Est du Burkina

Cette zone couvre une superficie de 8 200 km^2 avec une population de 229 252 habitants (recensement de 1985), un taux de croissance annuel moyen de 3,5 % et une densité de population comprise entre 20 et 50 habitants/km^2.
Les disponibilités sont moyennes pour les terres cultivables, faibles pour les eaux de surface, les pâturages et la végétation. Les ressources naturelles sont moyennement dégradées. Le système de culture est caractérisé par l'arachide, le riz irrigué et les cultures maraîchères. Cette zone sert de transit et de transhumance pour le bétail.

Une dizaine de projets et ONG interviennent dans la région.

IV. PROGRAMME DE RECHERCHE SUR LES RESSOURCES NATURELLES

Dans le cadre de cette communication et en rapport avec les objectifs spécifiques de l'Initiative sur les zones en marge du désert, seules les activités de recherche sur la gestion des ressources naturelles et celles prévues dans les études filières et macro-économiques en rapport avec les ressources naturelles, sont présentées.

4.1. Les recherches sur la gestion des ressources naturelles et des systèmes de production

Ces recherches sont conçues de façon à résoudre les six contraintes majeures identifiées au niveau régional :

- faible et/ou mauvaise disponibilité en eau,
- dégradation des sols,
- dégradation du couvert végétal,
- faible productivité des systèmes de production,
- dégradation des ressources fauniques et halieutiques,
- et faible performance des services d'appui aux producteurs.

Les thèmes et activités de recherche ainsi que les objectifs spécifiques correspondants sont contenus dans le tableau 1.

Pour appuyer ces activités sur la gestion des ressources naturelles, l'IN.E.R.A. dispose :

- de laboratoires de chimie, de physique et microbiologie des sols,
- d'une cellule de télédétection et système d'information géographique. Cette cellule est en mesure de réaliser des études dans les domaines suivants : zonage agro-climatique des cultures, emprise agricole et occupation des sols, évaluation pâturages et des ressources fourragères, répartition des cultures (coton-céréales).

4.2. Les études filières et macro-économiques

Les recherches dans ce domaine devrait contribuer à la levée des contraintes suivantes :

- la dégradation des ressources,
- la faiblesse des revenus des producteurs,
- les difficultés d'écoulement des produits et d'approvisionnement en intrants,
- et le mauvais fonctionnement des organisations paysannes.

En rapport avec la dégradation des ressources naturelles, les activités de recherches suivantes sont envisagées :

- étude de l'impact de la dévaluation sur la gestion des parcours, des espaces agricoles et des ressources forestières ;
- analyse des effets de la Réorganisation Agraire et Foncière (R.A.F.) sur la production ;

Tableau n° 1 : THEMES ET ACTIVITES DE RECHERCHE PRIORITAIRES PAR REGION (GNR) (Sahel Sahel)

CONTRAINTE 1 : FAIBLE/MAUVAISE DISPONIBILITE EN EAU			PRIORITE
OBJECTIFS SPECIFIQUES	THEMES DE RECHERCHE	ACTIVITES DE RECHERCHE	Région Sahel
ATTENUER LES EFFETS DE LA SECHERESSE SUR LES CULTURES ET LE COUVERT VEGETAL	1.1. Poursuite de la caractérisation des risques climatiques	1.1.1. Etude des fréquences d'occurrence des pluies et analyse des pluies	+++
		1.1.2. Analyse de la variabilité spatio-temporelle des autres facteurs du climat	+++
		1.1.5. Développement de modèles prévisionnels d'invasion de pyriculariose, streak, punaises, cantharides, sauteriaux etc...	+++
		1.1.6. Zonage agro-climatique des cultures et des pâturages (riz pluvial, maïs, sorgho..)	+++
		1.1.7. Etude de l'impact des hautes températures sur la croissance et le développement des plantes	+++
	1.2. Poursuite des études de mise au point de techniques d'économie de l'eau à la parcelle	1.2.1. Poursuite des études des besoins en eau des principales cultures des fourrages et des plantations ligneuses	++
		1.2.2. Mise au point de techniques mécaniques et biologiques de contrôle du bilan hydrique à la parcelle	++
	1.3. Mise au point de techniques d'optimisation de l'utilisation des ressources en eau à l'échelle du bassin versant	1.3.1. Etude de la redistribution de l'eau à l'échelle du bassin versant	+++
		1.3.2. Mise au point et expérimentation de systèmes de stockage et de valorisation des eaux de surface	+++
		1.3.3. Etude et expérimentation de méthodes de réduction de la demande évaporative	+++
		1.3.4. Mise en point des techniques de réhabilitation de protection et mise en valeur des bas-fonds et des plans d'eau	+++
	1.4 Poursuite de l'inventaire et de la caractérisation des zones humides (bas-fonds, plans d'eau) et suivi de leur évolution	1.4.1. Inventaire, typologie et caractérisation des bas-fonds et des plans d'eau	+++
		1.4.5. Analyse et suivi d'impact écologique des aménagements des bas-fonds et des plans d'eau.	+++
		1.4.4. Etude des stratégie de gestion participative des bas-fonds et des plans d'eau	++
		1.4.3. Evaluation du rôle et des modes de gestion actuel des bas-fonds et plans d'eau	++

CONTRAINTE 2: DEGRADATION DES SOLS			PRIORITE
OBJECTIFS SPECIFIQUES	THEMES DE RECHERCHE	ACTIVITES DE RECHERCHE	Région Sahel
ASSURER LA DEFENSE ET LA RESTAURATION DES SOLS	2.1. Poursuite de la caractérisation des sols	2.1.3. Etude des indicateurs de l'évolution de la qualité des sols	+++
		2.1.1. Etude et caractérisation des ressources en sols.	+++
		2.1.2. Représentation cartographique des ressources en sol à différentes échelles (parcelle, bassin versant, terroir etc.)	+++
	2.2. Poursuite d'études d'amélioration et de mise au point de techniques de CES/AGF adaptées aux conditions socio-économiques	2.2.6. Mise au point et amélioration des techniques de récupération des sols dégradés ou instables (sols dénudés, indurés, sodiques, dures, berges..)	+++
		2.2.1. Amélioration des performances des techniques mécaniques de CES (diguettes, cordons pierreux, travail du sol..)	++
		2.2.3. Mise au point de systèmes de culture agro-écologiques durables (cultures en couloir, couverture végétale...)	++
		2.2.5. Mise au point de modèle adapté au fonctionnement des agro-écosystèmes tropicaux.	++
CONTRAINTE 3 : DEGRADATION DU COUVERT VEGETAL			
MEILLEURE CONNAISSANCE DES FORMATIONS NATURELLES ET DES PARCOURS	3.1. Etude et caractérisation de l'état du couvert végétal	3.1.1. Etude de la dynamique et du fonctionnement des formations naturelles et des parcours	+++
		3.1.2. Identification des aires pastorales et quantification de leurs potentialités	+++
AMELIORER LA PRODUCTIVITE ET LA GESTION DES PARCOURS NATURELS	3.2. Mise au point de techniques améliorées de gestion du couvert végétal	3.2.1. Mise au point de techniques de régénération du couvert végétal et des parcours	+++
		3.2.2 Amélioration de l'organisation de la gestion des parcours naturels	+++
		3.2.3. Mise au point et tests de techniques sylvo-pastorales	+++
		3.2.4. Recherches de référentiels techniques de gestion des parcours	+++
		3.2.5. Amélioration de la productivité des pâturages	+++
		3.2.6. Mise au point de techniques de coupe, de conservation et des modes de stockage	+++
	3.3. Poursuite de la mise au point de techniques de valorisation et de diversification de l'exploitation des ressources végétales non fourragères	3.3.1. Réduction de l'utilisation du bois d'énergie et recherche de sources d'énergie de substitution	+++
CONSERVATION DU COUVERT VEGETAL	3.6. Amélioration de la gestion du bétail	3.6.1. Etude de l'impact de la gestion du bétail sur la dégradation du couvert végétal	+++

CONTRAINTE 4 : FAIBLE PRODUCTIVITE DES SYSTEMES DE PRODUCTION			
COMPRENDRE LES SYSTEMES DE PRODUCTION ET LES MODES DE GESTION DES RESSOURCES NATURELLES	4.1. Diagnostic sur le fonctionnement des systèmes de production et étude de leur dynamique	4.1.1. Enquêtes de reconnaissance	+++
		4.1.2. Etude des systèmes de culture	+++
		4.1.3. Etude des systèmes d'élevage	+++
		4.1.4. Etude du rôle socio-économique de l'élevage	+++
		4.1.5. Etude du système agro-forestier traditionnel	+++
		4.1.6. Etudes foncières	+++
		4.1.7. Etudes de l'impact de la migration sur la dynamique des systèmes de production	+++
		4.1.8. Dimension socio-économique de la femme dans les systèmes de production	+++
		4.1.11. Identification des unités socio-économiques et leur fonctionnement	+++
		4.1.12. Analyse des modes de production, consommation et de stockage	+++
		4.1.9. Inventaire des techniques endogènes d'alimentation des animaux	+++
		4.1.10. Analyse de l'allocation des facteurs de production	++
			++
	4.2. Diagnostic des modes de gestion des ressources naturelles	4.2.1. Inventaire et évaluation des stratégies de GRN et SP	+++
		4.2.2. Etude de l'impact des modes d'accès à la terre sur la gestion des parcours	+++
		4.2.4. Etude de l'impact de la migration sur la GNR	+++
		4.2.5. Etude des modes endogènes de gestion et d'amélioration des parcours	++
		4.2.3. Dimensions socio-économiques de la femme dans la GRN	++
	4.3. Diagnostic des interventions des structures de développement et leurs impacts sur la GRN et SP	4.3.3. Analyse des méthodes de gestions participatives et capitalisation des expériences	+++
		4.3.2. Etude sur le fonctionnement et les stratégies des organisations paysannes et professionnelles	+++
		4.3.4. Analyse et détermination des conditions de prise en charge de développement et leurs domaines l'encadrement par les organisation paysannes	++
		4.3.1. Inventaire et typologie des structures d'intervention	++

AMELIORER DES SYSTEMES DE PRODUCTION	4.4. Intensification et diversification des systèmes de production	4.4.1. Amélioration des innovations endogènes	+++
		4.4.2. Inventaire et évaluation des innovations techniques	+++
		4.4.3. Mise au point d'innovations sociales et expérimentations des méthodes participatives des populations à la GRN	+++
		4.4.4. Mise au point des techniques d'irrigation de complément à faible coût en pluvial	+++
		4.4.5. Introduction des systèmes de culture (itinéraires, techniques, assolement, rotation) appropriés utilisant des intrants à faible coût	+++
		4.4.6. Introduction des systèmes d'élevage appropriés (conduite de l'élevage...)	+++
		4.4.7. Evaluation de l'impact socio-économique des différentes innovations	++
	4.5. Poursuite des études d'amélioration et de maintien de la fertilité des sols	4.5.4. Optimisation des associations entre plantes et micro-organismes dans les systèmes de culture	+++
		4.5.5. Etude du rôle de l'arbre dans l'amélioration de la fertilité des sols dans les systèmes agroforestiers	+++
		4.5.3. Mise au point des techniques de valorisation des ressources locales	++
	4.6. Mise au point et test des formes d'intégration agriculture et élevage	4.6.3. Mise au point d'une approche participative d'amélioration des parcours	+++
		4.6.2. Evaluation et amélioration des stratégies paysannes d'intégration agriculture-élevage	++
		4.6.1. Amélioration des capacités de production du fumier ou matières organiques	++
CONTRAINTE 5. : DEGRADATION DES RESSOURCES FAUNIQUES ET HALIEUTIQUES			
ASSURER UNE GESTION RATIONNELLE DES RESSOURCES HALIEUTIQUES ET FAUNIQUES	5.1. Inventaire et étude de la dynamique des ressources fauniques et halieutiques	5.1.1. Inventaire et dynamique des populations	++
		5.1.2. Etude et aménagement de l'habitat	++
CONTRAINTE 6 : FAIBLE PERFORMANCE DES SERVICES AUX PRODUCTEURS			
AMELIORER LE SERVICE D'APPUI AUX PRODUCTEURS ACCROITRE LA PARTICIPATION PAYSANNE AU DEVELOPPEMENT DES SERVICES POUR UNE GESTION DURABLE DES RESSOURCES NATURELLES	6.1. Connaissance de l'environnement socio-économique des producteurs	6.1.3. Etude des circuits de commercialisation et d'approvisionnement	+++
		6.1.4. Etude de l'amélioration des conditions d'accès de la femme aux services	++
		6.1.2. Mise au point et expérimentation de systèmes d'épargne et de crédit	++
		6.1.1. Etude des circuits de crédit et d'épargne rural	++
	6.2. Diversification des sources de revenus des producteurs	6.2.2. Identification et introduction de nouvelles activités régénératrices de revenus	+++
		6.2.1. Etude de l'importance des activités agricoles et extra-agricoles	++

+++ 1 ère PRIORITE
++ 2 ème PRIORITE

- identification des conditions économiques d'une intensification et d'une diversification de la production agro-pastorale, préservant l'environnement ;

- analyse économique des procédés de transformation des produits et leur impact sur la gestion des ressources naturelles.

CONCLUSION

Les régions arides constituent des zones fragiles où les ressources naturelles devraient être gérées de façon intégrée avec la participation des populations. Un programme de recherche sur la gestion des ressources naturelles devrait permettre dans un tel contexte :

- de mieux connaître les milieux physiques et humains de ces zones ;
- de mettre à la disposition des populations et des projets de développement, des outils indispensables à la réduction, voire l'arrêt de la dégradation des ressources naturelles, des sols en particulier ;
- de proposer de nouvelles formes d'organisation d'utilisation et de gestion rationnelles des ressources naturelles.

Les innovations endogènes, institutionnelles et technologiques qui seront proposées devraient permettre une optimisation de la productivité tout en préservant les ressources naturelles.

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Agriculture pluviale, productions animales et dégradation au Sahel

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L'une des nombreuses définitions du Sahel situe cette zone entre les isohyètes 600 et 100 mm (figures 1a et 1b).

Le climat sahélien est caractérisé par une seule saison de pluies assez courte (Juin-Septembre) alternant avec une période sèche de huit à neuf mois. La pluviosité très variable d'une année à l'autre, a une répartition très irrégulière dans le temps et dans l'espace. Les données pluviométriques de Niono, localité du Sahel malien (figures 2 et 3), illustrent parfaitement ces fluctuations.

Cette variabilité inter et intra-annuelle dans la distribution des précipitations en domaine sahélien explique, pour une grande part, les importantes fluctuations au cours du temps des caractères des communautés végétales et celles des productions agricoles.

Comme le reste du pays, la zone sahélienne a une vocation agro-pastorale.

Dans ce document, on donnera un aperçu sur les cultures pluviales et les productions animales. Ensuite, on traitera la dégradation de l'environnement ainsi que les principaux facteurs qui en sont la cause.

Enfin, on tentera d'évaluer les besoins d'une recherche future ainsi que les opportunités qui se présentent.

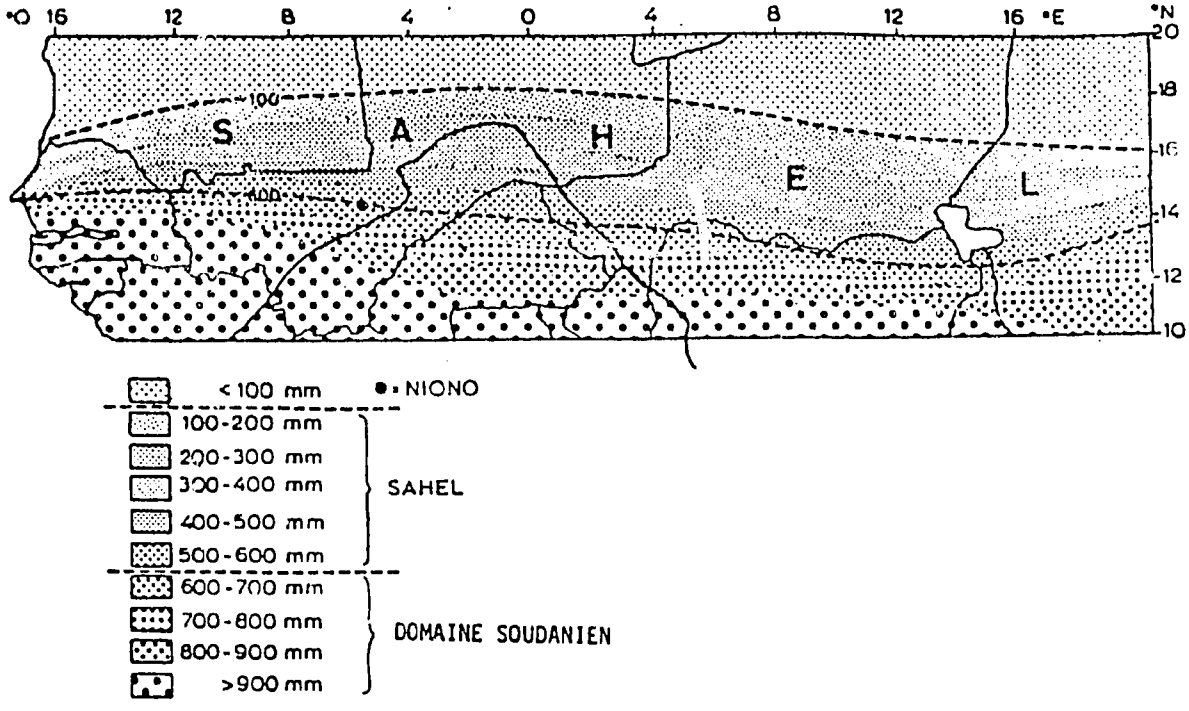
1. LES CULTURES PLUVIALES

Malgré les contraintes climatiques (faiblesse et mauvaise répartition des précipitations) et pédologiques (pauvreté des sols, particulièrement en azote et phosphore), le Sahel malien n'en demeure pas moins une région agricole.

Dans ce document, nous nous pencherons plus particulièrement sur les cultures pluviales.

1.1 Cultures sèches

Ce sont les cultures dont le cycle végétatif est essentiellement lié à l'eau de pluies. Elles sont réalisées dans les zones exondées à pluviosité supérieure ou égale à 300 mm par an. Il s'agit principalement du sud du Gourma en 6^{e} région (Région de Tombouctou) et des secteurs exondés de la 5^{e} région (Région de Mopti). Une bonne illustration des pratiques des cultures sèches est donnée par celles réalisées dans le Séno en 5^{e} région (Séno signifie dune de sable en langue locale peuhl) S. CISSE et O. BA, 1990:



La pluviosité annuelle moyenne du Sahel de l'Afrique de l'Ouest.
Les frontières nationales et les fleuves sont indiqués.
(in Penning de Vries et DJITEYE M. A., 1982)

FIGURE 1a

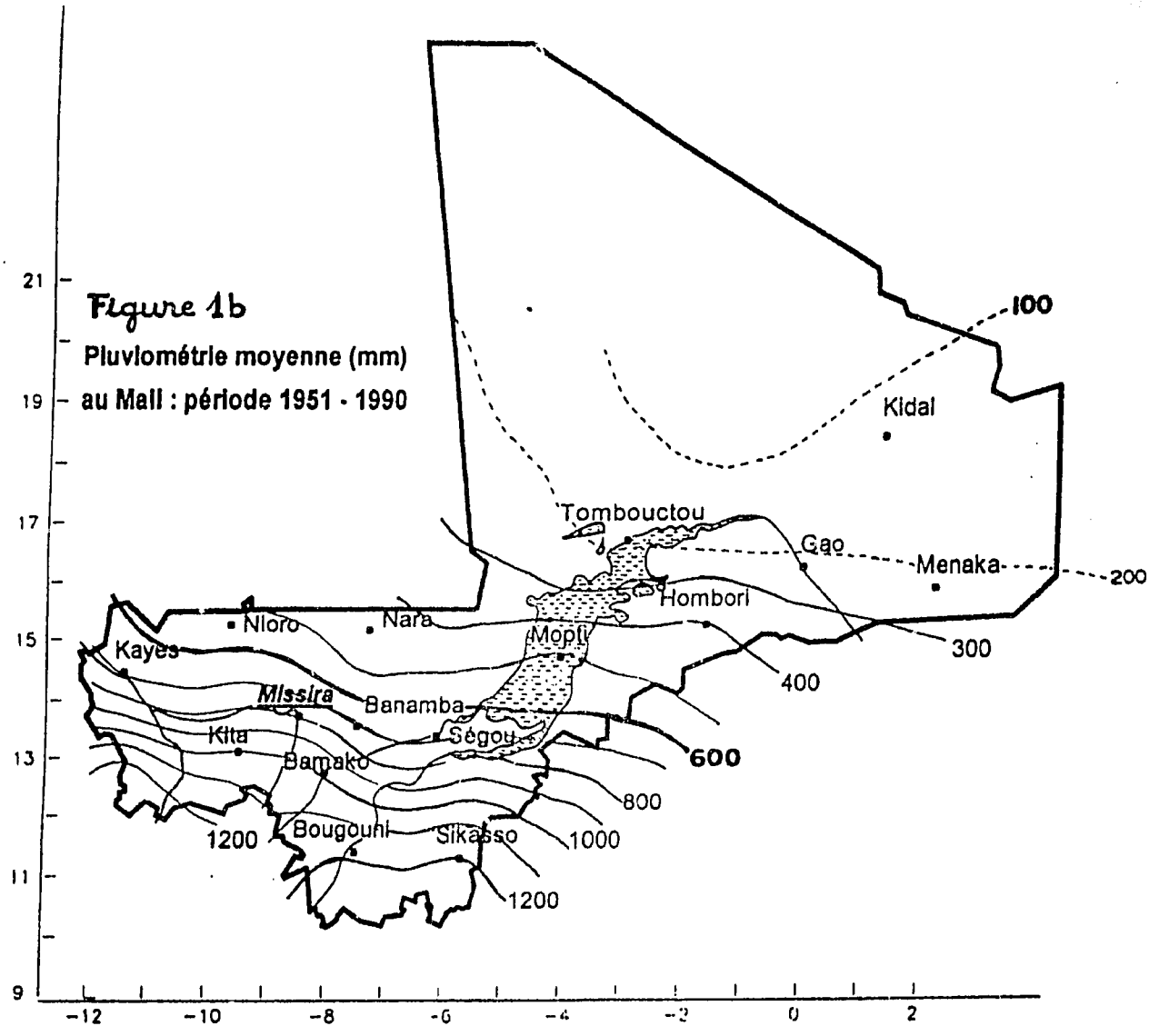


Figure 1b
Pluviométrie moyenne (mm)
au Mali : période 1951 - 1990
100
200
300
400
600
800
1000
1200
1200
Kidal
Tombouctou
Gao
Menaka
Hombori
Mopti
Nioro
Nara
Kayes
Missira
Banamba
Ségou
Kita
Bamako
Bougouni
Sikasso
21
19
17
15
13
11
9
-12
-10
-8
-6
-4
-2
0
2

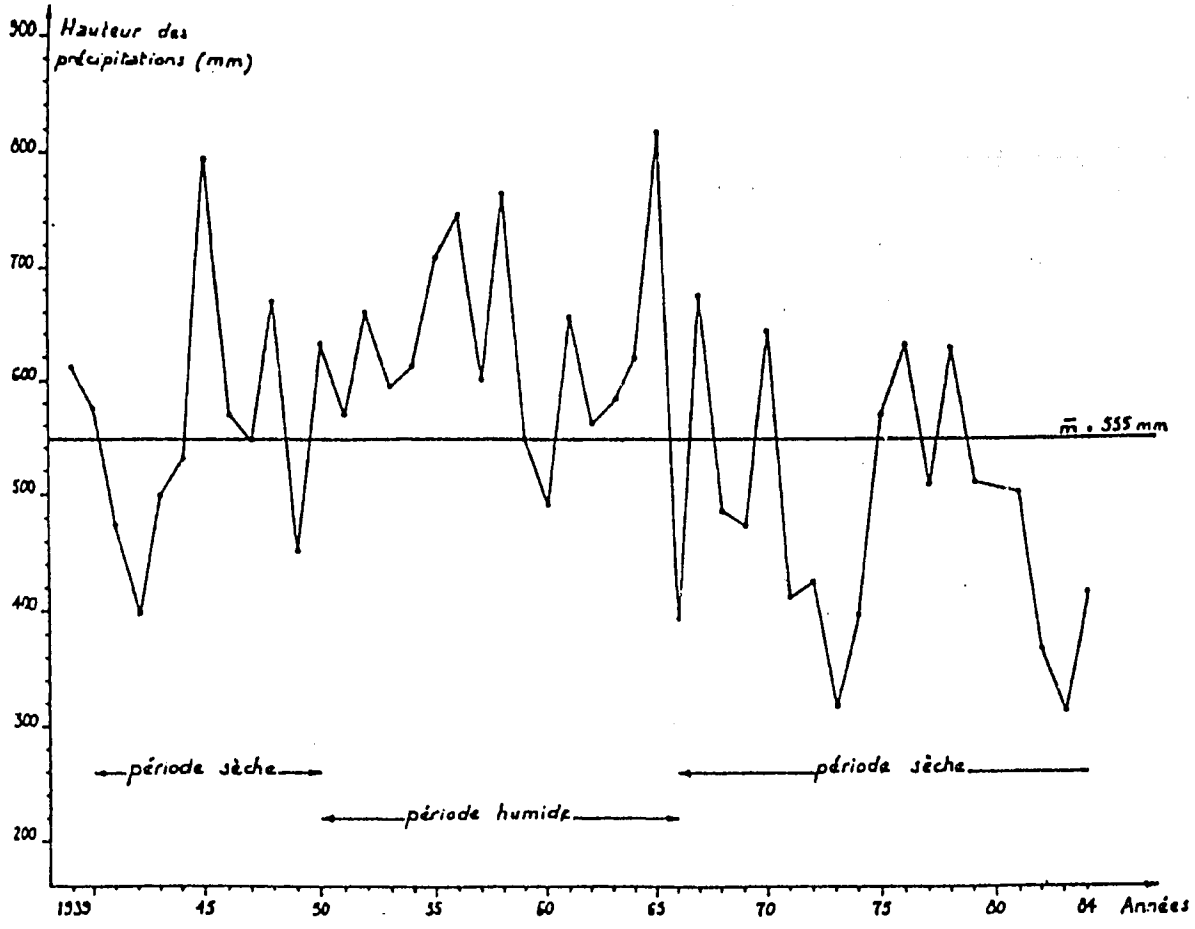
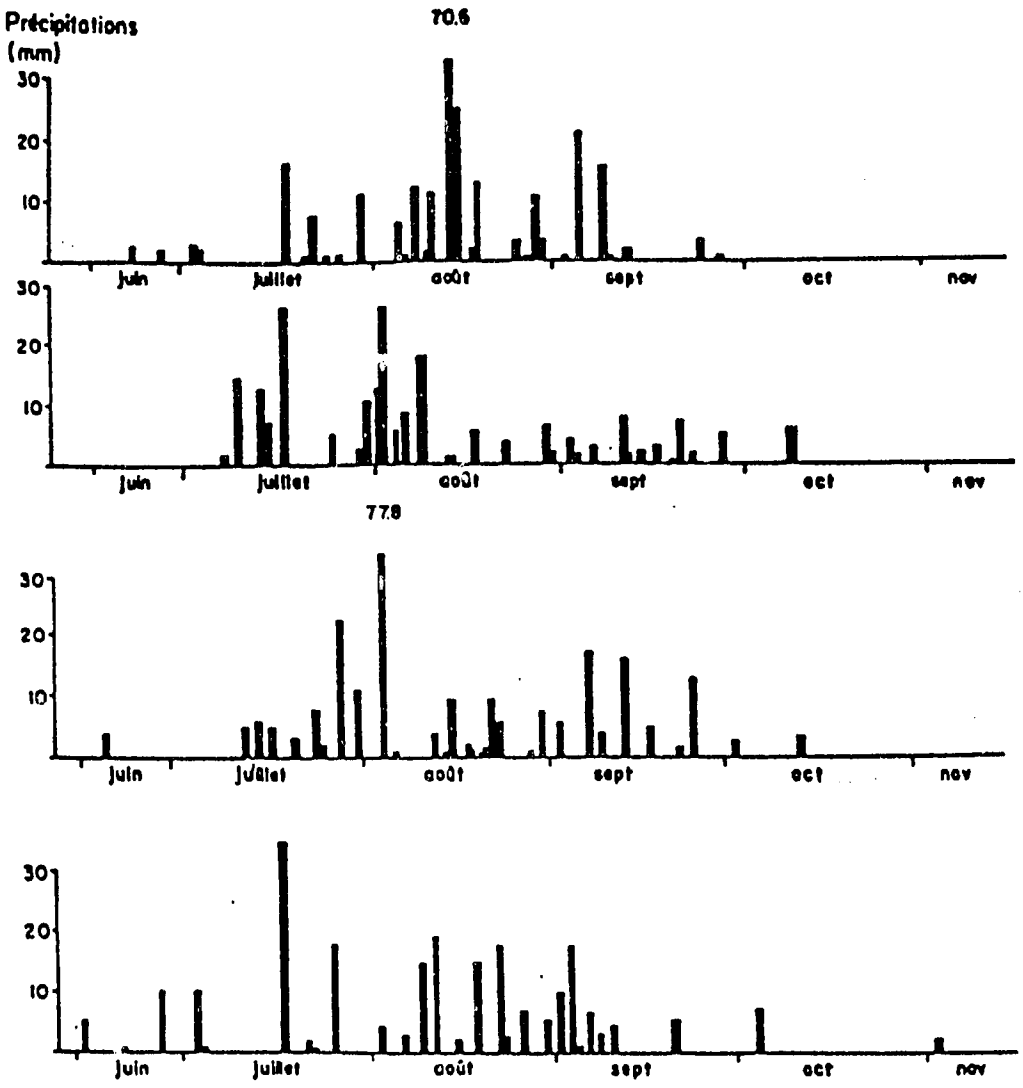


FIGURE 2. Variations interannuelles des précipitations à Niono, de 1939 à 1984.



Sources: recalculée d'après les données du PPS.

Distribution journalière des pluies de 1976 à 1979 au ranch de Niono.
(in Wilson, De Leeuw et De Haan, 1983).

FIGURE 3

1.1.1 Mil (*Pennisetum thyphoïdium*)

Deux variétés de mil sont cultivées dans ce secteur:

- mil à cycle long (120 jours et plus): est cultivé dans les champs de brousse "Kungo Foro" loin des villages (3 à 7 km). En général, il y a une préparation assez sommaire du sol qui consiste en un nettoyage manuel du champ. Les débris mis en tas, sont ensuite brûlés sur place. Lorsqu'il s'agit d'un nouveau champ, le nettoyage se fait par le feu. Quelques gros arbres sont conservés pour l'ombrage tandis que les autres sont abattus lorsqu'ils n'ont pas été décimés par le feu.

Le semis se fait dans des poquets dès les premières pluies sur des buttes organiques (buttes de l'année précédente constituées par les adventices rassemblées entre les pieds de mil, enfouies ensuite sous la terre ramassée entre les plants), des buttes simples faites à la daba ou sur des billons lorsque le labour est pratiqué.

Il y a un faible apport de fumier dans ce système. Ce fumier est mis au pied des plants de mil et les quantités appliquées dépendent des possibilités du paysan.

Les deux premiers sarclages consistent en un arrachage des adventices qui sont utilisées pour la constitution de buttes organiques.

Dans ce système, le niébé (variétés locales de haricot) est toujours associé au mil. Il est semé au moment du 1er sarclage, intercalé entre les plants de mil, sur des buttes organiques nouvellement érigées.

La récolte est faite à la main en couchant les pieds de mil.

Le transport des produits s'effectue à l'aide de charrette, à dos d'âne ou même le plus souvent sur la tête des paysans.

Les temps de travaux sont estimés à 61 H/j/ha (hommes/jour/hectare).

Quant au rendement moyen, il est de 600 kg/ha en conditions normales de pluviosité.

Lorsqu'il y a l'introduction de la charrue dans ce système, le temps des travaux est alors de 48 H/j/ha + 6 At/j/ha (attelage/jour/hectare) et le rendement moyen 900 kg/ha.

- mil à cycle court (90 à 100 jours) . Ce type de mil est cultivé surtout autour des villages (champs de case appelés "So-Foro". Ces champs reçoivent plus d'entretien: labour, hersage et fumure. Pour leur amendement, les paysans utilisent surtout la fumure organique (en saison sèche il y a un parcage des animaux sur ces champs). La fumure minérale est également utilisée (urée, phosphate d'ammoniaque, phosphate naturel de Tilemsi) mais de manière encore assez timide.

La culture du mil à cycle court nécessite en moyenne 63 H/j/ha pour un rendement moyen de 700 kg/ha.

- système semi-intensif de la culture de mil: à côté des deux systèmes traditionnels précédents, il existe un système semi-intensif pratiqué par des "**paysans pilotes**": il s'agit de paysans volontaires qui, en plus du matériel agricole et de l'utilisation de l'engrais, mettent en pratique les thèmes techniques recommandés par l'Opération Mil de Mopti tels que:

  * le traitement des semences
  * le piquetage des parcelles
  * le labour à la charrue
  * le semis en ligne
  * le sarclage
  * le démariage à 3 plants/poquet
  * la fumure organique et minérale.

Ce système intensif de production de mil nécessite en moyenne 38 H/j/ha + 10 At/j/ha pour un rendement moyen de 1.400 kg/ha (en conditions normales de pluviosité).

Au cours de la campagne 1986-1987, ce système couvrait 5% des superficies récoltées.

1.1.2 Sorgho (*Sorghum bicolor*)

Plante pouvant s'accommoder de sols peu fertiles, le sorgho ne réussit cependant que dans les stations argilo-siliceuses ou silico-argileuses, donc gardant une certaine humidité tout en restant assez perméables.

Le sorgho est cultivé essentiellement dans des stations à bilan hydrique favorable (bas-fonds) lorsqu'on est dans le Sahel. On comprend donc aisément que le sorgho pluvial ne soit pas une spéculation très répandue en zone sahélienne.

Du reste, la pluviosité du sud Sahel (600 mm/an) représente la quantité minimale d'eau qu'exige cette céréale.

La culture se fait généralement sur des buttes faites à la houe, mais sans autre préparation du sol. Sur les jachères, on pratique un labour de fin de saison des pluies ayant pour but d'enfouir la biomasse herbacée.

Les temps de travaux pour 1 ha de sorgho sont compris entre 90 et 113 H/j et le rendement moyen de 1.000 kg/ha.

1.1.3 Fonio (*Digitaria exilis*)

Plante très résistante à la sécheresse, le fonio réussit sous 300 mm de pluies/an. Pour cette raison, il s'adapte à la mauvaise répartition des précipitations. Il s'accommode de tous les terrains, mais ne réussit pas sur les sols imperméables. Réussissant bien sur sol sec et pauvre, ses meilleurs rendements ne sont cependant obtenus que sur sols profonds et riches en matières organiques.

Pour la préparation du champ de fonio, le paysan se contente d'un nettoyage par le feu et ensuite d'un labour très léger.

Le semis se fait à la volée et l'entretien d'une culture de foins peut se limiter à un sarclage après un mois de végétation. Toutefois, un second sarclage peut s'avérer nécessaire car, certaines graminées spontanées ne se distinguent du fonio qu'au stade floraison-fructification.

Pour toutes ces raisons, les temps de travaux sont assez faibles: 44 H/j/ha + 6 At/j/ha. L'attelage n'intervient que pour le labour et le transport des produits. En culture extensive, le rendement moyen est de 400 kg/ha.

1.1.4 Maïs (*Zea mais*)

Le maïs est essentiellement cultivé autour des cases dans des parcelles qui sont labourées dès les premières pluies. Il bénéficie de la fumure organique. Le semis qui se fait en ligne, commence dès que le terrain est prêt. Une semaine après la levée, les paysans procèdent à un autre semis pour remplacer les manquants. Ils mettent 3 à 4 graines par poquets. Ils démarient à 2 plants assez tôt, 15 jours après la levée. Ils profitent de ce démariage pour faire un sarclage manuel. En général, on procède au 1er sarclo-binage 10 jours après le semis et le 2^{e}, 15 jours plus tard.

La récolte du maïs est échelonnée. Pendant la période de soudure, seuls quelques épis sont coupés et décortiqués pour les repas du jour. Il constitue donc un aliment de soudure.

Les temps de travaux sont estimés à 57 H/j/ha + 11 At/j/ha. Rendement : 800 à 1500kg/ha

Le sarclage occupe à lui seul 45 % des temps de travaux car le maïs est très sensible aux adventices.

1.1.5 Arachide (*Arachis hypogea*)

Cultivée dans le sud Sahel, l'arachide ne peut réussir sous une pluviosité annuelle inférieure à 300 mm. Elle réussit bien sur des sols légers, bien drainés et pas très pauvres. Sa culture était surtout pratiquée par les femmes. Mais avec l'introduction de nouvelles variétés assez productives et l'importance de cette culture tant au plan de la fertilisation du sol que celui du revenu monétaire, les hommes également s'y sont lancés.

L'arachide est généralement en assolement avec le mil, et le type de rotation pratiqué, dépend de la fertilité du sol. On peut retenir:

- sur sols riches :
  [Arachide] - [Mil+Niébé] - [Fonio] - [Jachère]

- sur sols pauvres :
  [Arachide] - [Mil ou Sorgho] - [Arachide] - [Mil] - [Fonio] - [Jachère]

Pour la préparation du sol, les paysans font un labour (à la charrue ou à la houe) en début de saison des pluies. Lorsque le terrain est lourd, ils font des billons qui procurent à la plante la terre meuble nécessaire à sa fructification. Dans tous les cas, le labour n'est pas profond (15 cm au maximum). C'est la fumure organique appliquée à petites doses qui est favorable à la culture de l'arachide. Selon les paysans, les doses massives favoriseraient la formation de gousses vides. Aussi, préconise-t-on l'application de la fumure organique sur la sole précédant la culture de l'arachide.

Dès que la saison des pluies s'est bien installée, elle est semée en poquets ou en lignes à raison de 2 à 3 graines par poquet. Outre la lutte contre les mauvaises herbes, l'entretien comporte également le remplacement des pieds manquants et des binages dont la fréquence dépendra de l'envahissement par les herbes (en principe toutes les deux ou trois semaines au début de la culture).

La récolte s'effectue par arrachage à la houe.

Les temps de travaux sont estimés à 57 H/j/ha pour un rendement moyen de 550 kg/ha d'arachide coque.

1.1.6 Niébé (*Vigna unguiculata*)

Plante rustique et très résistante à la sécheresse, le niébé réussit même à 200 mm/an. Le niébé est rarement cultivé en pure. Par contre, il est pratiquement toujours associé au mil. Il est semé après le mil et tardivement car, dans la zone, le niébé est plutôt un aliment d'appoint. Il craint l'engorgement, même temporaire. Il reçoit les mêmes entretiens que le mil auquel il est associé.

Cette culture ne reçoit pratiquement pas d'engrais.

1.1.7 Voandzou (Vouandzea subterranea)

Le voandzou, appelé "**Pois Bambara**" est une plante rustique dont la culture est menée comme celle de l'arachide, mais reçoit moins de soins que celle-ci.

Le rendement moyen est de 500 kg/ha.

1.2 Riz pluvial (**Oryza spp.**)

La culture du riz pluvial est pratiqué dans la zone du Delta sur des sols qui restent engorgés pendant toute la saison des pluies et qui, pour cette raison ne conviennent pas aux autres cultures pluviales. Le champ est labouré dès que l'humidité du sol le permet au début ou parfois à la fin de la saison des pluies après la récolte.

Le semis se fait en ligne mais avec une densité assez élevée.

Si la contribution du riz pluvial à la production des différents types de rizicultures (riziculture flottante, submersion contrôlée, riz de décrue, riziculture des petits périmètres irrigués villageois) reste difficile à quantifier, on sait par contre que dans le Delta central, 1/3 des villageois pratiquent la riziculture pluviale.

1.3 Analyse des systèmes de cultures pluviales

Complètement dépendante de la pluviosité, l'agriculture pluviale est confrontée à différents types de contraintes.

1.3.1 Contraintes climatiques

Le déficit pluviométrique de ces vingt cinq dernières années et le raccourcissement de la saison humide à 2 ou 3 mois ne permettent plus aux variétés traditionnellement cultivées de boucler leur cycle. Ainsi, les paysans se "retournent" vers des variétés à cycle court mais moins productives.

De plus, la mauvaise répartition des précipitations qui amène à reprendre très souvent les semis, est également responsable des baisses enregistrées au niveau des rendements des cultures. L'érosion éolienne, particulièrement importante dans ce secteur, accentue le ruissellement, diminue ainsi l'infiltration de l'eau et aggrave le déficit pluviométrique.

1.3.2 Fertilité

La pauvreté des sols du Mali a été signalée par de nombreuses études dont celle du projet Production Primaire au Sahel (Penning de Vries et M.A. Djitèye, 1982). En particulier, on note une carence en Azote et en Phosphore qui limite la production des cultures.

1.3.3 Pratique traditionnelle de l'agriculture

Généralement, les paysans font la même culture plusieurs années de suite (exemple mil-mil) jusqu'à épuisement total du sol. De plus, l'engrais (généralement fumure organique) n'est pas toujours appliqué. A cela, il faut ajouter le raccourcissement de la durée de la jachère imposée par la pression démographique.

1.3.4 Contraintes techniques

Parmi les plus importantes on peut citer:

- le sous équipement agricole
- la non utilisation de semences sélectionnées
- l'insuffisance de l'utilisation de produits phytosanitaires
- la non diversification des cultures (l'exploitation qui est à caractère familial, privilégie les céréales alimentaires)
- l'insuffisance de l'encadrement technique
- l'insuffisance ou même la non utilisation de la fumure.

1.3.5 Contraintes socio-économiques

Le paysan de la région, n'en tire pas le profit qu'il mériterait quel que soit l'état de sa récolte (bonne ou mauvaise). Lorsque la production est mauvaise, malgré les prix élevés, le paysan hésite à vendre car il appréhende une période de soudure difficile. Si la production est bonne, la chute des prix qui en résulte ne lui permet pas de s'en sortir. A cela s'ajoute l'insuffisance de l'infrastructure routière et de l'équipement roulant qui auraient permis d'atteindre d'autres marchés plus intéressants. Pour toutes ces raisons, le paysan qui **"n'y croit plus"** se contente de produire pour sa propre consommation et ne cherche pas à améliorer sa production par l'emploi de la fumure minérale.

1.3.6 Amélioration de l'agriculture pluviale

Pour améliorer la production agricole en zone sahélienne, un certain nombre d'actions doivent être entreprises:

- organiser l'approvisionnement des intrants et abaisser les prix afin d'une plus grande incitation à leur emploi
- vulgariser la technique du compostage
- améliorer la commercialisation afin d'inciter les paysans à diversifier ses cultures
- mener une bonne politique de prix rémunérateur au producteur qui va amener le paysan à ne pas se contenter de produire pour se nourrir, mais plutôt à produire suffisamment pour pouvoir commercialiser le surplus
- faciliter l'accès au crédit agricole pour l'acquisition de matériel et d'intrants
- renforcer l'organisation du monde paysan qu'il faut sensibiliser, former et informer; se former également auprès des paysans qui ont certainement beaucoup de choses à apprendre aux techniciens.

2. LES PRODUCTIONS ANIMALES

Si l'agriculture n'est possible qu'au niveau de quelques stations privilégiées, il n'en est pas de l'élevage qui se pratique sur l'ensemble du Sahel. Cette région a une vocation pastorale imposée par les rigueurs du climat.

L'élevage sahélien est caractérisé par une grande mobilité des troupeaux à la recherche de pâturages, de points d'eau ou de terres salées. Traditionnellement, cet élevage se pratique sous trois formes principales, toutes déterminées en fonction du mode d'utilisation des pâturages, de la localisation et du mode de vie des populations.

2.1 Le nomadisme

Parmi les groupes pastoraux, ce sont principalement les Tamasheqs qui pratiquent le nomadisme (36,6% de la population du Gourma, selon les enquêtes menées en 1990 par le projet Soudan-Sahel-Ethiopie), suivis de loin par les peuhls (5%) et les maures (4,6%).

Dans ce type d'élevage, les familles se déplacent en permanence dans le Nord Sahel avec les animaux à la recherche de nourriture et d'eau d'abreuvement, selon des itinéraires qui peuvent changer d'une année à l'autre et que l'on peut schématiser par les figures 4 et 5.

Celles-ci montrent les mouvements des troupeaux dans le Gourma en fonction des saisons.

L'observation de ces figures permet de faire les observations suivantes:

- pendant la saison des pluies (Juin-Septembre) les animaux exploitent l'ensemble du Gourma intérieur grâce à la présence d'eau de surface (flaques, mares temporaires) et de l'herbe fraîche très riche en eau et présente partout. L'abreuvement ne se fait plus au fleuve, ni dans les mares permanentes, les puits et les puisards. Les pâturages ceinturant ces stations ne sont pas exploités, ce qui permet la restauration de la végétation, en particulier les communautés herbacées. La dispersion du cheptel dans le Gourma intérieur empêche, dans une certaine mesure, le surpâturage de telle ou telle station. Ainsi, les herbacées peuvent boucler leur cycle sans être trop perturbées dans leur développement. Les bourgoutières sont également en repos au plan de l'exploitation. Elles profitent de cette période pour se reconstituer après avoir fait l'objet d'une intense exploitation au cours de la saison qui a précédé.

Concernant la "curée salée" il s'agit d'une consommation de "terres salées" qui se rencontrent dans les stations particulières et qui apportent aux animaux un certain nombre d'éléments minéraux dont ils ont besoin. Après cette cure, les animaux doivent nécessairement se rendre au fleuve pour le "rafraîchissement" c'est à dire un abreuvement au fleuve qui aurait la vertu de neutraliser la "chaleur" produite par la consommation de la salée. Après le rafraîchissement, les animaux retournent dans le Gourma intérieur où ils vont poursuivre le nomadisme.

Les mares profitent également de cette saison des pluies pour faire leur plein d'eau.

- après les dernières pluies, les mares temporaires commencent à s'assécher et l'abreuvement des animaux se fait alors dans les mares semi-permanentes. Pendant toute la saison sèche froide (Novembre-Février), les troupeaux vont exploiter les zones pâturables à partir de ces points d'eau. Généralement, l'abreuvement se fait tous les deux jours et c'est la pâture nocturne qui est pratiquée. De cette manière, les animaux peuvent accéder à des pâturages éloignés d'une vingtaine de kilomètres. Il convient de signaler le cas des caprins qui peuvent rester deux mois et même plus sans s'abreuver lorsqu'ils exploitent les stations à *Citrullus vulgaris* (pastèque sauvage).

Fig 4. MOUVEMENTS DES ANIMAUX DANS LE GOURMA

(VALLEE DU FLEUVE ET GOURMA INTERIEUR)

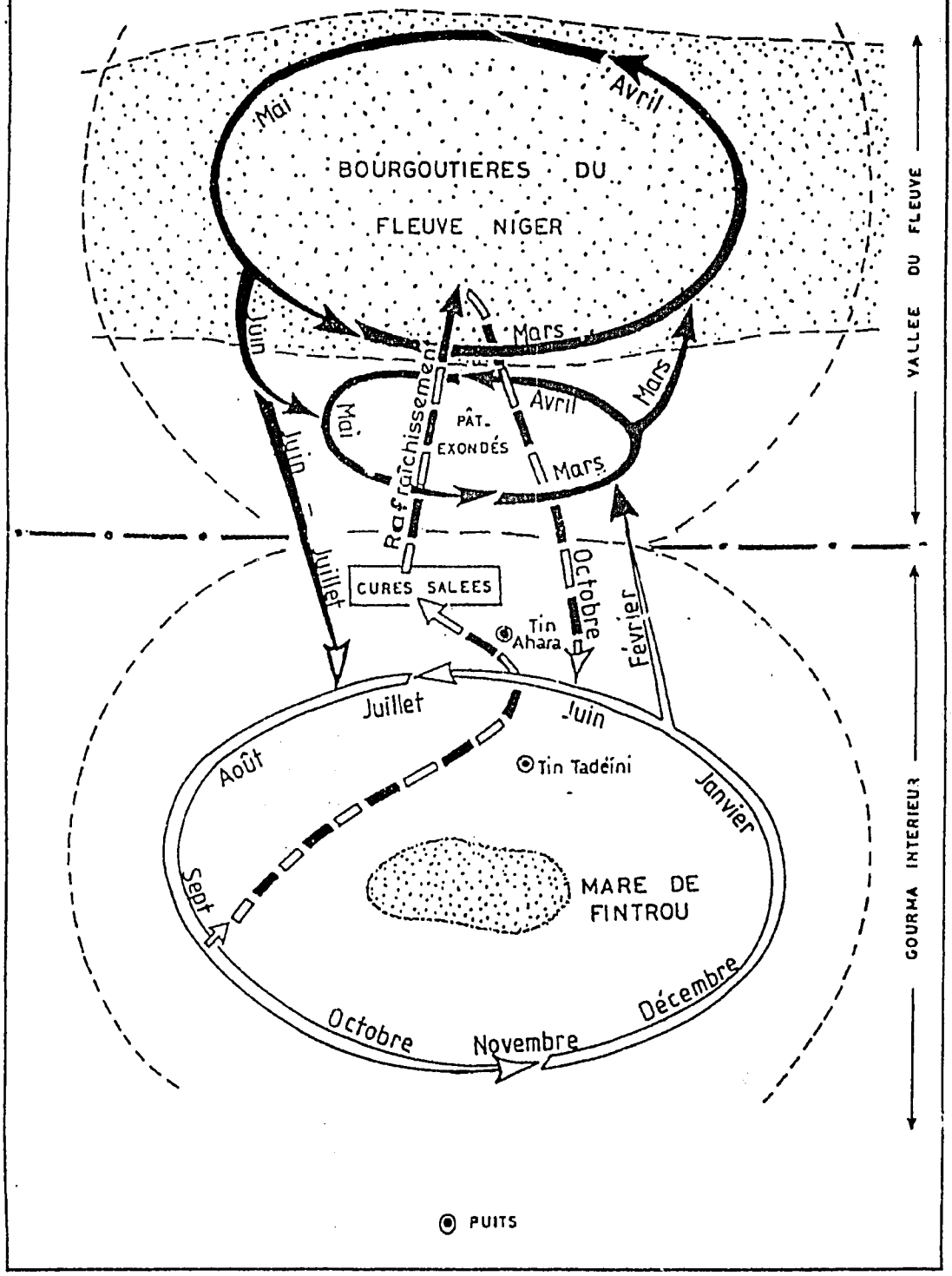
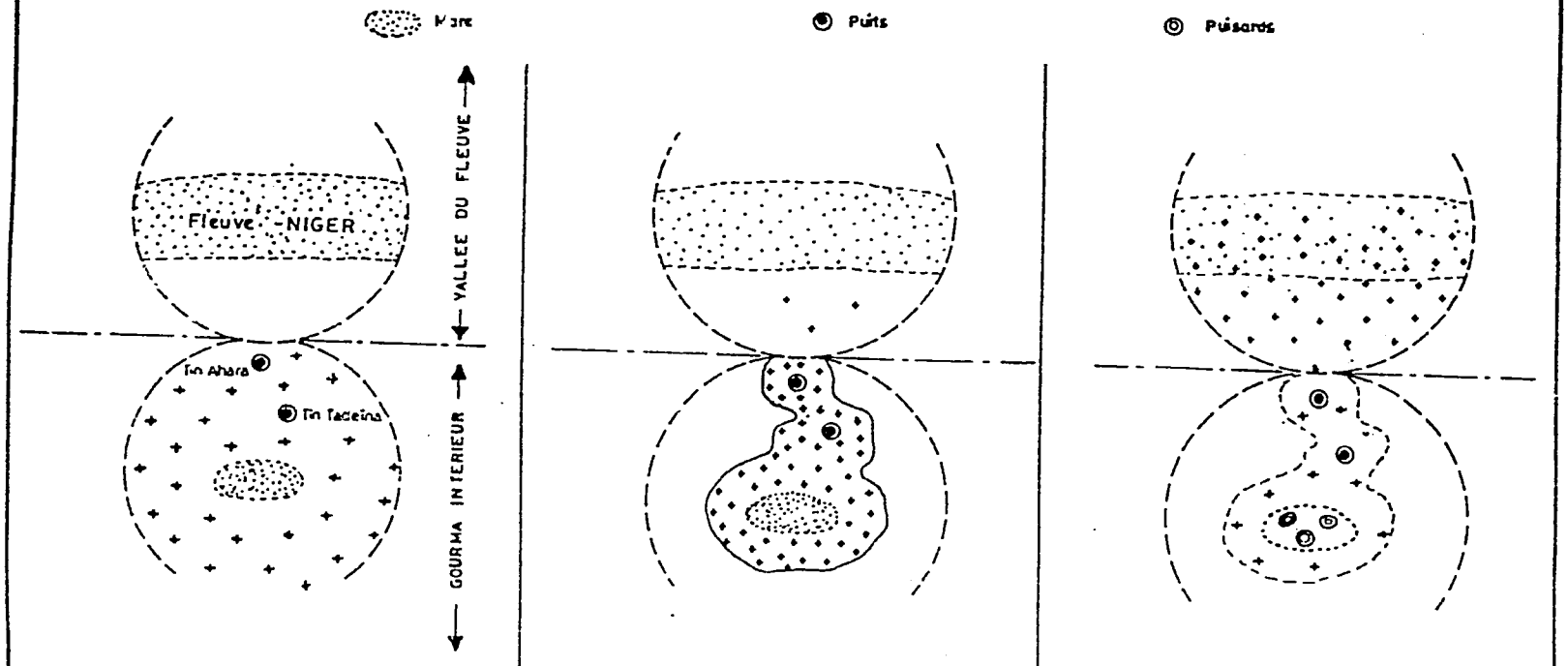


Fig 5 . LOCALISATION DES ANIMAUX DANS LE GOURMA AU COURS DES DIFFERENTES SAISONS



SAISON DES PLUIES (hivernage)

Les animaux (+) sont dispersés dans tout le Gourma intérieur car l'abreuvement est possible partout à cause des eaux de pluie (flaques, mares temporaires)

SAISON SECHE FROIDE

Flaques et mares temporaires sont asséchées. Les troupeaux se regroupent autour des mares semi-permanentes et permanentes et des puits

SAISON SECHE CHAUDE

Les animaux sont concentrés dans la vallée du fleuve où ils exploitent les bourgoutières et pâturages exondés.

Seuls, quelques troupeaux continuent à séjourner dans le Gourma intérieur.

Pendant ce séjour, cette plante confère au lait des chèvres son goût amer et qui, de ce fait, devient inconsommable.

- En saison chaude (Mars-Juin), les mares semi-permanentes se sont pratiquement asséchées. L'abreuvement n'est alors possible qu'au niveau des points d'eau permanents (fleuve, mares permanentes, puisards et puits). La pâture de nuit devient une nécessité pour permettre aux animaux d'accéder à des pâturages assez éloignés à cause de la rareté du fourrage consécutive à la concentration du cheptel au niveau des points d'abreuvement. Mais la majeure partie des troupeaux descend au fleuve pour exploiter les bourgoutières devenues accessibles à la suite du retrait progressif de l'eau. Leur séjour va se poursuivre jusqu'aux premières pluies qui déclencheront la remontée vers le Gourma intérieur et le cycle recommence.

2.2 La transhumance

Dans cette forme d'élevage, les troupeaux effectuent des périples précis et leurs mouvements au cours des saisons sont également commandés par la disponibilité d'eau, de pâturages et de terres salées. Si les Tamasheqs sont reconnus comme des nomades par excellence, les Peuhls eux, sont plutôt des transhumants. Ce n'est donc pas par hasard que les pistes de transhumance portent des noms empruntés au peuhl: "**bourtol**" au singulier, "**bourthi**" au pluriel.

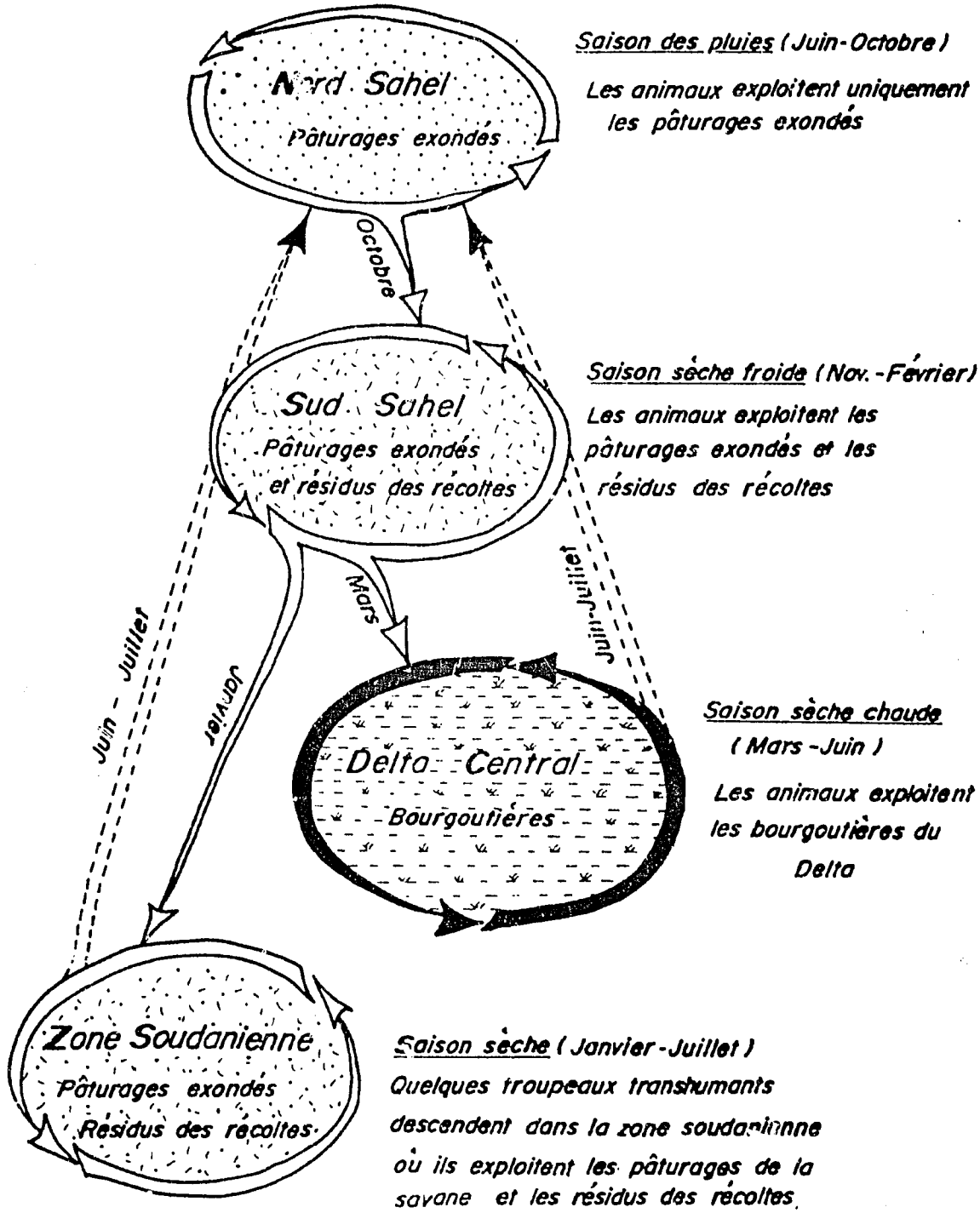
La transhumance peut s'effectuer soit sur des parcours réduits comme c'est le cas pour certains transhumants du Gourma qui effectuent leurs déplacements entre le Gourma intérieur et la vallée du fleuve, soit sur des itinéraires très longs comme celle de Diafarabé, une des plus anciennes et des plus célèbres du Mali. L'axe de cette transhumance passe par la Mauritanie où les troupeaux séjournent un certain temps au cours de la saison des pluies avant d'amorcer leur retour vers le Delta central du fleuve Niger pour l'exploitation des bourgoutières au cours de la saison sèche chaude (Février-Juin).

Ce système transhumant est essentiellement articulé autour des bourgoutières du Delta et de la vallée du fleuve. Toutefois, avec les dernières périodes de sécheresse qui n'ont épargné ni les pâturages exondés, ni les bourgoutières, des déplacements sont effectués en direction du Sud pour exploiter les pâturages soudaniens dès la fin de la saison des pluies.

Comme dans le nomadisme, ce sont les premières précipitations qui amorcent le retour des animaux au Sahel où leur séjour est alors rendu possible grâce à la reconstitution des pâturages et à la présence d'eau de surface.

La figure 6 donne le mouvement des troupeaux transhumants au cours de l'année.

Figure 6. MOUVEMENT DES ANIMAUX TRANSHUMANTS AU COURS DE L'ANNEE



Saison des pluies (Juin-Octobre)

Les animaux exploitent uniquement les pâturages exondés

Saison sèche froide (Nov.-Février)

Les animaux exploitent les pâturages exondés et les résidus des récoltes

Saison sèche chaude (Mars-Juin)

Les animaux exploitent les bourgoutières du Delta

Saison sèche (Janvier-Juillet)

Quelques troupeaux transhumants descendent dans la zone soudanienne où ils exploitent les pâturages de la savane et les résidus des récoltes.

2.3 L'élevage sédentaire

Ce type d'élevage se rencontre dans les secteurs où le développement de l'agriculture est incompatible avec la divagation des animaux. Les cheptels sédentaires sont constitués essentiellement de petits ruminants. Les animaux ne sont généralement nourris qu'avec le fourrage des pâturages naturels et les sous produits de l'agriculture. Les troupeaux ne sont gardés qu'en saison des pluies. En saison sèche, la plupart de ces animaux sont en divagation. Seuls, les moutons de case reçoivent une complémentation alimentaire à base de fanes d'arachide et de niébé, son, restes de cuisines et de sel.

2.4 Les espèces élevées

Pour des raisons de sécurité alimentaire et de contribution au revenu du ménage (consommation ou vente de lait, de viande, d'animaux), et pour une meilleure exploitation des ressources fourragères (herbacées et fourrage aérien), les éleveurs possèdent rarement une seule espèce animale.

2.4.1 Bovins

Ce sont exclusivement des zébus qui sont élevés dans la zone. Les Tamasheqs qui pratiquent le nomadisme dans le Nord Sahel élèvent généralement de zébus touareg et maure. Par contre, dans la zone du Delta central, les troupeaux bovins transhumants sont constitués en majorité de zébus peuhl auxquels s'ajoutent quelques zébus touareg et maure. Un des critères de distinction de ces différents types de zébus est la couleur de la robe. En général, les zébus touareg et maure sont rouge fauve alors que le zébu peuhl est dans la majorité des cas bicolore, blanc avec des bandes et/ou des tâches noires. Mais de plus en plus, on rencontre aussi des zébus bororo qui ont la réputation d'être très endurants et très résistants à la soif.

En 1988, l'effectif des bovins de la 5e région était d'un million de têtes de bétail.

2.4.2 Ovins et caprins

On trouve le mouton à laine (de couleur blanche ou noire) généralement le long du fleuve.En effet il ne supporte pas du tout la soif. Par contre c'est le mouton à poils ras qui est le plus répandu dans les secteurs exondés du sahel. Il s'agit de moutons peuhl, maure et touareg. De plus en plus on rencontre des métis issus du bali-bali (mouton à très grandes oreilles et à gabarit).

Quant aux caprins, c'est essentiellement la chèvre du Sahel, assez haute sur pattes, qui est l'espèce élevée. La chèvre naine de la zone soudanienne ou de Maradi ne se rencontrent que dans l'élevage sédentaire du Sud Sahel.

En 1988, l'ensemble des petits ruminants (ovins+caprins) était estimé à 2.500.000 têtes en 5e région.

2.4.3 Autres espèces animales

Parmi les autres espèces animales, on peut citer:

- les camelins: sont élevés surtout dans le Nord où on rencontre la race maure et la race touareg. Cette dernière est la plus recherché à cause de son aptitude au transport. En 1988, 4.000 camelins ont été recensés en 5^{e} région.

- les asins: les ânes sont très utilisés au Sahel, mais essentiellement pour les transports. Il y avait 180.000 ânes en 5^{e} région en 1988.

- les équins: en 1988, 15.000 équins ont été dénombrés en 5^{e} région. Ils sont utilisés comme monture ou animaux de trait.

2.4.4 Analyse des systèmes de productions animales

Comme l'agriculture, les systèmes de productions animales sont également tributaires de la pluviosité. En effet, quel que soit le système de production animale, les pâturages naturels constituent la base de l'alimentation des animaux. Ces pâturages sont exploités de manière collective, même si par endroit le droit foncier traditionnel confère des priorités d'accès aux ressources (pâturages, point d'eau, cure salée).

Cet élevage sahélien est confronté à un certain nombre de contraintes:

- **problème foncier**: au Mali, la terre appartient à l'Etat. Ce type de propriété en vigueur est sans nul doute à la base de l'échec enregistré au niveau de certaines innovations dans le système d'exploitation traditionnelle. **En effet, la terre appartenant à l'Etat, chacun se donne le droit d'en user, mais nul ne se sent responsable de son entretien ou de son aménagement.** Cependant, malgré cette contrainte foncière, les ethnies et fractions qui pratiquent le nomadisme et la transhumance, le font toujours avec un souci constant d'une coexistence pacifique vis à vis des voisins. Des règles de préséance ont toujours existé pour l'accès aux différentes ressources et chaque utilisateur sait à quel moment il doit conduire ses animaux sur telle aire de pâture, quelle fourche utiliser pour l'exhaure au niveau des puits, quel site fréquenter pour la cure salée. Ainsi, bien qu'utilisant les mêmes besoins, les éleveurs ont su mettre en place un certain nombre de "règles" permettant de minimiser les conflits et d'exploiter au mieux les ressources. Comme l'a souligné BOUDET (1975), "cette transhumance est traditionnellement nécessaire pour utiliser le potentiel fourrager régional, varier les types de fourrages consommés, profiter des sites de cures salées et assurer l'abreuvement des troupeaux (bovins, ovins, caprins) dans les meilleures conditions d'approvisionnement en eau et d'économie de travail pour l'exhaure".

- **contrainte socio-culturelle**: l'élevage constitue la principale forme d'épargne pour les populations sahéliennes. Par ailleurs, pour faire face le mieux possible aux temps difficiles, il est important que les troupeaux comportent le plus de têtes possibles. Les conséquences sont évidentes: un accroissement inquiétant du cheptel et c'est l'écosystème qui va en payer le lourd tribut. En retour, les répercutions sur les animaux sont nombreuses et souvent néfastes:

    * la production animale est très faible: 13 kg de viande par animal et par an

    * on enregistre une perte de poids et même la mort de certains animaux. Une mortalité élevée se rencontre surtout chez les jeunes: on estime que 30 sur 100 veaux, agneaux et jeunes chèvres meurent dans la première année au Sahel.

    * la mauvaise qualité et l'insuffisance de la nourriture font que les jeunes animaux (veaux mâles et femelles) atteignent l'âge de reproduction assez tard (4 à 5ans). Par ailleurs, la fécondité est très moyenne: 65% est un taux presque normal à cet âge. Par contre, la fécondité des petits ruminants est de 100% par an et l'âge de leur première mise bas est de 1 à 1,5 an. Cette différence explique pourquoi l'augmentation du cheptel est plus rapide chez les petits ruminants que chez les bovins après la sécheresse de 1969-1974.

Mais depuis les pertes catastrophiques causées par les épisodes de sévère sécheresse, l'élevage évolue dans un contexte socio-écologique nouveau. On assiste à l'apparition de nouveaux types d'élevages qui visent beaucoup plus la rentabilité économique que la sécurité sociale et qui diversifient les sources de l'alimentation du bétail (cultures fourragères, sous produits agro-industriels, optimisation du fourrage des pâturages naturels par la confection de foin de brousse, stockage de paille de brousse, etc...).

- **contraintes climatiques**: il s'agit essentiellement des grandes variations inter et intra-annuelles des précipitations. Les productions végétales étant correlées à la pluviosité, elles présenteront également d'importantes variations dans l'espace et dans le temps. Ainsi, les années avec des déficits pluviométriques, le faible niveau de production des communautés végétales a pour conséquence une baisse de la productivité des animaux pouvant se traduire même par des pertes assez importantes d'animaux, en particulier, lorsque le déficit persiste plusieurs années de suite, comme entre 1969 et 1974.

3. LA DÉGRADATION DE L'ECOSYSTEME SAHELIEN

L'écosystème sahélien, d'équilibre déjà précaire, est soumis à divers facteurs qui concourent tous à sa dégradation si des mesures ne sont pas prises pour éviter cet état de fait.

3.1 Facteurs de dégradation

3.1.1 Facteurs climatiques

Si le déficit pluviométrique de ces vingt cinq dernières années a entraîné la mort d'un grand nombre d'arbres et d'arbustes dans toutes les communautés végétales sahéliennes, ce phénomène apparait particulièrement marqué au niveau des formations à *Pterocarpus lucens*. Cette mortalité "climatique" massive dans les peuplements de *Pterocarpus*, semble affecter toutes les classes d'âge. Parmi les autres espèces ligneuses touchées on peut citer *Bombax costatum, Commiphora africana, Acacia seyal*, etc..

Au niveau de la strate herbacée, ce sont essentiellement les espèces vivaces qui ont souffert. C'est le cas de la graminée vivace *Andropogon gayanus* qui constituait 40% de la biomasse herbacée du ranch de Niono en 1970. Actuellement, elle ne se trouve qu'à l'état d'individus isolés cantonnés dans des stations à bilan hydrique favorable (zones dépressionnaires).

La mauvaise distribution des précipitations explique pour une grande part les fluctuations au cours du temps des caractères des communautés végétales,en particulier de l'abondance-dominance de leurs espèces composantes.

Pour pallier ces aléas de répartition des précipitations, certaines herbacées sahéliennes sont susceptibles de fournir plusieurs vagues de germination dont le nombre, en général assez variable pour chaque espèce, dépend à la fois de la nature du subtrat et de la hauteur des pluies.

Un arrêt brusque et prolongé des pluies peut également avoir des conséquences sur la composition floristique ultérieure du tapis herbacée. Ainsi, certaines espèces n'ayant pu constituer suffisamment de semences viables, peuvent être éliminées de la végétation de l'année suivante.

Enfin, les pluies tardives (Octobre) ont des effets néfastes sur les herbacées: d'une part elles détériorent la paille qui de ce fait, devient inutilisable par le bétail; d'autre part elles entraînent la réduction du stock semencier en provoquant des germinations en principe non suivies du développement d'individus producteurs de semences, donc défavorisant d'autant les espèces concernées lors de l'hivernage suivant.

Il est bon de signaler l'action du vent qui, en accentuant phénomènes de ruissellement et l'érosion hydrique, diminue fortement l'infiltration.

3.1.2 Facteurs anthropozoogènes

Pour l'installation des champs de cultures, l'homme procède au défrichement avec abattage des arbres. De même, pour ses besoins domestiques, il utilise les produits ligneux: bois de chauffe, bois d'oeuvre et bois de construction. De plus en plus, les plantes entrent dans le traitement des maladies.

Quant aux animaux, c'est leur concentration et leur séjour prolongé qui est néfaste pour l'écosystème: il y a une diminution, voire une disparition du couvert herbacé, un compactage du sol et la formation d'une croûte hydrophobe en surface, point de départ d'un processus de dégradation qui finit par faire disparaître même les ligneux, l'infiltration n'étant plus possible au niveau de ces stations. C'est le cas des zones ceinturant les points d'abreuvement et des pâturages où la pression animale est particulièrement forte. Il se produit d'abord un remplacement des herbacées à cycle long par des espèces à cycle court ou par des espèces à cycle long mais peu recherchées par le bétail. Puis, la pression continuant,on assiste à une disparition complète du couvert végétal et la formation d'une couche indurée en surface, surtout si la teneur du sol en éléments fins (limoneux ou argileux) est élevée. Par la suite, l'installation des herbacées sur ces stations s'avère très problématique.

4. PERSPECTIVES ET OPPORTUNUITES

Pour préserver l'écosystème sahélien, des efforts doivent être faits dans les domaines suivants:

- **l'intensification des cultures pluviales** (cf 1.3.6) qui aura comme conséquence la sédentarisation des parcelles de cultures. Ceci limitera les dommages causés par le défrichement pour l'installation des nouveaux champs

- **la conduite du troupeau**: dans le nomadisme et la transhumance, la dispersion des animaux sur l'ensemble des zones exondées du Sahel pendant la saison des pluies, constitue un frein au surpâturage. Ceci est très important car c'est la phase active des plantes qui arrivent ainsi à produire de la biomasse et des semences sans trop de perturbation. L'assèchement des mares en saison sèche contraint le bétail à laisser ces zones qui, de cette façon, sont épargnées de la surexploitation. Par contre, dans le système sédentaire, les animaux utilisent en permanence les mêmes aires de pâture et on enregistre ainsi une détérioration de l'écosystème. Ce type d'élevage est certainement le plus néfaste pour l'environnement dans sa conception traditionnelle. Pour éviter les inconvénients, de nouvelles dispositions telles que l'introduction des cultures fourragères, l'amélioration de la nourriture des animaux par l'utilisation de graines de coton, farine basse de riz, mélasse, etc., doivent être développées.

- **le respect de la capacité de charge des parcours**: n'est possible que si les éleveurs acceptent de "déstocker" leurs troupeaux.

- **la coupe de bois**: éviter les coupes anarchiques et abusives surtout pour les essences en voie de disparition

- **l'utilisation des plantes médicinales**: rationaliser les prélèvements afin d'éviter la mort des plantes, en particulier quand il s'agit des racines

- **le reboisement**: la nature ne peut tout faire surtout quand on l'entrave dans ses actions. Il faut que les populations acceptent de reboiser

- **l'organisation et l'animation des paysans** (agriculteurs et éleveurs) par:

  * la création d'associations pastorales et agro-pastorales,

  * la responsabilisation des éleveurs et agro-éleveurs en vue de leur participation effective à la mise en oeuvre des programmes et actions.

Le succès de toutes les actions envisagées dépendra de l'organisation du monde rural, son implication dans les différentes étapes de formulation des programmes et dans leur application. Une telle organisation des populations doit se faire autour d'un centre d'intérêt adapté au milieu et à leurs préoccupations. Ce n'est que de cette façon seulement que l'on pourra escompter des changements dans le comportement traditionnel des éleveurs et agro-pasteurs.

Pour la réalisation des programmes et actions envisagées, quelques opportunuités se présentent actuellement.

- En tout premier lieu il y a la politique de décentralisation en cours au Mali qui permettre aux populations de chaque région de prendre en main la gestion des ressources de leur zone. Il y aura une plus grande responsabilsation de ces populations qui se sentiront réellement concernées par les problèmes de leur zone et ainsi, on peut s'attendre à ce que les innovations soient acceptées plus facilement. Il à signaler la création de Centres Régionaux de la Recherche Agronomique, toujours dans le souci de décentraliser la recherche. Chaque C.R.R.A se penchera plus particulièrement sur les problèmes qui se posent au niveau de l'agriculture et l'élevage de sa zone.

- Ensuite, on peut penser aux projets de recherche dont les activités sont axées sur la zone sahélienne:

  * Projet S.S.E (Soudan-Sahel-Ethopie) projet de coopération entre le Mali et la Norvège dont la recherche menée dans le Gourma porte sur le pastoralisme, l'utiiisation des ressources naturelles renouvelables, la médecine traditionnelle, la nutrition et le rôle de la femme.

  * Projet P.S.S (Production soudano-sahélienne): projet de coopération entre le Mali et les Pays-Bas qui est la poursuite du projet P.P.S. (Production Primaire au Sahel) exécuté de 1976 à 1980. L'un des objetifs de ce projet est l'optimisation de l'utilisation des fertilisants dans le cadre d'un développement agricol durable. Un autre objectif est de voir la productivité des animaux qui utilisent à la fois des pâturages naturels et des pâturages artificiels (*Stylosanthes hamata*).
    Toutes ces données permettront la construction de modèles de productions.

- Enfin, les O.N.G (Organisations Non Gouvernementales) constituent aussi des structures pouvant aider à appuyer la réalisation des programmes et actions.

L'Institut du Sahel: deux programmes sous-régionaux pour la lutte contre la dégradation des terres au Sahel

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I. INTRODUCTION

Créé en 1977, l'Institut du Sahel (INSAH) est une institution spécialisée du Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) qui regroupe actuellement neuf pays : Burkina Faso, Cap-Vert, Gambie, Guinée-Bissau, Mali, Mauritanie, Niger, Sénégal et Tchad. Instrument de coopération sous-régionale en matière de recherche, sa mission et ses objectifs s'inscrivent dans le cadre plus global du mandat du CILSS à savoir : "s'investir dans la recherche de la sécurité alimentaire et dans la lutte contre les effets de la sécheresse et la désertification pour un nouvel équilibre écologique au Sahel".

Après dix sept (17) ans d'activités, l'INSAH dispose à ce jour d'un capital précieux d'expériences en matière de coordination et de promotion de la recherche. Ce capital a été acquis à travers des activités centrées sur la lutte contre les effets de la sécheresse et la désertification et comprenant notamment : l'amélioration des mil, sorgho, niébé et maïs ; la lutte intégrée pour la protection des végétaux ; les études et analyses en matière d'agro-sylvo-pastoralisme et de sécurité alimentaire ; l'agroforesterie ; et l'éducation environnementale. Toutes ces activités ont eu une composante de formation de spécialistes sahéliens.

L'expérience de l'INSAH porte également sur la coordination et l'animation de réseaux : le réseau sahélien de documentation et d'information scientifiques et techniques (RESADOC) et le réseau de recherche sur la résistance à la sécheresse (R3S). En plus, il dispose en son sein d'un centre d'études et de recherches sur la population pour le développement (CERPOD).

Durant les deux dernières années, l'INSAH a subi une profonde mutation qui se situe dans le cadre du redressement et de la relance durable du CILSS (cf. annexe). Le cadre d'orientation stratégique à long terme de cette institution ainsi que son plan triennal (1995-1997) ont été adoptés par ses instances de décision au cours de l'année 1994. La présente note sur les programmes de recherche de l'INSAH s'inspirera fortement de ce plan qui contient l'essentiel des besoins en matière de recherche sous-régionale au Sahel pour les trois années à venir.

II. MISSION ET STRATEGIE D'INTERVENTION

II.1. Mission

Dans le cadre du plan d'orientation stratégique du CILSS, la mission assignée à l'INSAH est d'assister les états-membres à travers la recherche, à définir des stratégies et à mettre en oeuvre des programmes qui les aideront à atteindre la sécurité alimentaire sans mettre en danger l'environnement. Pour ce faire, il devra :

- entreprendre des études et recherches en vue de proposer des options de développement en matière de sécurité alimentaire, de gestion des ressources naturelles et de population au Sahel ;

- coordonner et promouvoir la recherche scientifique et technique en tant qu'instrument de développement des états-membres du CILSS ;

- assurer la formation en vue de capitaliser les acquis et de contribuer à la mise en place d'une masse critique régionale des ressources humaines capables d'organiser et de gérer le développement durable :

- assurer la communication et la vulgarisation de l'information scientifique et technique;

- contribuer à l'émergence d'un espace scientifique et technique au niveau régional.

II.2. Stratégie d'intervention

La stratégie d'intervention de l'INSAH s'articule autour de trois axes :

- coordonner et promouvoir les activités de recherche des systèmes nationaux sans entrer en concurrence avec eux, en leur "faisant faire" la recherche ;

- responsabiliser davantage les systèmes nationaux de recherche en faisant le plus possible appel au leadership des compétences nationales en vue de favoriser l'émergence de centres régionaux d'excellence. Dans cette perspective, des mécanismes de concertation et d'échange permettant de valoriser la complémentarité et la collaboration entre ces systèmes seront renforcés ;

- développer la capacité d'intervention de l'INSAH qui sera un lieu privilégié de réflexions stratégiques basées sur des études et des recherches prospectives, tout en mettant un accent particulier sur la communication et la vulgarisation scientifiques et techniques.

Pour accomplir sa mission, l'Institut du Sahel s'est organisé autour de deux programmes : Recherches-Agro-socio-économiques et Population/Développement.

III. PROGRAMMES

Conçus à partir du mandat du CILSS, les deux programmes de l'INSAH, Recherches Agro-socio-économiques et Population/Développement (communément appelés Programmes Majeurs) sont axés sur la sécurité alimentaire par la lutte contre les effets de la sécheresse et la désertification et par voie de conséquence visent à freiner la dégradation des terres. Ils ont été élaborés en concertation avec les principaux partenaires, notamment les Etats et les donateurs. S'inscrivant dans le long terme, ils seront exécutés sous forme de programmes triennaux glissants.

III.1. Recherches Agro-socio-économiques

III.1.1. Objectif stratégique

Le programme de recherches agro-socio-économiques a pour objectif stratégique de proposer des options pour lever les contraintes agro-socio-économiques au développement durable du Sahel. Ce faisant, il contribuera à la mise en oeuvre de la Convention internationale sur la désertification, notamment son article 17 (d) relatif à la recherche-développement. Il comprend cinq (5) activités :

- le développement des capacités pour l'émergence d'un espace scientifique régional ;

- les études et analyses d'appui aux politiques et stratégies en matière de sécurité alimentaire et de gestion des ressources naturelles et de lutte contre la désertification (SA et GRN/LCD) ;

- l'appui aux activités de recherche agricole pour une agriculture durable ;

- la recherche pour la mise au point et la diffusion d'outils méthodologiques en éducation environnementale;

- la documentation et la communication scientifiques et techniques.

III.1.2. Développement des capacités pour l'émergence d'un espace scientifique régional

Le développement des capacités vise essentiellement à assurer la promotion des recherches agro-socio-économiques et environnementales au sahel. Il s'agira d'oeuvrer pour l'émergence d'un espace scientifique régional et pour accroître la synergie entre les programmes des systèmes nationaux de recherche.

Cette activité comprend la mise en place d'un mécanisme de concertation permanente entre les chercheurs eux-mêmes et entre ceux-ci et leurs partenaires de développement (forum). Ce mécanisme sera renforcé par l'organisation de séminaires sectoriels thématiques de priorisation des thèmes de recherche et de séminaires scientifiques internationaux de synthèses des acquis de la recherche. Des visites d'échanges entre chercheurs seront également développées.

Par ailleurs, les initiatives de réformes institutionnelles de la recherche en cours dans la sous-région au Sahel (Gambie, Mali, etc.) seront suivies en vue d'en tirer des leçons profitables aux autres pays du CILSS. Un accent particulier sera mis sur l'adaptation de la recherche aux grandes options actuelles des pays sahéliens que sont la décentralisation et la participation effective des populations et des collectivités locales dans les prises de décision sur l'utilisation des terres.

Des études ponctuelles pour la promotion de la recherche seront menées sur des thèmes précis : financement durable de la recherche, impact de la recherche sur le développement, etc.

III.1.3. Etudes et analyses d'appui aux politiques et stratégies en matière de SA et GRN/LCD

Des études et analyses seront menées en vue de mieux connaître la problématique agro-alimentaire et environnementale au Sahel afin d'améliorer la formulation et la mise en oeuvre de politiques et programmes pour une croissance économique durable fondée sur une sécurité alimentaire auto-centrée et une gestion rationnelle des ressources naturelles.

En matière de sécurité alimentaire, les études et analyses porteront notamment sur les opportunités et le défi d'augmentation de la production agricole et alimentaire face à la dévaluation du franc cfa : changement des prix relatifs aux produits agro-alimentaires, transmission des variations de prix aux producteurs, conditions de développement des échanges régionaux, conditions essentielles de réponses de l'offre des producteurs aux nouvelles incitations.

Les problèmes liés aux filières et au transfert de technologies seront également étudiés. Des appuis méthodologiques scientifiques et financiers (mini-bourses) seront apportés aux systèmes nationaux de recherche pour des études nationales concertées à dimension régionale pour les politiques et stratégies de sécurité alimentaire et de revenus.

En matière de gestion des ressources naturelles, l'inventaire et l'analyse des pratiques d'utilisation seront menés en fonction des systèmes de production et des zones agro-socio-écologiques de la sous-région. Une base de données sur ces pratiques sera mise en place à partir de laquelle des relations causes-effets seront déterminées en vue de proposer des outils d'aide à la prise de décision.

A partir des acquis des études prospectives déjà menées (CILSS, Club du Sahel, Cellule Cinergie), des études et analyses prospectives basées sur le triptyque Environnement - Economie - Démographie seront menées et des options stratégiques régionales en seront développées et proposées aux décideurs. Un accent particulier sera mis sur la durabilité des systèmes étudiés en prenant en compte la pauvreté des sols et des populations.

Par ailleurs, en vue du suivi des programmes d'action nationaux et du programme d'action sous-régional qui seront élaborés et exécutés dans le cadre de la Convention Internationale sur la Désertification, une méthodologie de suivi-évaluation des activités d'utilisation des ressources naturelles sera conçue, développée et testée. A cet effet, les acquis du cadre d'évaluation socio-économique et environnementale au Sahel déjà élaboré par le CILSS seront capitalisés. En plus, en collaboration avec l'Observatoire du Sahara et du Sahel (OSS), un réseau de sites d'observatoire de suivi agro-socio-économique et environnemental à long terme (ROSELT) sera mis en place en vue de générer l'information agro-socio-économique nécessaire à la prise de décisions pour la gestion durable des terres.

Des appuis seront apportés aux systèmes nationaux de recherche pour des études nationales concertées à dimension trans-nationale pour les politiques et stratégies de gestion des ressources naturelles.

En équipe consolidée au sein du système CILSS (Secrétariat exécutif, INSAH et AGRHYMET), des activités concertées d'appui, d'analyses et de suivi-évaluation seront menées dans le cadre de la mise en oeuvre de la Convention Internationale sur la Désertification, aussi bien au niveau sous-régional que national. Une attention particulière sera accordée à la recherche-développement.

III.1.4. Appui aux activités de recherche pour une agriculture durable

l'Institut du Sahel appuiera les systèmes nationaux en vue d'accélerer la génération des technologies appropriées, adaptées aux conditions socio-économiques du Sahel et qui préservent le potentiel productif des écosystèmes afin qu'ils puissent subvenir aux besoins des générations actuelles et futures. Le rôle du programme consistera essentiellement à donner des orientations et à apporter l'appui et l'impulsion nécessaires (à la demande et selon les besoins) aux systèmes nationaux.

Cette activité sera ciblée sur la mise en euvre du cadre d'action INSAH-SPAAR (Special Program for African Agricultural Research de la Banque Mondiale) pour la relance de la recherche agricole au Sahel.

L'appui aux systèmes nationaux se fera dans les domaines suivants :

- recherche sur les ressources phyto-génétiques : collecte, évaluation et conservation des variétés de céréales et des semences forestières locales adaptées aux conditions sahéliennes, mais dont certaines sont menacées de disparition ;

- mise en place de pôles d'excellence de recherches : pôles sur le sorgho avec l'IER du Mali comme leader, la pathologie et la productivité des petits ruminants avec l'ISRA du Sénégal comme leader, la gestion des ressources naturelles en concertation entre le Mali, le Sénégal et le Burkina Faso ;

- diagnostic des risques de sécheresse allant du champ paysan à l'échelle régionale en vue de prédire et d'améliorer l'alimentation hydrique et son efficience pour les cultures ;

- création variétale et sélection pour la tolérance à la sécheresse ;

- recherches sur la conservation et la fertilité des sols ;

- recherches sur les systèmes de production en particulier sur les relations entre l'agriculture et l'élevage et sur l'agro-sylvo-pastoralisme.

Un accent particulier sera mis sur la lutte intégrée contre les ennemis des végétaux, notamment par : la poursuite des recherches pour la mise au point de méthodes de lutte intégrée ; la mise en place d'un programme sous-régional de recherche sur les plantes locales à effets pesticides ; et la poursuite de l'homologation commune des produits agro-pharmaceutiques, notamment à travers le Comité Sahélien des Pesticides qui est déjà fonctionnel. Des orientations et des impulsions catalytiques seront apportées aux systèmes nationaux pour un contrôle plus efficace de l'utilisation des produits agro-pharmaceutiques et des introductions végétales.

III.1.5. Recherche pour la mise au point et la diffusion d'outils méthodologiques en éducation environnementale

La recherche en éducation environnementale vise à mettre au point, tester et diffuser des outils méthodologiques d'éducation et de communication environnementales en vue de garantir la pérennité de l'éducation environnementale au Sahel. A cet effet, les acquis méthodologiques au niveau de l'enseignement primaire (Projet PFIE) seront consolidés notamment par l'extention de l'expérience, une large diffusion des outils élaborés et une prise en charge effective des actions par les Etats.

Cette expérience au niveau du primaire sera capitalisée pour la mise au point, le test et la diffusion d'outils méthodologiques destinés à l'enseignement secondaire.

Par ailleurs, des actions seront formulées en vue d'aider les pays à étendre l'éducation environnementale à d'autres groupes cibles hors du circuit formel de l'école: les femmes, les urbains, les jeunes non scolarisés.

III.1.6. Documentation et communication scientifiques et techniques

Au Sahel, malgré des efforts notables, force est de constater le faible taux d'adoption des résultats de la recherche au niveau des structures de développement. C'est à partir de ce constat que l'INSAH réorientera ses activités de documentation et d'information vers une vraie gestion de l'information scientifique avec un accent particulier sur la communication et la vulgarisation des résultats de la recherche.

Cette activité sera transversale pour les deux programmes agro-socio-économie et population/développement. Il s'agira de :

- consolider les acquis du Réseau Sahélien de Documentation et d'Information Scientifiques et Techniques (RESADOC) et de le développer pour une meilleure circulation de l'information scientifique et technique au bénéfice de la sous-région ;

- développer la cellulte de documentation spécialisée en population/développement;

- renforcer le partenariat avec les unités nationales dans la collecte et la diffusion des informations adaptées aux besoins par la création de "centres d'excellence" au niveau des systèmes nationaux de recherche ;

- créer, développer et diffuser des banques de données sur la recherche agricole : programmes, chercheurs, résultats, technologies, etc.

- promouvoir au niveau national des publications destinées à diffuser et vulgariser les résultats de la recherche vers des groupes cibles : chercheurs, décideurs, vulgarisateurs, etc.

- développer la capacité de collecte et de diffusion de l'INSAH à travers : la dissémination documentaire ciblée (clearinghouse), le service questions-réponses, l'alerte bibliographique et la fourniture rapide de données factuelles avec l'utilisation de moyens technologiques avancés (courrier électronique) et les publications ;

- mener des études ponctuelles d'appui à la recherche sur : les bases et banques de données, les micro-nutriments, le marketing de l'information, etc.

- organiser des conférences d'information scientifique sur des thèmes précis ;

- utiliser des moyens multi-médias pour une meilleure vulgarisation des résultats de recherche.

III.2. Population/Développement

III.2.1. Objectif stratégique

L'objectif stratégique du programme Population/Développement est de proposer des options pour lever les contraintes démographiques au développement durable du Sahel. Il sera exécuté par le CERPOD.

Les travaux de recherche porteront sur les principaux phénomènes démographiques que sont la fécondité, la mortalité (ou la santé) et la migration afin de pouvoir donner des informations pertinentes et nécessaires à la planification du développement aussi bien au niveau national que régional.

Ils visent à corriger deux faiblesses majeures : l'insuffisance des aspects explicatifs de la situation démgraphique actuelle au sahel et l'absence de perspective d'intégration régionale dans la problématique population/développement.

III.2.2. Population, environnement, développement

Les institutions nationales chargées de l'intégration des variables démographiques dans la planification de développement, manquent d'outils nécesaires à cette intégration qui s'avère pourtant indispensable à la mise en euvre des politiques de population. Par ailleurs, la formulation de ces politiques intègre rarement les interrelations existant entre les variables démographiques, l'environnement et le développement qui sont fondamentales pour le CILSS. A partir des études déjà réalisées aux niveaux national et régional, de l'amélioration des modèles déjà développés par le CERPOD (INTEGRA, PAGE) et des données socio-économiques disponibles et en utilisant le logiciel REDATAM, il sera entrepris les recherches nécessaires à la prise en compte des inter-relations ci-dessus évoquées dans la planification du développement.

III.2.3. Migrations et urbanisation

En dépit de l'intensité des mouvements migratoires et de l'importance de leurs implications socio-économiques et écologiques, les migrations constituent la variable démographique la moins connue au Sahel. Aussi, l'étude "Migrations et urbanisation

en Afrique de l'ouest" exécutée dans cinq pays sahéliens (Burkina Faso, Mali, Mauritanie, Niger et Sénégal) et dans trois pays non sahéliens mais ayant les échanges migratoires les plus intenses avec le Sahel (Côte d'Ivoire, Guinée-Conakry et Nigéria) permettra d'avoir, pour la première fois, la base de données la plus importante sur les flux migratoires, leurs causes et leurs effets.

En raison de l'urbanisation rapide du Sahel, essentiellement due aux flux migratoires, des analyses approfondies des données ainsi collectées seront faites pour les besoins de la planification urbaine et de l'aménagement du territoire. Enfin, une étude sur "migrations sahéliennes et intégration régionale en Afrique de l'ouest" sera menée à partir de ces données et d'autres données économiques (flux commerciaux et financiers).

III.2.4. Santé et société

La réduction de la morbidité et de la mortalité, notamment maternelle et infantile constitue une des priorités des politiques nationales de population. L'amélioration de la situation sanitaire des sahéliens nécessaire à la promotion des ressources humaines et de ce fait au développement du Sahel n'est cependant possible que si l'on connait les déterminants de la morbidité et de la mortalité. C'est pourquoi, trois types d'activités de recherche seront menées.

Le premier portera sur les corrélations existant entre la fécondité et la mortalité maternelle et infantile à partir des données déjà collectées, en particulier par les enquêtes démographiques et de santé.

Le second traitera de la propagation du SIDA en rapport avec la mobilité géographique des hommes, les régimes matrimoniaux de la mobilité conjugale.

Enfin, un observatoire de population sera mis en place dans le cercle de Kolondiéba (Mali) afin d'y permettre la conduite d'études longitudinales, notamment sur l'évolution des comportements en matière de santé.

III.2.5. Femme, famille et développement

L'amélioration de la condition de la femme est une préoccupation des pays sahéliens aussi bien en matière de santé, d'éducation que de promotion économique. Mais comment y parvenir ? Dans cette recherche, il s'agira de restituer les fonctions productive et reproductive de la femme sahélienne dans le contexte des stratégies demo-économiques familiales en vue d'en identifier les facteurs d'amélioration pour les besoins de la planification. L'approche "genre et développement" sera privilégiée afin de permettre de faire des propositions des plus pertinentes pour les interventions sur sur le terrain.

IV. CONCLUSION

Avec près de deux décennies d'activités de recherche sous-régionale ciblée sur la lutte contre les effets de la sécheresse et la désertification, l'INSAH est bien armé pour poursuivre son rôle de coordination et de promotion de la recherche au Sahel. Ses deux programmes triennaux, qui s'inscrivent dans le long terme, et le nouvel instrument juridique que constitue la Convention Internationale de lutte contre la Désertification constituent un cadre cohérent et propice pour la mise en place d'un partenariat international dynamique de recherche sous-régionale en matière de lutte contre la dégradation des terres.

La responsabilisation, par consensus, de l'INSAH en tant que point focal de coordination pour la mise en oeuvre de l'ensemble des programmes de recherche transnationaux de lutte contre la désertification dans le Sahel contribuera fortement à améliorer l'efficience des actions, conformément à l'esprit et au contenu de la Convention Internationale de lutte contre la Désertification.

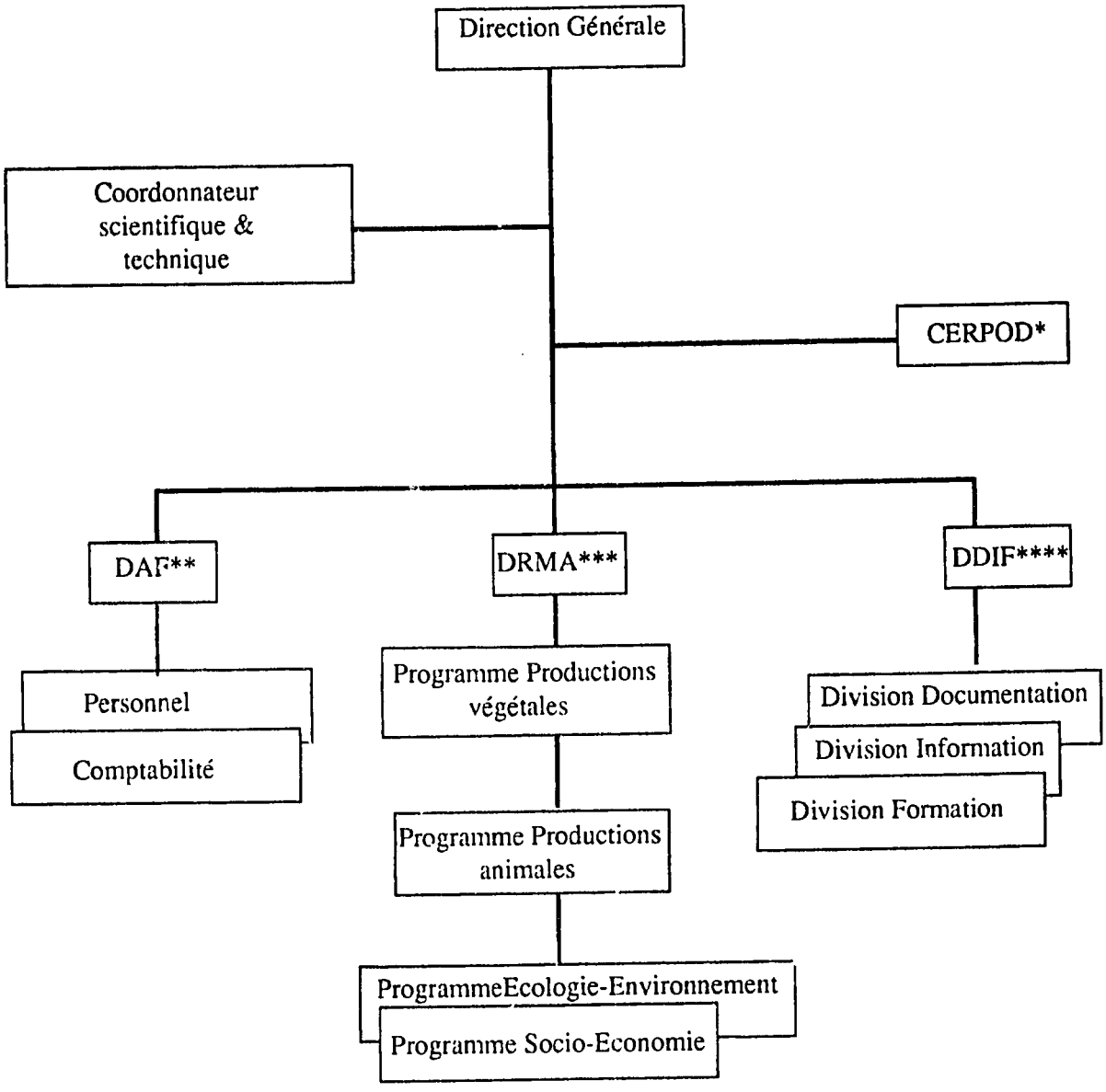
ANNEXE

Organigramme de l'INSAH

1. Avant la restructuration

2. Actuel.

Organigramme de l'Institut du Sahel avant la restructuration



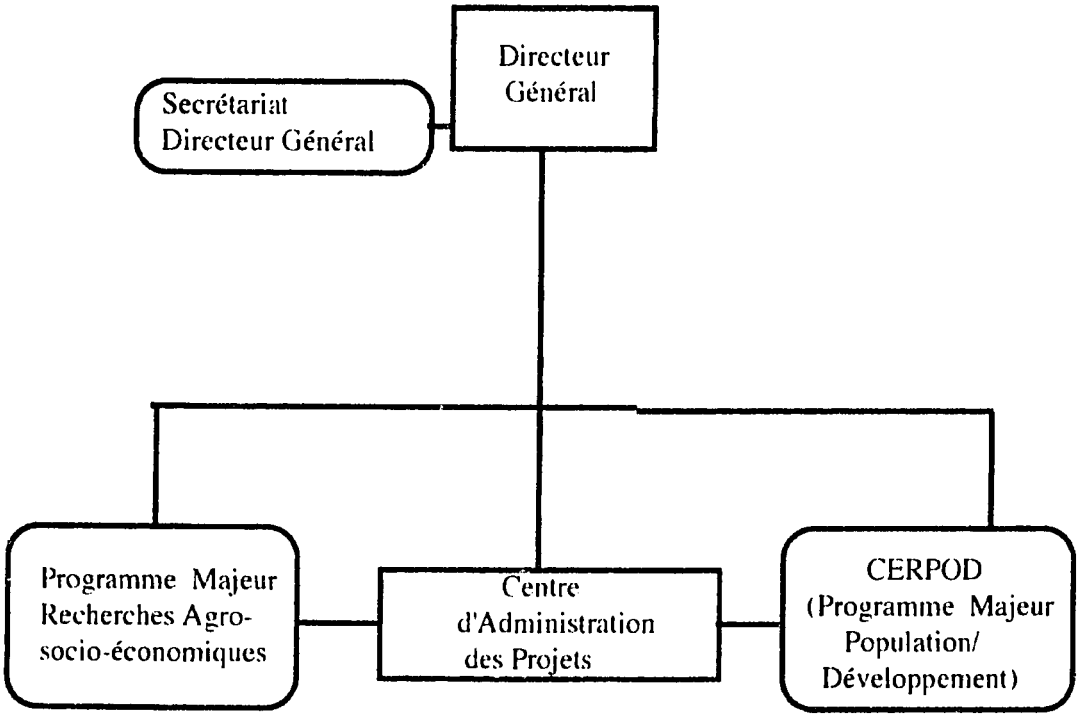
* Centre d'Etudes et de Recherche sur la Population pour le Développement

** Direction administrative et financière

*** Département de la recherche sur le milieu et l'agriculture

**** Département de la documentation, de l'information et de la formation.

Organigramme actuel de l'Institut du Sahel



Communication de l'Association Internationale Six "S"

G Gasana

Secrétaire Exécutif
Association Internationale Six "S"

BREF HISTORIQUE

Depuis sa création en 1976, l'Association Internationale Six"S" (Se Servir de la Saison Sèche en Savane et au Sahel) a développé et appliqué un certain nombre de méthodes dites **"d'auto-promotion"** pour encourager les productrices et les producteurs des pays sahéliens à faire face aux défis du monde rural. Six"S" est ainsi reconnue comme une structure d'appui aux organisations paysannes pour les aider à résoudre leurs préoccupations prioritaires soit :

- la valorisation des ressources locales,

- l'organisation et la structuration paysanne.

Les pays membres de Six"S" sont : le Burkina-Faso, la Gambie, la Guinée-Bissau, le Mali, le Niger, le Sénégal et le Togo. Ces pays se retrouvent régulièrement au sein de l'Assemblée Générale et du Conseil d'Administration.

Plus d'une centaine d'organisations paysannes sont nées ou ont été fortifiées par ce système d'appui dans des contextes politiques et administratifs souvent hostiles. Toutes ont appris à valoriser leurs ressources en comptant avant tout avec leur propre force; il y a eu des efforts d'investissement des groupements villageois pour mettre en oeuvre des activités génératrices de revenu, comme par exemple, le petit élevage, le maraîchage, l'artisanat, ou pour entreprendre des opérations d'intérêt commun comme l'épargne-crédit, la mise sur pied de petites unités de transformation, ou encore la construction de diguettes anti-érosives et de retenues d'eau,...

Dans des pays comme le Burkina-Faso, le Mali et le Sénégal, ces organisations paysannes ont profité depuis les années 1990 du climat d'assouplissement politique, et acquis suffisamment d'expériences et de maturité pour se fédérer et devenir plus revendicatifs dans leurs contextes d'affirmation respectifs. Les perspectives annoncées de décentralisation vont constituer un nouveau terrain de négociation.

PHASE DE TRANSITION : 1992 - 1994

Pour faire face aux exigences internes et externes de son évolution, l'Association Internationale Six"S" s'est réunie pour définir des nouvelles orientations mieux adaptées au contexte actuel (Atelier de Bobo-Dioulasso de juillet 1992). Le débat, guidé par l'analyse des défis qui se présentent et se présenteront dans les années à venir au monde paysan d'Afrique, et par la nécessité de constituer une force paysanne organisée capable de faire progresser les intérêts du monde rural, a formulé la finalité de Six"S" de la manière suivante :

> "Aider à l'émergence des mouvements associatifs paysans en Afrique de l'Ouest et les accompagner dans la recherche de la maîtrise de leur propre développement."

Cherchant à s'adapter à ces nouveaux contextes, l'Association Internationale Six"S" a consulté ses partenaires du Nord et du Sud avant de décider d'entreprendre en 1993/1994 des études et analyses diagnostics sur les mouvements paysans du Burkina-Faso, du Mali et du Niger pour mieux situer son rôle et ses services dans les

années à venir. Il était en effet capital pendant cette phase de transition de recueillir des informations pertinentes, d'échanger régulièrement avec ses membres pour pouvoir organiser en novembre 1994 une Assemblée Internationale Extraordinaire décisive pour l'avenir de l'Association.

Les études réalisées dans les trois pays d'intervention Six"S" se sont penchées sur les thèmes ci-dessous et ont recueillis les résultats suivants :

- **la configuration des organisations paysannes** :1) Le paysage des organisations paysannes au Burkina-Faso se présente comme un **paysage touffu** (la majorité sont d'anciens groupements "ORD"; près du tiers sont des groupements Naams. On y trouve des "Groupements de jeunes agriculteurs", des "Coopératives" et des "Coopératives d'épargne et de crédit") 2) Au Mali, le processus de démocratisation libère brutalement un **fort processus d'éclosion** (à côté des formes organisationnelles classiques, apparaissent des formes inédites d'organisation comme le GIE, Syndicats agricoles,...) 3) Les groupements de paysans relancés grâce aux appuis de Six"S" ont consolidé les unions et créé la première fédération du Niger, **MORIBEEN**. Mais les différentes organisations de base ont actuellement très peu ou pas de liens entre elles.

- **aspirations des organisations paysannes** : Valorisation de l'identité paysanne et prise de responsabilités dans les orientations politiques et économiques concernant le monde rural;

- **défis actuels rencontrés** : Environnement (dégradation), social, (démographie, avenir incertain pour la jeunesse) économie (diminution de l'aide financière), politique (démocratisation, décentralisation);

- **Atouts ou forces pour relever les défis** : Importance numérique, motivation des membres, mobilisation, entente et solidarité

- **faiblesse des organisations paysannes** : mauvaise gestion, difficultés organisationnelles, manque de compétences, dépendance financière, méconnaissance des textes, analphabétisme

- **besoins d'appui** : Valoriser les ressources locales, gérer les ressources financières, formuler des propositions et négocier dans les instances de décision, valoriser les expériences acquises (savoir-faire technique,...)

La méthode adoptée a également offert l'opportunité aux représentants d'associations paysannes d'organiser une rencontre nationale. A cette occasion, les auteurs des études ont pu restituer les résultats de leurs travaux.

AU BURKINA-FASO

L'environnement associatif étant plus complexe et diversifié, c'est à un comité composé de 5 organisations paysannes qu'incombait la responsabilité de la Rencontre Nationale. Cette rencontre a donné l'occasion d'échanger sur les résultats de l'étude-diagnostic, et de réfléchir ensemble sur les contraintes mais aussi sur les défis qui se présentent au monde rural. Des commissions ont été mises sur pied pour aborder des thèmes cruciaux, comme par exemple : la dégradation de l'environnement (eau, fertilité des sols, type de semences,...), l'élevage, l'artisanat, les activités socio-économiques,... Une aspiration à une meilleure représentation au sein des instances

AU MALI

C'est un comité ad'hoc composé de différentes sensibilités d'organisations paysannes qui a organisé la Rencontre Nationale. Elle a aussi permis aux organisations paysannes de se connaître, d'échanger leurs expériences, et d'aspirer à une meilleure représentation au sein des instances décisionnelles. Le résultat escompté peut être la fédération prochaine des organisations paysannes pour la défense de leurs intérêts, notamment en ce qui concerne les défis (défis économiques, politiques et environnementaux).

AU NIGER

La Rencontre Nationale a été organisée par la Fédération du Niger, MORIBEEN. Elle a donné l'occasion à tous les représentants d'organisations paysannes de réfléchir sur les voies et moyens pour mieux exploiter toutes les potentialités de ces organisations et pour renforcer leur présence auprès des instances décisionnelles. Grâce à cette rencontre, de nombreuses organisations se sont créées depuis lors.

PERSPECTIVES DE SIX"S" POUR LES ANNEES A VENIR

Considérant le paysage socio-économique du milieu rural analysé dans les études-diagnostics et considérant les apirations des organisations paysannes exprimées lors des Rencontres Nationales et lors de l'Assemblée Internationale Extraordinaire de leur Association, Six"S" agit en qualité de structure d'appui et ceci dans deux domaines prioritaires : valorisation des ressources locales et organisation et structuration. Le but étant de renforcer les mécanismes de solidarité paysanne, de favoriser l'intégration des rapports et de promouvoir la valorisation des ressources locales. Pour le monde rural ce sont des défis qui doivent se traduire dans :

1) l'engagement dans de nouveaux choix de production et combattre la dégradation des sols et de l'environnement,

2) la recherche de nouvelles formes de "service",

3) la création d'organisations de contrôle, ou de défense des intérêts ruraux,

4) la présence dans les cadres de concertation.

Pour l'Association Six"S", ces défis constituent son nouveau programme de coopération et de développement articulé autour de cinq volets principaux :

1) Volet "Caisse d'épargne et de crédit"

2) Volet "Production végétale et animale - commercialisation"

3) Volet "Organisation de la vie associative"

4) Volet "Formulation /négociation de programme et recherche de financement"

5) Volet "Identification et création de réseaux de compétence"

ANNEXE

CAS DU BURKINA - FASO : LES GROUPEMENTS NAAM ET LA LUTTE CONTRE LA DESERTIFICATION

La Fédération des Unions des Groupements Naam est une association nationale autochtone de 4700 groupements répartis sur tout le territoire du Burkina-Faso dans 1147 villages.

Vivant dans un pays Sahélien, le problème le plus crucial et actuel, préoccupant les groupements Naam est la dégradation de l'environnement et ses effets bien imbriqués : dégradation du couvert végétal, appauvrissement des sols, baisse de la production vivrière, famine, pauvreté,...

Pour la résolution de ces problèmes, la FUGN accorde une place primordiale aux activités de reconstitution du couvert végétal.

Elle a développé avec les groupements de base et les populations rurales des approches en matière de gestion des ressources naturelles. La stratégie consiste à amener les populations à prendre en charge les activités de protection et de reconstitution du couvert végétal en les sensibilisant et en mettant à leur disposition des connaissances, des techniques qui leur sont accessibles et appropriées.

Le principe de base est de partir des savoir, des savoir-faire du milieu et les améliorer ou innover

A cet effet, la FUGN a créé deux cellules techniques : la cellule hydraulique et la cellule agroforesterie qui encadrent les activités des groupements selon deux axes prioritaires : **protection et restauration de l'environnement.**

1) La conservation des eaux et des sols : a) les diguettes (ce sont des cordons pierreux d'environ 20 à 30 cm de hauteur placés le long des courbes de niveau pour retenir la terre et ralentir l'écoulement de l'eau permettant ainsi une meilleure infiltration), b) les digues filtrantes (ce sont des sortes de murs en pierre libres pouvant atteindre 1,50m de haut et 100m de long: On les réalise en présence d'une ravine ou d'un passage privilegié d'eau), c) le zaï (le zaï est un mot mooré originaire du Yatenga. Il s'agit d'une technique traditionnelle permettant de transformer des terres devenues incultes en nouveaux champs. Elle consiste à faire des trous d'environ 40 cm de large et de 20 cm de profondeur dans lesquels on met du compost ou du fumier recouvert d'une mince couche de terre. Ensuite, au moment propice pour le semis, un léger coup de pioche dans chaque trou de zaï permet d'y enfouir les graines de céréales

2) L'agroforesterie : a) construction de diguettes avec andropogon goyanus dans les zones, b) végétalisation des ouvrages de conservation des eaux et du sol par des semis d'andropogon goyanus et des plantations d'arbre ou d'arbustes le long des diguettes, des retenues d'eau, c) création de pépinières villageoises, d) construction de fosses fumières et compostières, d) tapis herbacés (la reconstitution de tapis herbacés sur des zipellés : terres indurées et dénudées permet de créer de nouveaux pâturages

Bilan et perspectives :

La FUGN a des acquis certains en matière de stratégie d'animation, de techniques de protection de l'environnement. Le plus grand capital est l'engagement des populations à résoudre elles-mêmes leurs problèmes à partir déjà des ressources et techniques locales.

Mais les difficultés existent :

- L'accès aux informations utiles n'est pas évident car nécessitant des infrastructures et des moyens financiers permanents,

- la recherche exige aussi des moyens tant matériels que financiers dont les Naam n'en disposent pas toujours et à temps opportun,

- L'environnement international apporte toujours des questions et problèmes nouveaux dont il faut toujours faire face : inventer de manière permanente de nouvelles stratégies.

Introduction méthodologique à la méthode TOPP

D Kohli

Cové Consultants

Méthode du cadre logique (Logical Framework System) ou Target Oriented Project Planning (TOPP) ou Planification Par Objectifs (PPO).

= structure logique permettant la mise en place organisée et hiérarchisée des 5 éléments clés suivants :

(1)	La Finalité	
(2)	L'Objectif	(à atteindre)
(3)	Les Résultats	(à produire)
(4)	Les Activités	(à mener)
(5)	Les Ressources (humaines, financières, matérielles)	(à injecter)

= outil de planification, mais aussi de programmation, de gestion et d'évaluation.

T()PP ⇒ structure d'opérations cohérente pour un projet ou un programme donné.

La cohérence peut être vérifiée sur 4 points :

I Les Activités, les Résultats, l'Objectif et la Finalité sont déterminés avec précision, en termes mesurables, objectivement vérifiables.

II Il y a une relation de cause à effet entre Activités / Résultats / Objectif / Finalité.

III Les Conditions critiques (ou hypothèses), qui sont les facteurs externes susceptibles d'influencer les relations de cause à effet, sont clairement identifiées et articulées.

IV Les indicateurs permettant de vérifier ou / et de mesurer le degré de réalisation de la finalité sont identifiés.

TOPP ⇔ 2 étapes distinctes : I Phase d'analyse
II Phase de Planification

puis programmation [plans d'opération, programmes d'activité]

I PHASE D'ANALYSE

Description du contexte

Analyse des problèmes

Identification du problème principal, de ses causes et de ses effets ⇒ hiérarchie des problèmes.

Analyse des potentialités

Alternatives d'action

II PHASE DE PLANIFICATION

Schéma de planification de Projet / Programme

Pourquoi....	le projet / programme est-il entrepris ?	*Finalité Objectif*
Quels..	résultats le projet / programme veut-il atteindre ?	*Résultats*
Comment...	compte-t-on atteindre ces résultats ?	*Activités*
Quels.....	sont les facteurs externes revêtant de l'importance pour le succès du projet / programme	*Suppositions*
Comment..	suivre et évaluer les activités, résultats, et objectif du projet / programme	*Indicateurs*
Où.....	trouver les données nécessaires au monitoring, au suivi, à l'évaluation	*Sources de vérification*
Par quels moyens..	mettre en oeuvre les activités	*Ressources Intrants*

QUELQUES DEFINITIONS

Finalité (ou objectif global)
Etat futur positif ou Objectif global supérieur que l'intervention devra contribuer à atteindre D'autres projets/programmes ou activités contribuent également à la réalisation de la Finalité

Objectif (ou objectif spécifique)
Etat futur positif caractérisé par des bénéfices durables pour le groupe cible visé par l'intervention et dont les prémisses doivent se manifester pendant la durée de l'opération.

Résultats
Produits des activités entreprises qui constitueront ensemble l'objectif (spécifique).

Activités
Travaux que l'intervention doit exécuter pour obtenir les résultats.

Indicateur Objectivement Vérifiable
Données opérationnelles des objectifs et résultats; l'IOV tient compte des groupes-cibles, de la qualité, de la quantité, du lieu et du temps.

Sources de Vérification
Indication de la provenance et de la forme des informations sur la réalisation des objectifs et résultats.

Suppositions (= hypothèses) (= conditions critiques)
Conditions importantes pour la réussite de l'intervention, mais non maîtrisables par le projet/programme lui-même. A définir pour les activités, les résultats et l'objectif spécifique.

QUELQUES ASPECTS IMPORTANTS

Quelles leçons pouvons nous tirer des expériences du passé, dans le domaine des différents réseaux ou programmes internationaux de recherche agronomique?

1. Les mécanismes de planification, de suivi (monitoring) et d'évaluation jouent un rôle très important. Dés le début d'un programme, il faut prendre en compte ces mécanismes.

2. L'impact des programmes et des réseaux est généralement limité à cause de l'absence d'une composante de Transfert de Technologie ou à cause de liens trop faibles avec le monde rural et les services techniques.
   Il est recommandé d'inclure le transfert de technologie comme une composante fondamentale du dispositif.

3. La coopération entre programmes et réseaux est souvent trop faible. Il en résulte le risque de duplication et de sous utilisation des ressources.
   Il faut donc rechercher une meilleure collaboration et la complémentarité entre les programmes.

4. La durabilité des programmes est parfois critique. Pour remédier à cela, il est recommandé de :
   * concevoir les nouveaux programmes ou réseaux comme un mécanisme de collaboration entre les membres et non pas comme une nouvelle institution.
   * mettre en place des mécanismes qui permettent de réactualiser les priorités en fonction des expériences.

* veiller à ce que les financements extérieurs jouent un rôle de complément, sans se substituer aux financements propres.

5. La plupart des réseaux ou programmes sont définis par discipline ou par culture. Les aspects liés à la gestion des ressources naturelles ne sont pas suffisamment pris en considération..

QUELLES PRE-CONDITIONS POUR LE SUCCES ?

A Consensus sur :
- les problèmes
- la hiérarchie de ces problèmes
- les objectifs prioritaires.

B Des mécanismes clairs et explicites de planification, suivi, évaluation, et circulation de l'information.

C Structures simples et opérationnelles pour :
- l'exécution
- la coordination
- le suivi et la planification
- la prise de décision

Ceci implique de connaître avec précision les compétences, disponibilités, responsabilités et tâches de chaque partenaire.

D Participation étroite des différents acteurs impliqués : centres régionaux, NARS, ONG, monde paysan, services techniques,... en vue de mettre en place dès le début des dispositifs d'échange et de transfert.

LES ETAPES DU PROCESSUS

PHASE D'ANALYSE, DIAGNOSTIC

Session 1	Besoins et possibilités des programmes de gestion des ressources pour enrayer la dégradation des sols. Perspectives nationales et régionales.
Session 2	Impératifs en matière de recherche appliquée. Perspectives internationales.

PHASE DE PLANIFICATION

Session 3	Concevoir une approche efficace pour la recherche. Bases de la planification.
Session 4	Mécanismes institutionnels.
Session 5	Renforcement institutionnel et ressources humaines.
Session 6	Propositions pour la poursuite du processus.

Matrice de Planification de Projet

	Description sommaire	Indicateurs Objectivement Vérifiables	Sources de vérification	Suppositions
FINALITE				
OBJECTIF				
RESULTATS				
ACTIVITES				

Presentation from the Intergovernmental Negotiating Committee for a Convention to Combat Desertification

G de Kalbermatten

Coordinator for Policy and Programme Development
Intergovernmental Negotiating Committee for a Convention to Combat Desertification (INCD)

(Salutations and greetings from the Executive Secretary of INCD)

The elaboration of the International Convention to Combat Drought and Desertification in countries experiencing serious drought and/or desertification, particularly in Africa, is meant to bring about a sort of "new deal" between members of the international community, development practitioners, and the local population, to reverse land degradation in arid lands, particularly in Africa. I am pleased to report that 87 countries, mostly African and OECD countries, signed the Convention on 15 Oct 1994 in Paris. Today the number of signatories has reached 94. Gathering the statutory 50 ratifications for the Convention to enter into force may take 2 years. In other words, the first Conference of the Parties would take place in 1997. Of course, the resolution on urgent action for Africa reminds us that action cannot wait. The task ahead during the interim period is considerable, and the stakes are high. At the signing ceremony, donors indicated that at least US$1-2 billion would be available for the implementation of the Convention during the interim period. Some of those resources could and should be devoted to sponsoring more innovative and participatory approaches in strengthening or launching integrated research on marginal drylands.

The ICRISAT proposal for a systemwide ecoregional initiative can be seen as an early attempt to implement some key provisions of the Convention, such as Article 17 on Research and Development, Article 18 on Technology, or Article 19 on Capacity Development, and would be of considerable interest for the Committee on Science and Technology, as foreseen in Article 24.

This is why we are grateful for the opportunity to participate in this Workshop and benefit from the collective wisdom of this group. Our Secretariat has a mandate for circulating information and facilitating the implementation process of the resolution on urgent action for Africa.

Allow me to start with a few remarks of a more general nature.

Today, it is recognized that there is much more to desertification than the containment of moving sand dunes. It is difficult to grasp the full impact of the loss of the agroecological balance in arid lands, but it is safe to say that desertification may interact with climatic variations, that it implies the potential genetic erosion of the plants, animals, and microorganisms constituting the biological diversity of dryland environments, and that it deeply affects the socioeconomic conditions of the local population.

The impact of consequent hardships and erosion of cultural integrity cannot be overemphasized. For instance, the Almeria Symposium organized by the Government of Spain and INCD in February of last year explored the relationship between desertification, migration, and conflicts, and found environmental casual factors characteristic of the drylands in almost half of the 50 or so armed conflicts which were raging at that time. This kind of causal linkages may announce the ominous consequences of the scarcity of renewable resources in a planet which is likely to be home to 9 billion human beings in the next 50 years. And this, while at present 900 million people are at risks of desertification. The drafters of the Convention have recognized the complexity of the challenge and have proposed to meet it with a holistic approach.

This Convention can be visualized as a five-storied pyramid. First, the ground floor, the local level which is crucial for our purpose and I will revert to it; then the national level; at the subregional level, it would be IGADD for eastern Africa; then the regional level, concerning the African continent; and finally the top of the pyramid, the global level, where the Secretariat of the Desertification Convention is located. The four last stories must be understood as a superstructure to serve the first one, the local level, the field in affected areas where the impact of all planned measures must ultimately be felt. The task before us is to take the action down there.

One might describe this Convention in various manners. It is the first significant multilateral instrument to be adopted after UNCED in 1992. It integrates environment protection with a more sustainable and human development. It balances the interests of the North and the South in meeting the expectations of the latter with respect to the global management of natural resources. It provides donor countries with an enhanced convergence of operational policies and the needed framework for integrated strategic planning. It identifies the primacy of the fight against poverty to restore degraded land. Without pretending to innovate in the technical aspects of the combat against desertification, the Convention draws the - sometimes bitter - lessons of past experiences to propose another way of managing natural resources. It anticipates the people-centred approach to development that will be one of the foci of the forthcoming World Summit for Social Development (Copenhagen, Mar 1995).

In a sense, the Convention is probably the first legally binding international instrument that replaces so clearly the notion of aid with the one of partnership. No more supply-driven initiatives down the one-way street of financial flows, but an exchange among all, which should maximize the potential of everyone. Early and consistent coordination of assistance is a direct consequence of the Convention's provision. This partnership, of course, associates the government, the NGOs, and the local communities with the international donors. We can summarize it in one sentence: no partnership in the outcome without a partnership in the process.

The key feature of the implementation of the Convention is the launching of a genuinely consultative and participatory process which gathers all concerned actors of the civil society in affected countries. The commitment of local populations and a greater decision-making power to decentralized authorities are considered to be necessary conditions for a more sustainable impact of planned action. The perception of the end users must be integrated up front in the programming phase. Ideally, the Convention should be implemented through a multiplicity of integrated initiatives which firmly base at the local level all aspects of the combat against desertification, including, of course, needs assessment, identification of constraints, response strategies, training, and research.

It is important for international partners, in the meantime, not to confuse matters by sponsoring an entropic multiplicity of strategic planning frameworks that overlap with each other, stretching thin Government resources, confusing local authorities, and discouraging intended beneficiaries. Indeed, we must achieve a homogeneous planning framework to combat desertification that will integrate the multidisciplinary areas of concern listed in the ICRISAT proposal for a systemwide ecoregional initiative.

The shaping up of this mechanism at the national level is described in Article 18 of the Regional Implementation Annex for Africa, which could be said to be the implementation edge of the Convention. The resolution on urgent action for Africa, in its operative paragraph

8, reaffirms the priority of partnership arrangements at national and subregional levels in the affected African countries. These partnership arrangements, covering agreed-upon NAPD, involving medium-term capacity-building and investment programmes, can become privileged platforms for developing integrated research on marginal drylands in collaboration with the respective national agricultural research systems.

How can the ICRISAT initiative be built in the process?

Desertification is about the degradation of arid lands and related natural resources potential, a complex process that still needs to be much better understood, but which certainly includes a broad range of parameters with a crucial focus of multidisciplinary research. International partners may intervene at all levels: more globally through early-warning systems, the collection and standardization of basic data sets, or the development of mapping systems. They can launch specific initiatives at the regional or subregional levels. They may usefully intervene in all their traditional technical fields while promoting institutional strengthening, capacity-building, and technology transfer. And they can do much more.

In order to reach the intended beneficiaries of the Convention, priority must be given to participatory ecodevelopment programmes, in French "du type gestion des terroirs" in affected African countries. These programmes would include on-the-ground research in the eight major categories of activities proposed in the ICRISAT initiative. How can we ensure the interest and involvement of the local people? The message is: research must be integrated with development activities providing direct and early benefits. These programmes may remove the pressure of vulnerable groups on the fragile environment by diversifying their economic options. The concept proposed is to exchange the demand-driven programe inputs which meet the immediate, self-identified socioeconomic needs of the population against their active commitment in longer-term activities beneficial for the environment. Such activities identified during the INCD preparatory process include the following, for instance:

1. Linear plantation of fodder on arable land and migratory routes combined with rotational grazing.
2. Village forestry schemes integrated in farming systems.
3. Development of alternatives to forest products, including alternative sources of energy and changing designs and material for housing and fencing.
4. Research and development on fast-growing tree species suitable for dryland afforestation.
5. Community-based seed collection, storage, and distribution of indigenous multipurpose trees.
6. Forest protection schemes against pests and fires.
7. Strengthening of national institutional capacity for wildlife protection.
8. Regulation of the consumptive use of the wildlife resource and promotion of nonconsumptive use of wildlife resource through income-generating activities.

All these areas would benefit from the ICRISAT initiative.

This list cuts across sectors as diverse as forestry, range management, or tourism. Perhaps it suggests that we must follow a cross-sectoral critical path, and that desertification must be approached from various angles. If so, the comprehensive NAPD would provide a relevant framework for coordination at the local level. It is also interesting to note that the type of

measures proposed by the population during the INCD case studies (in Botswana, Mali, Uganda, Tunisia) often combine the fight against desertification with income-generating opportunities at the local level.

Let me add, Mr Chairman, some concrete information on the steps that should now be taken by affected countries.

It is of course important that we should not reinvent the wheel: the Convention builds on past experience and existing planning frameworks. Basically, as a first step, Governments are expected to designate an appropriate national coordinating body to function as a catalyst at the national level in the preparation, implementation, and evaluation of the NAPD. The Secretariat of this body, functioning as a national focal point, is usually located in the Ministry of Environment, Rural Development, or Agriculture.

The national focal point will then be to:

* review in the light of the Convention the institutional and budgetary measures to be taken by the State;
* convene a broad-based consultative process with the civil society and international partners;
* undertake a participatory assessment of past and current action and proposed implementation strategies;
* organize a national forum to formalize the interactive process leading to the convening of a consultative group in which partnership agreements would be concluded.

These arrangements will determine the financing packages to fund the NAPD, including their research components.

In this last research we should work together with those responsible for the DMI to better establish the interface between research in arid-land degradation and investment programmes that will be of interest to finance institutions such as the development banks, the FED, or IFAD. This is a task of overriding importance. We may think about targeted research projects, in- situ conservation programmes, production of valuable dryland products (resins, gums, pharmaceuticals) or the selective support for dryland nature reserves, and view these activities as integral parts of dryland ecosystems conservation.

An overview of crop and animal production and land degradation in Botswana

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Background

Botswana lies between latitudes 18° and 27° south and longitudes 20° and 29° east, with a land area of about 576 000 m^2 and rainfall ranging from 650-700 mm and 150-200 mm in the extreme north and south west respectively. However, the catchment areas of the Limpopo river in the east, often receive 400-500 mm rainfall annually (Sims, 1981). The rainy season usually starts in October and ends in March, but the variation in the amount of rainfall, distribution and onset of the rainy season is high. Summer temperatures range from 23-28 °C, with high potential evaporation and low humidity. The winters are cold with possibility of frost in certain areas and temperatures varying between 15 and 20° C during day time and falling drastically at night to below zero at times.

While 60-70% of the country is covered by Kalahari sands, the rest is comprised of sandy loam, loamy, heavy and in some cases stony and shallow soils. Natural fertility of the soils is low and soil texture is poor, with the non- Kalahari soils becoming hard when dry and causing runoff (Darkoh, 1989). Under ground water is the major source of water for drinking and watering livestock. **The major agricultural activities include mixed farming of both livestock and crops, primarily to distribut risks, but livestock seem tobe predominant.**

Crop Production

Botswana is largely a pastoral country, with less than 5% of the country suitable for rainfed agriculture(Darkoh, 1989). However, about 45 % of the population do not own any cattle and as such arable farming is still important for this sector of the population. The cropping system is at best traditional, catering for subsistence needs of the majority of the rural population. With commercial crop farming accounting for a small percentage of the arable farms. The important dry land crops are, sorghum, millet, maize, cowpeas, melons, and groundnut. These are often grown as mixtures under traditional cropping systems, with very little changes towards sole cropping which is advocated by the Ministry of Agriculture.

National crop production trends over the years are difficult to determine due to fluctuations in rainfall patterns often influencing the area under cultivation nation wide. The cultivated area increases in years of good rainfall and declines when drought is experienced or threatening. According to the 1990 crop statistics, the average area under cultivation between 1981 and 1990 was 272 000 hactares. Presently this area may have

decreased drastically due to drought.

Production levels have remained low over the years, mainly due to drought, bad cultivation practices, low soil fertility, breakdown in soil structure, erratic rainfall, loss of moisture and low yield potential of the cultivated varieties and crops especially under low moisture conditions. The high evaporation and day temperatures in summer and low night temperatures at other times are not conducive to good plant growth and yield. However other contributory factors are persistant drought, low humidity, low organic matter and soil capping which causes poor emergence and thus low plant populations.

Livestock production

Botswana's livestock sector is characterised by an extensive beef production based on communal grazing/ traditional system, and with a limited freehold/commercial sector(Darkoh, 1989; Ministry of Agriculture[1], 1991) which account for only 0.9% of the cattle farms in Botswana. Commercial ranching was encouraged through the establishment of the tribal land grazing policy(TGLP). However, these ranches are seen as just the extension of the traditional cattlepost system since their management is no different (MoA[1], 1991). Even with the provision of leasehold cattle ranching, the communal areas still hold about 86 % of the national herd.

Performance under both communal and freehold systems has provided valuable information on the role of management on production, in this case calving and off-take since livestock production in Botswana is predominantly for the support of the beef industry. Under the traditional/communal system, the calving percentages are as low as 47.3% as compared to 74.8 % in commercial ranch conditions(Ministry of Agriculture, 1990) and offtake of 8% and 17 % respectively (Ministry of Agriculture[1], 1991). These statistics reflect on management since reproductive performance is influenced by the nutritional status of the livestock. Under communal rangeland system, livestock are dependent on the veld for food, and during the dry periods of the year or after prolonged drought, grazing is usually poor, depleted and of low quality, thus affecting livestock performance. Lack of controlled grazing, and range management in communal areas poses a problem of quality and quantity, especially during the dry season.

Digestability and crude protein content are also identified as the major factors influencing live weight gain of grazing animals during the dry season(Ministry of Agriculture[1], 1990). The grasses in Botswana are characterised by low levels of phosphorus content especially in the sand veld areas which holds the largest livestock numbers. It is therefore not surprising that performance under communal areas is comparatively lower than the commercial areas where supplementation and dry season feeding are practised.

Cattle mortality during favourable weather conditions is about 12% in communal areas and 5% in freehold farms, but can rise to about 22 % for communal areas in a drought year (Ministry of

Agriculture[1], 1991).

Smallstock is important in subsistence farming where sheep and goats are often kept for home use. Observation of livestock populations during drought years seem to suggest that smallstock can withstand drought better than other types of livestock, however, this information has not encouraged commercialisation to any great extent. Over 80% of smallstock population is in the communal areas (Ministry of Agriculture[1], 1991), where husbandry methods remain poor resulting in high mortality rates, low birth rates and offtake. The trend is not any different from that of cattle. Other types of livestock which have increased significantly over the past few years are poultry and pigs.

Traditional agricultural system do not have specific emphasis on conservation of natural resources, thus a high risk for land degradation can be expected.

Land degradation

In Botswana, land degradation is recognised as a major threat to the economy and the environment, thus numerous efforts have been directed at preventing and reversing land degradation where possible. The main causes of land degradation is overgrazing, but arable farming, deforestation (especially that caused by collection of firewood and veld fires) and wildlife contribute to some extent (Ministry of Agriculture[4], 1994). Indicators of rangeland deterioration such as bush encroachment, invasion of shrubs of low nutritive value or unpalatable species, and reduced plant cover are common in the rangelands (Ministry of Agricuture[3], 1990). By virtue of its fragile natural environment, Botswana, has a fair share of the natural land degradation, however, man's contribution cannot be over looked.

On the cropping side, lack of adequate crop rotation, excessive tillage, bush clearing to increase the area under cultivation and expansion of cropping into areas marginal for arable farming predisposes land to degradation. Too often fields are over-worked making them prone to soil erosion which in turn causes a decline in soil fertility. The separation of arable lands from livestock production areas also discourages utilization of manure in the fields which could otherwise help in upgrading soil physical and chemical structure.

Wind erosion can be a problem in areas where wind speeds are high, rainfall is low and vegetation sparse often as a result of over-grazing and drought. The western region is a typical example where natural forms of land degradation such as sand dune formation are on the increases. Overgrazing is particularly noticeable around watering points, and in the poorly managed ranches where there is a large scale vegetation changes and invasion by inedible or unpalatable species. Research experience has shown that land degradation is mainly due to lack of grazing management and control of stocking rates especially in communal areas and poorly managed ranches.

With increase in cattle population, there has been an expansion of livestock production into the Kalahari and other sand veld areas which were traditionally wild life areas and now

opportunities for further expansion are limited, compounding the problem of overstocking and degradation of vegetation (Darkoh, 1989; Ministry of Agriculture, 1994). The effects of Tribal land Grazing policy which was formulated to address the problem of overstocking, have been limited and overgrazing and soil erosion are still a problem in Botswana.

Persist drought compounds the effects of poor farming practices, with dust storms being a common feature all over Botswana, natural forms of land degradation such as sand dune formation are being observed in different parts of the country(SADCC. 1987, Ministry of Agriculture[2], 1991.

Future Research needs and opportunities

There has been a lot of effort devoted to the development of projects intended to address the problem of land degradation in Botswana (TGLP, sand dune stabilization, Sloca to mention but a few). However, little attention was given to soil erosion and conservation in research especially in testing and adapting imported technologies/ methodologies prior to implementation, thus prevention of land degradation and reclaimation efforts were frustrated. Major issues in arresting problems of land degradation lies in management of natural resources and better intergration of crops, livestock, wildlife and humans in promoting conservation. The socio-economic implications of all these activities need to be understood before embarking on any projects to curb the problem of land degradation.

Promotion of food production towards food security at national and household level should be accompanied by conservation components which will be part of crop, range, livestock improvement and soil and water management. Indications are that, exotic varieties and animal breeds with high yield or superior performance under experimental management often fail to achieve the same under farmers conditions, because their potential can only be realised profitably under high management as compared to the landraces.

Maintaining genetic stocks of crops and indigenous livestock for increased use in breeding is prerequisite. Indigenous livestock have been shown to have better adaptation to harsh climatic conditions, and ability to better utilize the limited poor feed resources and have resistance to a range of diseases(Ministry of Agriculture[3], 1990). Instead research should concentrate on increasing the total genetic merit of the Tswana cattle for beef production through improved reproductive and growth rate, maternal performance and calf survival. This should be augmented by development of management strategies to enhance the genetic capabilty of the indigenous stock.

In some areas, research findings have shown that stocking rates are more important than grazing systems (Ministry of Agriculture[3],1990), thus for a livestock country like Botswana emphasis should be on both aspects of range improvement and maintenance of optimum livestock populations for the type of fragile environment in question.

Alternative energy sources with emphasis on agroforestry, solar power, utilization of coal should be explored to reduce fire wood collection for home use. Investigations into use of any type of manure in restoration of fertitilty and prevention of soil erosion through better agronomic practices such as crop rotation, soil and water conservation and incorporation of crop residues are necessary.

Veld products as a potential undertaking for areas that are marginal for crop and livestock production should not be overlooked.

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Desert margins in Kenya: definition and characteristics in the context of agriculture

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INTRODUCTION

Kenya is located approximately between latitudes 4°21'N and 4°39'S and longitudes 34° and 42°E bisected by the equator and longitudes 38°E. It occupies an area of 582,646 km^2 with 13,393 occupied by water masses of inland lakes. The country is characterized by diverse climatic variability ranging from permanently snow capped mountains with rainfall exceeding 2000 mm per year to ecological deserts with rainfall of less than 250 mm in a year. However, the humid part of the country is small. Eighty percent of the country is semi-arid or arid lands, which may be considered as desert margins. Approximately 25 percent of Kenya's 25 million people and 50 percent of the livestock are found in these desert margins. Desertfication processes of land degradation such as accelerated water and wind soil erosion, deforestation and chemical degradation have been shown to threaten the livelihood of the population living in these lands. In addition these processes threaten the biodiversity of both the biota and the flora.

This paper defines the desert margins of Kenya, in the context of the use of these lands for agriculture (crop and livestock production). The physical, climatic and land use characteristics of these lands are also outlined. Further, the paper describes some of the human induced constraints and suggests an initial approach to solutions in order to restore

or maintain the productivity of these lands while at the same time preserving the biodiversity of both the flora and the fauna.

AGRO-CLIMATIC

The term agro-climate implies climate in relation to growing of crops (agriculture) is used. Agro-climatic studies cover long term studies of rainfall, temperature, evapotranspiration, humidity, solar radiation, sunshine and winds all of which are important to plant growth and agriculture. When other factors of natural environment such as relief, vegetation, and soils are included the term agro-ecology is used.

In Kenya, several attempts have been made to defines zones of agricultural potential based on ecological factors of climate, soils and vegetation. These attempts are in various details depending on the available information. Early attempt by Edwards (1940, 1956) were based on interpretation of vegetation using indicator species. Later in 1966, these results were combined with calculated moisture indices using Thornthwaite's water balance method (Thornthwaite, 1948) to produce the first maps of agroecolocal zones of East Africa (Pratt and Gwyne, 1966). The water balance method is based on monthly average rainfall and evapotranspiration. Hence this study were based on rainfall, evapotranspiration and vegetation.

Currently, the widely uses systems are those of Sombroek etal (1982) and Jaetzold and Schmidt (1983). Sombroek etal used the ratio of annual average rainfall to evapotranspiration as well as temperature to arrive to 8 agroclimatic zones and 9 temperature zones in Kenya. Jaetzold and Schmidt combined these parameters with a water balance to calculate the length of growing period and to arrive at 8 major agro-ecological zones in Kenya.

The extent of various ACZ identified by Sombroek etal (1982), is shown in table 1. The high temperature and low r/Eo ratio zones are the desert margins of Kenya. These are zones with r/Eo % of less than 50 and average annual temperatures of more the 16 °C.

This constitutes about 83 percent of the country.

Table 1. Extent of agroclimatic and temperature zones in Kenya

Ave. Annual Temperature		24-30	22-24	20-22	18-20	16-18	14-16	12-14	10-12	<10	Total	Percent
Temperature Zone		1	2	3	4	5	6	7	8	9		
r/Eo %	ACZ											
>80	I	-	-	0.53	0.52	0.53	0.25	0.35	0.2	0.16	2.54	4.36
65-80	II	0.02	0.05	0.61	0.4	0.45	0.51	0.28	0.06	-	2.38	4.09
50-65	III	0.23	0.07	0.58	0.49	0.65	0.48	0.07	-	-	2.57	4.42
40-50	IV	0.48	0.36	0.84	0.45	0.59	0.15	-	-	-	2.87	4.93
25-40	V	3.23	1.94	1.46	1.26	0.84	-	-	-	-	8.73	15.00
15-25	VI	9.54	2.7	0.24	0.16	-	-	-	-	-	12.64	21.72
<15	VII	26.3	0.17	-	-	-	-	-	-	-	26.47	45.48
Total		39.8	5.29	4.26	3.28	3.06	1.39	0.7	0.26	0.16	58.2	100.00
Percentage		68.38	9.09	7.32	5.64	5.26	2.39	1.20	0.45	0.27	100.00	

CHARACTERISTICS OF DESERT-MARGINS OF KENYA

Geomorphology

Much of the desert margins in Kenya is characterized by erosion uplands, plateaus and plains underlain by either Precambrian Basement system or sedimentary rocks. These land forms occur across the country from the coastal region to the plans and ecological deserts of the northern districts. Lithology is highly variable but the desert margins of Kenya excludes the high lying areas above 1800 m ASL.

Plateaus are predominantly of erosional origin but noneroded volcanic uplands and plateaus occupy a smaller proportion of these areas. The erosion uplands are occasionally interrupted by river valleys and high relief hills and mountains of either volcanic origin or underlain by resistance Basement System rocks. They have variable relief intensities but not exceeding 300 meters. Plains and plateaus have mostly very low relief intensity and some are also dissected by river valleys and hills.

Rainfall, evapotranspiration and temperatures

Rainfall in the desert margins of Kenya is less than 850 mm per year, erratic and unreliable. The arid and very arid areas occupy 68 percent of the countries as shown in table 2. These are areas in which rainfall below long term annual average is received in more than 1 out of every three seasons. Rainfall is predominantly bimodal with one season receiving slightly higher rainfall than the other.

Table 2. Average annual rainfall in the desert margins of Kenya.

Agroclimatic zone	% of country	Av. annual rainfall (mm)	1st season (mm)	2nd season (mm)
IV (Semi-humid)	5	700-850	250-350	250-300
V (Semi-Arid)	15	550-700	150-300	150-200
VI (Arid)	22	300-550	100-200	50-150
VII (Very Arid)	46	200-300	Unpred.	Unpred.

Average annual evapotranspiration in these areas exceed 1500 mm. This is low in the higher lying areas with average daily temperature of less than 16 °C but more than 2000 mm in the lower lying windy areas with average daily temperatures of more than 24 °C.

Land use

The major land uses in these areas are:

(i) Mixed rainfed arable farming and semi-extensive grazing
(ii) Irrigated farming
(iii) Predominantly extensive livestock production (nomadic pastoral and ranching)
(v) Wildlife game reserves, parks and ranches.

The mixed rainfed farming and semi-extensive grazing is practiced predominantly in the semi-humid and the semi-arid areas. This consistsof mainly small scale subsistence farming in which crops are produced together with a few livestock (cattle, sheep and goats) grazing in the open but

restricted areas. There is permanent cultivation in the much higher rainfall areas but farming is mainly of shifting type of cultivation. However due to population pressures and land tenure systems, fallow periods have been reduced considerably. There is also, to a less extent production of monocultures of wheat, and barely in the higher lying cooler areas.

Irrigated farming is practiced in the plans at the vicinities of the major rivers of the country. These are mainly gravity feed types of irrigation but there are a few overhead systems. Unfortunately irrigation schemes have a record of failing in the country.

Extensive livestock production, wildlife games reserves parks and ranches are found along each other in the arid and the very arid areas where rainfall is insufficient and too unreliable for arable farming. Shifting cultivation is also practiced by some of the farming communities.

HUMAN INDUCED CONSTRAINTS

If we admit that the natural ecological conditions of climate are natural phenomena beyond the control of the human race, we can enlist the problems in the desert margins as those that are caused by the human race itself, either internally or externally. These are condition or practices that damage these environments, associated with the inhabitants of within or without the areas. Some of the critical ones prevalent in Kenya are discussed here.

Population pressure

Population growth in Kenya has been one of the highest in the world since the 1970s. This has caused a high population pressure not only in the high and medium potential areas but also in the desert margins. In addition to the normal population growth, there has been a tendency of migration from the high rainfall areas, where percapita land has become very small, to the desert margins where there is still room for settlement. The increasing population demands more food and other basic needs. In an agrarian society as the Kenyan society, the demand is strongly felt on the land. In the fragile desert margins with low resilience, such pressures can not be accommodated. The settlements require more infrastructure such as roads and housing. These cause concentrations of rain waters of the already erratic rainfall, and cause accelerated soil erosion. The increasing households also requires fuel. The only available source of fuel in most

of these areas is wood. Wood is, therefore, removed at a rate that it can not regenerate. The result is removal of the soil cover causing desiccation and accelerated water and wind erosion. Whether rainfall decreases or not, the effectiveness of the rainfall is reduced because little infiltrate into the soil to be taken up by plants and produce biomass.

Landuse

Closely associated with the increasing population is the land use systems in these areas. The predominantly subsistence small scale arable farming and nomadic pastoralism are all low input systems. Such systems can be practiced sustainably only within the capacity of the land with either long fallow periods or low stocking rates. As the population increases the fallow periods are reduced to lengths that do not allow the land to recover the soil fertility. As the periods become shorter, land degradation sets in causing even higher losses of the land productive capacity. In the pastoralist systems, the increasing population requires more livestock for their milk and beef. These also increase beyond the carrying capacity of the land, causing permanent removal of the vegetation and consequently, accelerated land degradation.

The immigrant population from the high rainfall areas to the desert margins are culturally farmers. They practices continuous cultivation of crops which are not appropriate for the semi-arid and arid area, causing even more stress to the environment.

Lack of appropriate technology

Because of it's complexity, the management of the desert margins require special research. While much research has been conducted on the utilization and management of the higher rainfall areas this has not been so for the desert margins, especially in Kenya. These areas have been neglected not only in research but also in development. This is understandable because, the population that has inhabited the area has been small. Secondly many researcher do not want to work in the area because of the harsh climatic conditions. The gap in knowledge of the area is, therefore immense. Even the distribution of meteorological or agro-meteorological stations in the area, despite the erratic nature of parameters such as rainfall, is very low. There is very little understanding of the dynamics of not only the climatic systems in these areas but also the social, cultural and institutional setting. There is hardly any understanding of how the inhabitants, who

comprised the people, domesticated livestock and wildlife coexisted for a long time in the past without necessarily damaging the environment. Although it is evident that the productivity of these environments has declined significantly and there are indications that the much desired biodiversity is under serious threat, not solutions or practical interventions have been found. It is not exactly established whether climatic conditions have changed and if so the cause of the changes. We are, therefore, devoid of adequate appropriate technologies for the management of natural resources in these areas.

CONCLUSION

Desert margins occupy such a large proportion of Kenya that their management and utilization is of utmost importance. These land have immense potential which if well utilized will be beneficial not only to the inhabitants but also to the country. There is a conflict between agricultural development and natural resource and biodiversity conservation and preservation in these areas.

Even on the basis of equity the Kenya society is obliged to invest in the research and development in these areas. However, currently the environment, biodiversity and the overall productivity of these lands is under serious threat by various forms of degradation. Desertification processes are immense and active. These areas are now the buffer area for the growing population causing even further pressures on the fragile and ecologically unproductive environments. They can easily be rendered totally unproductive and even if they don't become climatic desert, they could be ecological deserts.

Development interventions for the area are not currently available because little is know about the environment. There has been insufficient research in all fronts of science. Investments in the area for research and development may not pay off immediately. External inputs and public investment will be required. Due to the harshness of these environments, mechanisms have to be developed to attract research and development in these areas. Extra benefits have to be provided to research and development workers.

In research and development of the area, conventional monolithic approach will not succeed. It will be necessary to understand all the factors involved such as human, society, institutional,

economic and more importantly, ecological. In other words an holistic approach will be required to every disciplinary problem. The future of development in these areas and the community inhabiting them lies in an integrated land resources research and development.

Subregional efforts in developing arid and semi-arid lands (ASALs) of eastern Africa

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Introduction:

The Intergovernmental Authority on Drought and Development for Eastern Africa (IGADD) was created in 1986 by seven Member States of Djibouti, Eritria, Ethiopia, Kenya, Somalia, Sudan and Uganda. It was a response to the periodical droughts and the scourge of desertification that had afflicted the subregion. As these phenomena were transboundary in nature, the governments of the subregion found it necessary to muster all political will and concert their effort to counteract these scourges. There was conviction that the problem of drought and desertification could not be seen in isolation but in other national and subregional environmental contexts. From our experience, it is now established that desertification is a result of natural, human institutional, legal and administrative causes. The subregional experiences further conclude that it is a function of a host of other variables often related but impossible to disentangle effectively. That understanding confirms the vision of founders of the Authority who emphasized that combating desertification was a development problem.

IGADD mandate:

The rationale of establishing IGADD is contained in the preamble to the Agreement. Here the Heads of State and Government are convinced of the need for concerted efforts to combat drought and other related natural disasters and their consequences; and affirm their resolve to strengthen their cooperation in all fields to ensure the development of the subregion. Arising from this rationale are technical and political approaches of IGADD in fulfilling its mandate. Important to note is that development issues are quasi political-technical and the thin dividing line is for clarity of functions.

a) Technical mandate

In this, the technical mandate of IGADD is primarily to focus on subregional programmes and projects where its tasks are to coordinate efforts and to facilitate fund mobilizations and contacts for these subregional activities. It uses its good offices to facilitate contacts of Member States in fund rasing, coordination, sensitization, project formulation, information exchange, research, networking and training. In all these activities it should be understood that IGADD is not an implementing agency and performs catalytic role and backstopping to national and subregional programmes. In fact IGADD interventions are based on the principle of added value out of subregional cooperation. Strengthening of subregional or national institutions for subregional use is quite consistence with IGADD operations. In this respect the strengthening of (National Agriculture Research Organisation) NARO in Uganda to coordinate Agricultural Research and the Drought monitoring center in Nairobi have been well noted success in the IGADD context. IGADD has regular annual subregional meetings of Directors of Meteorology, Meetings of Directors of Hydrology, Meetings of the Directors of Early warning systems. Plans are under way to institutionalize other Subregional Committee in different sectors of development. Suffice to say that IGADD has both the capacity to assist any organisation that requires political support to the highest level. The forum will always be there.

b) Political mandate

The original rationale had a component confirming the will to coordinate and cooperate within the subregion. It has become apparent that IGADD Summit meetings have offered unique possibilities for the readers of the subregion to discuss matters of general interest. Similarly, the Council of Ministers offer a forum for mutual exchange of information within the region not available before the creation of IGADD. The availability of these fora for general political discussions must not be underestimated. We have realized that few programmes can be realized, initiated nor implemented without political cooperation at the highest level. Similarly, activities within IGADD (workshops, training, and seminars) have created opportunities for sharing of development experiences among civil servants of all countries and for scientific exchange within government and academic circles.

The two major thrusts of IGADD:

At the creation of IGADD, the Member States prepared a Plan of Action which spelled out the main areas of emphasis. Between 1986 and 1989 the Plan of Action was reviewed with a view to sharpening the area of focus on two broad areas covering the mandate. In 1990 the Secretariat developed two strategies which forms the main thrust of IGADD activities; the Subregional Food security Strategy and the Subregional Strategy to combat desertification and protect the environment. These two strategies were further consolidated in a 5 year programme that stipulates what is achievable in the fulfilling of the mandate. During the implementation of the projects arising out of the programme, a number of assumptions, observations and problems might be relevant to this workshop.

Special focus on arid and semi arid lands:

For the IGADD subregion, IUCN (1989) concluded that from a meteorological point of view a prudent prognosis is to assume continued low rainfall totals yet anticipate periods of increased precipitation. A medium-scale farmer in Kenya concurs with this prognosis in his observation" ...that rains have become unpredictable and planting seasons confused...climatic change has affected farming in that for a number of consecutive years he has seen a gradual drop in production". From the results of research into the investment policy implication of climate change in Kenya a team of Kenyan scientists have observed mean temperature increase of 0.45 degrees C for the last 15 years. Consequently, land use strategies to accommodate such extremes may be prudent. Unfortunately there are no current IGADD subregion plans for these eventualities of climate change. This scenario is alarming given that the impacts of global warming to Kenya is not entirely different from other countries of IGADD. Investment in Research and planning oriented to this eventuality would be justified now and in the future.

The reports of dryland degradation (or desertification) largely relate to the situation in 1989/90, following a period of some recovery from a low point in 1984/85 (although Somalia seems to have had a less severe drought than the other IGADD countries in the first half of the 1980'ies). What remains overwhelmingly clear, however, is that the food productivity of the IGADD ASAL in 1990 ies falls short of the level required both to maintain elementary human nutritional standards as defined by WHO and FAO, and to maintain the social and cultural integrity of traditional land use practices, particularly those of the pastoralists.

While, the problems of insufficient productivity of the IGADD ASALs is obvious, there are good reasons to believe that permanent damage to the drylands has not taken place, and that there is scope for improvement.(Mustafa, S. 1988)

The IGADD ASALs appear not to have lost their resilience. Investment in these lands could make economic sense albeit under high natural uncertainty. This is contrary to the conclusions by some development agencies who are pessimistic of ASALs economic and ecologic performance. Several suggestions are that there was general improvement in the rangelands that following the return of the rains in 1985, although the biomass was of poor nutritional value. "the green desert syndrome". That there have been changes in species composition have been amply demonstrated (e.g. in the of the Sudan by Ahlcrona (1988) and by Suliman (1988)), the question is rather whether we are witnessing a natural succession of pioneer species that eventually will lead to a restoration of the original flora given normal weather. Reports from highly marginal areas, e.g the Red Sea Hills of the Sudan and from Djibouti, suggest that the grass cover is severely depleted and that there are few young browse trees. (Taiah, M.H. 1985)

Socio-economic issues:

As one former Secretary General of OAU once put it ".. drought, desertification, famine, food deficiencies which today afflict us must not lead us into an error of fighting the wrong battle. The purpose of the war is not to limit population but to fight poverty with all its manifestations. The true battlefield is therefore primarily social economic one. While we may be expending great amounts of money and efforts to resolve specific physico-demographic problems, our countries are getting poor and poorer". During the preparation of the two IGADD Strategies, and in assisting Member States to fully participate in UNCED and INCD process, the above sentiments were found still relevant. Evidence from various sources indicate that desertification is more than a technical problem, and for this reason a summary of a number of social economic aspects become relevant.

Population:

In 1989, over 130 million people inhabited the subregion, with the highest density in Uganda and the lowest in Somalia. The population growth rates in the ASAL areas of IGADD are probably lower than both the national averages and the overall IGADD average of 3.17 % . Unfortunately about 60% of this population is youth below the age of 25. To tap this potential for environmental protection, IGADD has formulated a subregional programme focussing on the youth with Phase I, starting with youth in Primary and Secondary schools. Furthermore we cannot divorce the population pressure in the high potential area from the low population of the ASALs since its over-spilling to the fragile lands presents both the land use problem and ethnic tensions. The population issue particularly its planning, is therefore very relevant in management of the IGADD drylands. Arising out of the recommendations from the recent United Nations Cairo Conference on population, many IGADD governments will probably develop population policies aimed at reducing the population growth, and thereby concur with the recommendations of several other UN agencies and major international donors.

Refugees, the absence of peace and security

The IGADD subregion has more refugees than any other comparable area in the world as refugees sources, sanctuaries or both. Yet none of these countries (Djibouti, Ethiopia, Kenya, Somalia, Sudan, and Uganda) have GDP mmore than US $ 400. War, civil strife, political unrest, drought and famine have created what currently is the largest refugee problem in the world, amounting to approximately 3.5 million people. This figure (a 1992 estimate, which is quite low) represented approximately 7.6% of the total subregional population. Whilst waiting for political solutions, the environmental impacts of any IGADD member country hosting a large number of refugees is both alarming and disastrous. A typical example that illustrates the magnitude and seriousness of the situation is as below:-
Estimates of rural wood consumption in a typical ASAL area indicate that the annual wood requirement for a family of five for hut construction and cooking is 3.1 m^3 per head. Assuming that the consumption of refugees would be modest and reduce it to half the normal consumption, a camp of four thousand refugees would require approximately 30 0000 m^3 annually. The standing volume of wood in most ASALs is estimated to be about 50 m^3 per ha. which implies that the typical camp of 4 000 refugees would deplete 600 ha. in the first year of establishment and 100 ha. annually thereafter! In and around refugee camps, ecosystems have been cleared of all trees and shrubs and the destruction of the surrounding woody vegetation progresses at a rate that could confirm the above estimates. In fact the inhabitants of a 4-5 year old camps have to walk for several hours to find trees and shrubs to cut.

Often spontaneously occupying marginal ASAL areas at high population densities, they compete with the local population for land, water and energy. The problem is further exercebated by migration of environmental refugees who spontaneously occupy the ASALs with their livestock and who are agro-pastoralist. We have witnessed large dust bowls and increasing inter-ethnic tensions between the refugees and the indigenous people.

In 1993, the highest body of IGADD, the Summit, concerned by the above and many other development aspects impeded by absence of peace in the subregion, formed a Peace Initiative Committee for the Horn of Africa. Various peace talks are in the process and we hope to have good results as soon as possible.

Agricultural production:

In all IGADD states there is a tendency by governments and the general public to invest in agriculture even where physiographic conditions do not allow the practice. The ultimate solution to the fragile lands problem is to raise the productivity of the high potential lands. All factor being favorable, a large agricultural surplus would create a high rate of economic development, employment, and specific development projects that benefit the vulnerable groups in the ASALs. In this respect we are pessimistic of agriculture in the ASALs because the only alternative would be through irrigation. In fact without irrigation, agriculture in the ASALs will remain at subsistence level which has proved its inability to feed the people. From its findings in the Study of Potential Population Support Capacity (PPSC) in developing countries, the FAO found out that at low levels of input use, all the IGADD member states were unable to feed their existing population from their own resources. The subregion has thus a structural food deficit. In normal years the subregion needs to import approximately

1.5 million tons of cereals. It is for this reason that we argue that alternative means of livelihood outside agriculture should be sought for IGADD ASALs.

Livestock production:

Livestock constitute the main source of food, capital and cash income for the pastoralists of ASAL and an important asset for agro—pastoralists. The IGADD livestock production has suffered very much for the last 10 years mainly due to periodic decimation by drought diseases, shortage of water and deterioration of natural pastures. Subregional ASALs have sustained periodical shocks in form of droughts with variable responses. While indicators of productivity, carrying capacity and resilience continue to be debatable, the pastoralists are moving far a id far, getting less and less. There is also a preferential shift from cattle to smaller livestock and camels. Impact and response to range degradation is not confined to pastoralist only. As a result of periodic droughts and desertification, intensified by civil strife and local conflicts, large out immigration from the ASALs and concentration of populations in small urban centers has created a class which is vulnerable, destitute and permanently relying on famine relief. It erroneously confirms the notion that equates marginal lands with poor people and poverty. Research has shown that with appropriate management and inputs the IGADD ASALs could sustain three times the present livestock population. That goal can only be achieved when there is willingness to allocate resources and proper planning to these areas. The IGADD/SIDA Dryland Husbandry Programme attempts to redress these issues especially in training, information and in enhancing the pastoral communities indigenous technical know-how.

Some of the issues that require special attention in ASALs development;

a) Data and information

The information base is too limited in all countries of the Sahelian region, and the existing documentation is weak and often unreliable. The amount of available information is diffusely scattered in different institutions, most of it outdated, in various scales and for different purposes. In most cases the country surveys are concentrated on the high potential areas which are promising with quick returns. Indeed, one basic problem that confronts most of the policy makers, planners, researchers, project formulators etc. in the ASALs is the lack of specific information when required. Therefore the need for research, geographic information networks and training remains urgent.

In this respect IGADD is in the process of establishing a regional Environmental Information System and Networks. In designing the IGADD EIS/EIN a careful discrimination and scope of information has been established. Choice of data type, method of collection, analysis, and presentation have been related to how the information will be used in policy-making or resource management. Meaningful analysis and updating will be done through dialogues between the information system managers and users.

During the creation of EIS/EIN, it has been evident that there is variances of data and information between and within countries. This variance creates problem to researchers, planners and policy makers and is largely responsible for wrong policy decisions and duplication of efforts. The worst scenarios have been where data and information from World Resources Institute has to be called upon to reconcile data sets from the same country.

b) Science and Technology transfer.

There is a general agreement that most of the interventions in ASALs have had discouraging results. At a subregional level we take interventions in terms of projects and programs as vehicles for subregional cooperation in technology transfer, human resources development, and institutional building. There should be an element of added value in subregional cooperation, with participating counties deriving mutual advantage in research information exchange, training and projects networking. Interventions in the ASALs should therefore be considered in the broad context of technology transfer in addition to the financial resources infused from outside.

Science and technology transfer/transplant presupposes the existence of an enabling environment as precondition for its diffusion and acceptance. It entails clarity in definition, basic information, and existence of the root technology, and means of technology transmission. Most of these are missing in the IGADD ASALs. The most glaring deficiency in the subregion is the poor communication infrastructure development. Although much progress has been made since the early 1960s, much remains to be done. It is noted that the communication axes were built during colonial times to connect and facilitate the drain of raw materials from the hinterland to the coastal areas for export. Indeed little has been done since independence, and little is likely to be done under the current wave of structural adjustment programs because as widely noted, the infra-structural development is their first casualty. Constraints in communication is not only limited to availability of roads and railways, but other areas of communication such as telephone, telefax, radio and other modern electronic linkages. Most of these are not only very expensive but their availability and condition in ASALs is to say the least, deplorable. Indeed it is a virtual scandal that while these facilities are becoming cheaper in developed countries, their cost in developing countries is rising. What it means in real terms is that:-

i) the extension of research results to the users is greatly impeded;
ii) exchange of information among and between researchers, and further to other development actors becomes greatly hampered.

c) Research and development:

In ASALs development biotechnology and remote sensing have particularly big potential that is grossly under-utilized. Both of them require the understanding of natural dynamics, basic information and research networks. Through biotechnology, drought resistant strains of crops could be developed but once more, their extension to the users could be impeded by poor communication. Indeed as mentioned earlier, the subregion should direct its research and development efforts to cope with the eventual drier ecosystems. This calls for conservation of biodiversity and protecting the available material from pests and diseases. On the other hand the application of remote sensing for planning and monitoring of agricultural, range management, forestry, livestock, water management and reforestation becomes necessary given that it is cost effective and has wide coverage. IGADD has therefore formulated a project on strengthening Remote Sensing Applications for Food Security, Early warning Systems and Environmental Monitoring in the Subregion. Research and development is an area that could benefit significantly from subregional cooperation and a number of areas could be of interest to this forum:-

i) promotion, research and development of under-exploited food crops in the IGADD ASALs.

ii) establishment of networks of genepools of native range pasture species for IGADD ASALs

iii) Subregional quarantine networks in the IGADD subregion

iv) Subregional animal diseases control in IGADD ASALs

d) **Institutional and policy framework.**

Since 1978 the issue of drought and desertification has been heard more through international aid agencies and NGOs efforts for funds for projects rather than from the national government themselves. The result has been frequently a mosaic landscape of donor projects activities that the recipient countries are not aware of let alone able to coordinate. However in coordination of member states effort in combatting desertification, absence of inter- donor or interagency coordination and cooperation has grossly impeded the subregional coordination. This is paradoxical since the same donors preach popular participation, unaware that their own acts are the first infringement to the principle of popular participation. Popular participation is a political consultative process in a community or nations decision making and process, and it involves both the recipient and the donor. The proliferation and funding of any imaginable project of the interest to the donor is a challenge that will be with us for a long time. However, we have observed with concern some of the consequences of the above as:

i) unsatiable appetite for creation of financially unviable new institutions to coordinate what is perceived as uncoordinated activities;

ii) sudden upsurge of networks to network other networks that seem not to have worked;

iii) duplication of efforts and thin spreading of resources; and

iv) uncalled for competition for recognition among development actors.

The UN Convention on Desertification is very clear on this issue and the coordination structures at national and subregional level form the first part of the Emergency actions for Africa. At subregional level IGADD has been assisting the Member States during the INCD negotiation and will continue to assist in the follow-up particularly in rationalizing the role of different institutions in the subregion.

Conclusion:

Despite the dismal results from the previous interventions in the drylands of the Sahel, it is important to be optimistic about the future of the ASALs. These lands are not wastelands and could be managed to productive levels. Indeed, much of the Sahelian drylands are not degraded beyond repair. Given proper economic and technological inputs guided by proper policy and coordination, most ASALs could be restored to productivity. Unfortunately, the

present level of poverty, investment in these lands is low and governments prefer investment in the high potential areas with quick and high outputs.

We are convinced that there are hopes for recovery and possibilities of economic growth in the ASALs since the physico-biological prerequisites are present. The need of harmonized national and subregional planning to guide their policies become imperative. So, whilst all the prerequisites for recovery and development of ASALs are present, the challenges to socio-economic and institutional policies to national governments remains formidable.

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SACCAR: an overview of the organisation and its activities

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Introduction

The Southern African Centre for Cooperation in Agricultural and Natural Resources Research and Training (SACCAR) is a well established organisation which is well positioned to participate, and play an important role, in regional initiatives for several Sub-Saharan countries. The organisation has a long association and close working relationship with the national agricultural research systems (NARS) in southern Africa, and considerable experience in the development and coordination of regional initiatives in agricultural research and training. In this paper, an overview of the organisation is presented including the background to its formation, mandate, objectives, activities and modus operandi. A brief description of its projects and programmes is also provided.

Background and Origin of SACCAR

The origin of SACCAR traces back to the establishment of the Southern Africa Development Coordination Conference (SADCC), a loose regional cooperation effort initially launched by nine southern African countries. At a meeting held in Lusaka, Zambia, on April 1, 1980, the heads of state and governments of Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe established a framework for joint collaboration which was to be known as SADCC. In accordance with this framework, the countries declared their commitment to pursue policies aimed at economic liberation and integrated development of their national economies, and resolved to forge economic collaboration in their productive sectors such as agriculture and natural resources, energy, mining, industry and trade, transport and communications, and tourism. As agreed, a decentralised model of regional cooperation was adopted with each member state being given the responsibility for coordinating the activities of one or two sectors. As a result, Botswana was given the responsibility to coordinate agricultural research.

In 1990 Namibia became the tenth member of SADCC followed by South Africa in August, 1994. In 1992, the members of SADCC decided to transform their loose regional cooperation effort into a treaty or more binding cooperative agreement which resulted in the formation of the Southern African Development Community (SADC).

In view of the overriding importance of agricultural research to southern African countries, it was recognised from the outset that its coordination required the establishment of a separate Commission. As a result, SACCAR was established in 1985 to provide an institutional basis for long-term research cooperation and serve as a secretariat for the Consultative Technical Committee for Agricultural Research (CTCAR) of SADC.

Mandate and Objectives of SACCAR

At its inception in 1985, SACCAR was charged with the overall responsibility of coordinating agricultural research and training activities and promoting cooperation among member states. Its original mandate was to:

- promote cooperation in agricultural research among the national agricultural research systems (NABS) of member states;
- facilitate exchange of information among the NARS;
- promote the development of human resources necessary to man the NARS; and
- promote coordination of SADC agricultural research activities.

However, following the adoption by SADCC of a renewed policy and strategy document for the development of food and agriculture in 1987, its mandate was expanded to include training of professional manpower for the agricultural sector and coordination of research on cash crops as well. In 1992, the Council of Ministers of SADC directed SACCAR to balance the development of research in food and agriculture with that in natural resources. The directive culminated in the development, in 1993, of a Regional Policy and Strategy for Food, Agriculture and Natural Resources (FANR) which amalgamated the policies and strategies of food and agriculture with those of natural resources. The essential interlinked components of the combined policy and strategy for the FANR sectors are food security, agricultural development and natural resources development.

In keeping with its expanded mandate and conformity with overall FANR policy and strategy, the objectives of SACCAR are to:

- promote and disseminate available and appropriate agricultural technology among SADC countries;
- coordinate, promote dialogue and implement studies on research policies, priorities and constraints common to all member states and initiate cooperative research projects to overcome them;

- coordinate regional research and natural resources utilisation and conservation, and establish mechanisms for integrated research in all Food, Agriculture and Natural Resources (FANR) disciplines;

- generate new technologies needed by farmers to raise production and productivity through regional collaborative projects and close liaison with national programmes;

- strengthen the capabilities of national agricultural research systems (NARS);

- promote rapid and continuous provision, interchange and utilisation of scientific and technical information;

- provide such regional support services and functions as may be necessary to assist and inform national and regional institutions; and

- promote professional training in FANR.

Activities

The activities of SACCAR can be broadly classified into core and coordination activities. Core activities are those undertaken by the organisation itself, whereas coordination activities are associated with regional initiatives which are generally executed by other organisations. Its core activities include:

- Development of agricultural and natural resources information services

- Provision of a reference centre on agricultural and natural resources research and training

- Promotion, organisation and sponsorship of in-depth studies, workshops, conferences and seminars on researchable problems common to the region

- Award of research and travel grants

- Manpower training and career development

- Impact evaluation and policy analysis

Its coordination functions are to:

- formulate, manage, monitor and evaluate regional research and training projects and programmes

- promote effective use of external research agencies by coordinating input of donor agencies and research institutions that support agricultural and natural resources research, technology generation and training

- assess regional manpower need and coordinate actions to develop training activities and manpower supply

In pursuing its mandate for promoting regional cooperation in agricultural research and training, SACCAR has adopted different models of operation. At its inception, the dominant model was based on implementation of regional projects by selected executing agencies which were tasked with managing regional initiatives. Such agencies were, and still are, primarily international agricultural research centres such as ICRISAT, IITA, CIMMYT and ISNAR. More recently, this model has been superseded by a networking approach. In a few instances such as the upcoming initiative on Strengthening of Faculties of Agriculture and Natural Resources, SACCAR itself will take on the role of executing agency. This emerging scenario demonstrates a change in SACCAR's role from that of a purely coordinating body, to one of a more active player in regional cooperation.

Projects and Programmes

The portfolio of SACCAR's regional projects and programmes is as follows:

1. Sorghum and Millet Improvement Programme (SMIP). The programme is based in Zimbabwe and executed by ICRISAT with funding from USAID.

2. Grain Legume Improvement Programme (GLIP). This programme consists of groundnut research based in Malawi, bean research based in Tanzania, and cowpea research based in Mozambique. The executing agencies are ICRISAT, CIAT and IITA and funding is provided by Canada, the Federal Republic of Germany (FRG) and European Union (EU).

3. Land and Water Management Programme. The training component is based at SACCAR and was until recently executed by a private company IPM, GmbH with funding provided by the European Development Fund (EDF) of the Commission of European Communities (CEC). Its research component is decentralised in Botswana (Vertisols), Tanzania (Integrated water techniques) and Zimbabwe (Utilisation of vleis). Components for Malawi and Zambia being developed.

4. In-Service Training in Research Management which is executed by the Eastern and Southern Africa Management Institute (ESAMI) in Tanzania and the International Service for National Agricultural Research (ISNAR). Funding is provided by USAID.

5. Regional Programme for Strengthening of Faculties of Agriculture, Forestry and Veterinary Medicine (REPSAF). An ongoing component of the programme is the development of regional M.Sc. programmes in Malawi (Animal Science), Zimbabwe (Agricultural Economics), Zambia (Crop Science) and Tanzania (Irrigation and Land Use Planning) under funding from FRG. The soon to be launched REPSAF Capacity Development Project will be executed by SACCAR with funding from the Canadian International Development Agency (CIDA).

6. Agroforestry Research which is executed by ICRAF and implemented in Malawi, Tanzania, Zambia and Zimbabwe under funding from CIDA.

7. SADC Plant Genetic Resources Centre which is based in Zambia, executed by the Nordic Gene Bank and funded by the Nordic countries.

8. Maize and Wheat Network which is coordinated from Zimbabwe, executed by CIMMYT and funded by the EU.

9. Regional Vegetable Research Programme which is based in Tanzania and executed by the Asian Vegetable Research and Development Centre (AVRDC). Its training component is funded by FRG.

10. Southern African Root Crops Research Network (SARRNET) for cassava and sweet potato which is executed by IITA in collaboration with CIP and funded by USAID. The project is based in Malawi with collaborating scientists in Mozambique, Tanzania and Zambia.

11. Southern African Agricultural Information Network (SAAINET) which is designed to strengthen SACCAR's information services and promote information sharing, exchange and dissemination throughout the SADC region.

In addition to the above, a number of other projects have been developed and are awaiting the availability of funding before implementation.

Conclusion

In summary, SACCAR represents a well established regional organisation which could play a useful role in the Desert Margins Initiative. However, of its member states, only Botswana presently appears to be considered eligible for the Initiative. There is a possibility though, that some of its other member states, in particular Namibia, might be considered eligible as well.

Will this Convention make a difference and how can NGOs contribute to this?

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One of the main reasons why the Plan of Action to Combat Desertification produced disappointing results has been a top down approach. The people whose livelihoods were affected by desertification and drought were rarely consulted or involved in the implementation of the plans. NGOs emphasized this when they participated as observers in the INCD negotiation process towards the Convention. That fact was recognized by the INCD. As a result, in terms of popular participation this Convention is unique because it acknowledges that desertification needs to be tackled primarily at the national and local level. The Convention is not very prescriptive about action to be taken by local communities. The point of departure seems to be that people in the communities know the causes of desertification and they know what needs to be done to combat it. Government policies can either hinder, or assist them. Direct Government intervention is not the best means to tackle the problem. Instead an enabling policy environment is needed within which land users can plan, manage and invest in their land.

The Convention is a commitment by the international community to create such an enabling environment for local communities. This is clearly stated in the first principle of the Convention which says that "the Parties should ensure that decisions on the design and implementation of programmes to combat desertification and/or mitigate the effects of drought are taken with the participation of populations and local communities and that an enabling environment is created at higher levels to facilitate action at national and local levels".

So, as far as peoples participation is concerned the Convention provides a very promising starting point.

How do NGOs fit in this scenario? NGOs have experience with community participation on the project level. The role of NGOs is to act as very active intermediaries between the government and the communities. This requires building partnerships with governments because the governments need to facilitate the legislative and policy-making infrastructure that is needed for community participation. I would like to single out three concepts mentioned in the Convention in which NGOs and Governments need to cooperate:

1. National Action Programmes
National Action Programmes are the cornerstone of the Convention. The Convention stipulates that National Action Programmes shall:
(f)provide for effective participation at the local, national and regional levels of non-governmental organizations and local populations, both women and men, particularly resource users, including farmers and pastoralists and their representative organizations, in policy planning, decision-making, and implementation and review of national action programmes;

2. The Convention mentions the establishment of National Coordinating Mechanisms in which NGOs should be involved. These mechanisms would ensure the efficient use of all available financial resources. This provision in the Convention puts NGOs in a strategic position to promote community oriented approaches.

3. National Desertification Funds
The Convention suggests the establishment of National Desertification Funds in which NGOs participate. The National Desertification Funds are meant to channel financial resources rapidly and efficiently to the local level.

So the Convention contains several mechanisms for NGO and Government cooperation aiming at facilitating community participation. However, these mechanisms will only materialise at the national level if the NGO community in a country is aware of the Convention and the opportunities contained in there for NGO and community participation. It is important to realize that from each country maximum one, sometimes two NGOs have been involved in the INCD process. Most countries did not have a NGO representative at all.

The few NGOs that were involved in the INCD face the enormous task bringing this Convention home and to the communities. They cannot do this on their own. Therefore they first need to motivate the wider NGO community in their country to join forces.

For these reasons the NGOs that have been active in the INCD process have established a network called RIOD.

RIOD stands for Reseau international d'ONG sur la Desertification. Through RIOD we hope to mobilize many more NGOs to become active in implementing the Convention. The network will also accomplish that new ideas and approaches develop much faster because the thinking process is a collective one.

RIOD is a communication mechanism that is composed of focal points at the national, sub-regional, regional and global level. The focal points are the communication nodes through which the participating CBOs and NGOs will be interlinked in a worldwide network.

Focal points are existing NGOs that have the capacity and are adequately positioned to fulfil this role of intermediaries between the various levels of NGO activity

The RIOD network is unique in its objective of bridging the gap between a Convention that has been negotiated at the inter-governmental level and the people at the community level. Communities have been actively combatting desertification long before negotiations on the Convention started. They will continue doing so regardless of whether or not their governments sign the Convention. In fact, most communities are not even aware of the Convention. However, the NGOs believe that the Convention can strengthen communities in their efforts to combat desertification. Through the network, NGOs aim to inform communities about the Convention and to create avenues that ensure that the affected communities can propose solutions that

will form the basis of national action programmes.

NGOs have developed an NGO Action Plan to Combat Desertification as a first step in the implementation of the Convention. This Plan includes guidelines for:
-NGOs organizing an NGO forum in each country. The purpose of the NGO forum is to inform other NGOs about the Convention, RIOD and the Action Plan;
-the formation of an NGO based committee that will take responsibility for coordinating further implementation of the NGO Action Plan (in countries where there is a national NGO council or federation the committee can be set up as part of these existing organizations);
-NGOs/CBOs organizing nation wide awareness raising campaigns;
-NGOs/CBOs taking the initiative to set up mechanisms for community consultations.

To conclude with I would like to say a few words about the consultation processes we have in mind. Consultation processes need to be designed to suit local conditions and involving people at all stages. This is not easy but also not impossible. At the local level, even within countries, there is significant cultural diversity. So what may be the correct protocol for dealing with one community may not be the same for the next. Important is that people must be given access to the process. So often incorporation of community based consultations remains hidden. Reports are written back in the office, discussion and modifications are made at departmental level and final drafts are reviewed by a few key people. What comes back to the community level often bears little resemblance to the information which was provided, resulting in lack of ownership of the implementation phase. Whereas in this technological age of portable, battery powered laptop computers, mini-printers, video-camaras and tape recorders it is possible to produce documents in the field for people to review. The results of meetings can be produced overnight and reviewed the next day. Letters from community leaders can be written on the spot and delivered with the endorsed records of the meetings. Meetings can be videoed and taped. Community consultations can be conducted in local languages and transcripts can be produced in both local and national languages. Participative processes, especially when community based solutions are being sought, must be a two way flow. People at the community level must have the opportunity to feed into the planning process in a real way. Their voice must not only be heard, it must be listened to.

Thank you.

Alleviating the consequences of agricultural drought

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INTRODUCTION

According to the United Nations Environment Program approximately 70% of potentially productive dry lands are threatened by drought and desertification. Recurrent drought is a serious constraint to agricultural production.

Ecological regions where drought recurs have been known for many centuries. Despite the frequent droughts that have affected the world's poorest countries, the global response has usually been launched only after the drought or famine has occurred.

Though various multilateral, bilateral and non-governmental organizations and development agencies have been involved in emergency relief, and others in research related to agricultural drought stress, there seems to be no orderly and systematic assembly of information based upon the relevant agencies' experience. Nor does there appear to be an internationally organised program to plan and prepare for future droughts which, though difficult to predict with precision in future time, will inevitably recur in the regions most frequently affected. The past pattern of reacting after drought has reappeared, is wasteful, uneconomic and allows immense suffering among those directly affected.

Against this background and with encouragement of the Canadian International Development Agency (CIDA), the Canadian Hunger Foundation (CHF) and the Agriculture Institute of Canada (AIC) convened a meeting at the World Bank in Washington on October 24, 1994 during Centres Week of the Consultative Group on International Agricultural Research (CGIAR). Sixty three representatives of fifty two concerned institutions attended. Annex 1 lists attendees as well as interested parties who were unable to attend. The range of interest includes: the International Agricultural Research Community, Donor Governments, Foundations and Funding Organizations, Northern and Southern NGOs, United Nations Agencies, International Financial Institutions, and Southern Governments.

The meeting supported the need for a systematic mechanism to better apply the experience of science and research to the realities facing the poor living in zones of recurrent drought.

CHF and AIC accepted to launch a feasibility phase for a Drought Alleviation Initiative given the:

i) Apparent high level support for the concept.
ii) Willingness of key stakeholders to serve as a Feasibility Advisory Committee
iii) Potential for financial support to ensure the study will achieve desirable results.

The maturing of Governmental, NGO and Intergovernmental relationships provides new opportunities for synergy. CHF, as an example, experiences this in its current role on the

NGO Advisory Committeee to IFAD, its working group role with the World Bank, in its relationship with FAO, in its business with the Inter-American Development Bank and in its ongoing joint programs with Northern and Southern NGOs and NGO coalitions. CHF intends to draw on these involvements and networks to foster NGO partipations in this initiative.

The Agriculture Institute of Canada complements this initiative with its technical expertise. AIC has consulted with its members and committees where agreement has been given to form a technical advisory group to help guide this initiative.

OVERALL GOALS

To alleviate the consequences of agricultural drought by:

- Bridging the farmer in the field with the opportunities and benefits of science, indigenous knowledge, technology and drought - tolerant farming systems.

- Establishing post-production systems that ensure safe protection, together with economic, technically efficient and equitable distribution of the products of crops and livestock.

FEASIBILITY PHASE

This document's primary focus is on the feasibility phase, where the goals are:

- To formulate an indicative plan of action, for achieving the overall goal, by determining the elements, instruments, modalities leadership requirements, together with the essential operational, material and human resources.

- To examine the opportunities by a case study at an ecologically suitable location.

OVERALL OBJECTIVES

1.0 To promote an international realization that agricultural drought is a critical issue for international development; not an inevitable, irremediable disaster.

2.0 To integrate drought alleviation as a discrete component of the international desertification program. Ecologies left unprotected from, and unprepared for recurrent drought stress will eventually be abandoned, uninhabited and deserted; literally transformed into deserts.

3.0 To investigate the feasibility and practicality of creating an international cooperative drought alleviation program, to determine the manageable scope and to propose a schedule for implementation.

FEASIBILITY GOALS

To explore the feasibility of an international drought alleviation program to include appropriate governmental and non-governmental agencies of relevant experience and resources.

To determine the feasibility of establishing and maintaining an international information network to acquire and analyze practical knowledge and understanding of agricultural drought, and thereby to propose courses of collective and situation specific action to enhance the capabilities of nations and communities prone to drought stress to survive and to be supported by sustainable systems of food security.

FEASIBILITY OBJECTIVES

The feasibility phase will have eleven objectives:

1.0 To consult with and engage those governmental and non-governmental organizations interested in investigating the concept.

2.0 To establish a feasibility advisory committee comprising multi-disciplinary and multi-stakeholder interest. A preliminary list of organizations willing to serve on an advisory committee appears as Annex 2.

3.0 To identify the underlying issues and precisely define the elements pertinent to this initiative.

4.0 To design an indicative approach and operational methodology for Information Acquisition and Dissemination with the capacity to:.

4.1 Acquire and analyze pertinent scientific and indigenous knowledge along with the operational experiences of implementing organizations including NGOs and government extension services.

4.2 Determine "best practice" regarding information acquisition and dissemination.

4.3 Advise on organizations or coalitions of organizations interested and capable of meeting these requirements.

4.4 Propose national and international mechanisms necessary to achieve these requirements.

5.0 To determine practical mechanisms for implementation at the field level including:

5.1 Analysis of current constraints to farmers accessing appropriate knowledge and agro-inputs, including but not limited to socio-cultural, policy and economic factors.

5.2 Ease of access to information and requirements for training of NGO and government extension workers.

5.3 Institutional capacities that require strengthening.

5.4 Operational funding of extension institutions including NGOs.

5.5 Adaptation of relevant, applicable results of research and technology to specific agro-ecological circumstances.

5.6 Evaluation of potential early warning systems.

5.7 Planning, acquisition, distribution and management of strategic reserve stocks in drought-prone regions; methods of supply and finance including revolving funds for local and foreign contributions.

5.8 Technological remedies worthy of adaptive research.

6.0 To develop a management plan including:

6.1 Formulating mechanisms to integrate multi-lateral, bilateral, foreign NGO and other donor efforts.

6.2 Establishing national and international linkages with NGOs and government services within each agro-ecological region and country.

6.3 Activating a two tier mechanism. The first, aimed at safe-guards against drought and the second, at pre-determined approaches for orderly response when drought returns.

7.0 Soliciting input to the proposed initiative from a wide cross section of currently interested organizations as well as potential participants not as yet introduced to the concept.

8.0 Determining the initial geographical scope for the initiative and the associated level of effort and resources required. Indications are to focus on Africa due to the recent re-occurence of drought and famine and resulting donor, scientific and human imperatives for action.

9.0 Formulating and assessing the cost of initial actions that can be used to solicit the necessary funding.

10.0 Identifying an International Steering Committee with the responsibility of defining policies and priorities to govern the initiative and thereafter to monitor its implementation.

11.0 Identifying the ongoing management systems and services needed to ensure coherence and coordination.

COLLABORATION

At the highest levels the world recognizes the environmental threats to our common future. No individual initiative can rise to these challenges in isolation.

"Alleviating the Consequences of Agricultural Drought" is an initiative complementary to the work of others. It is a practical initiative that will serve to strengthen national and international commitments and global agreements.

Accordingly this initiative will be designed and its strategies assessed in relationship to the Desertification Convention and the Desert Margins Initiative.

PRELIMINARY SCHEDULE OF WORK

Dec 1994

- Solicit funding for Feasibility Phase
- Seek input to Feasibility Plan
- Recruit members of the Feasibility Advisory Committee
- Establish mini-secretariat in CHF for Feasibility Phase

Jan 1995

- Finalize Feasibility Objectives and Work Breakdown Structure
- Develop detailed Workplan
- Attend International Planning Workshop on Desert Margins Initiative in Nairobi (January 23-26)
- Launch data gathering activities

PRELIMINARY SCHEDULE OF WORK (Cont'd)

Feb-Apr 1995
- According to Workplan
- Preliminary report for presentation to CGIAR mid year meeting

May 1995
- Progress Report to CGIAR mid year meeting May 22-26, 1994, Nairobi
- Workplan adjustments

Jun-Sept 1995
- Finalize feasibility phase document
- Distribute in September in preparation for International Centres week

Oct-Nov 1995
- Discussion with delegates to the 50th Anniversary activities of FAO in Quebec City, Canada
- Presentation for direction and approval at CGIAR annual meeting in Washington October 28-November 1, 1994
- Preparation of Final Plan of Action and distribution to potential funders
- Other follow up actions

COORDINATION

The concept for an initiative to alleviate the consequences of agricultural drought was initially brought to the Canadian Hunger Foundation and the Agriculture Institute of Canada by Dr Joseph Hulse. With the subsequent support of the Canadian International Development Agency (CIDA) and interest by the International Development Research Centre (IDRC), the initiative was tested with various individuals and organizations. The resulting interest has provided the critical level of interest to warrant undertaking a feasibility plan.

Responding to this interest, the Canadian Hunger Foundation has assumed an initial convening role and will provide the necessary coordination/secretariat services during the feasibility period. This function is being provided with the collaborative support of the Agriculture Institute of Canada.

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Session 2: Generic Research Imperatives: International Perspectives

Session 2: Exigences de la recherche générique: perspectives internationales

Presentation of the background document

M V K Sivakumar

Director, Soils and Agroclimatology Division
ICRISAT

The current interest within CGIAR in natural resource management research in the context of ecoregional initiatives has already been described in the Opening Session by Dr. J.G. Ryan. We started assessing the value and desirability of initiating a major research program related to the desertification issue in June 1993, just around the time the INCD negotiations on the Desertification Convention got under way. Following our consultations with UNEP on the preparation of DMI, UNEP engaged Dr. Wolfgang Baier of Agriculture Canada as a Consultant to prepare the background document after extensive discussions with the NARS, NGO's, Regional Organizations and associated International Agricultural Research Centers.

During February-March 1994, Dr. Baier travelled to Kenya (for consultations with NARS, IGADD, UNEP and ICRAF), Ethiopia (ILCA), Niger (ISC, INRAN), Burkina Faso (INERA, CNRST, NGOs), Botswana and Namibia. He submitted his final report end of April 1994 which was modified in August 1994 after receiving comments from several of the interested partners in the initiative. A copy of the revised version of the background document, which we submitted to the Technical Advisory Committee of CGIAR for their review, has been sent to all of you along with our invitation letter in September 1994. In this presentation, I wish to highlight some of the salient points of this background document.

The Desert Margins Initiative emphasizes a bottom-up, participatory approach. In the limited time at his disposal, Dr. Baier consulted several of the NARSs, NGOs, IARCs, regional organizations and SPAAR, but these consultations were by no means complete. Let me emphasize that the purpose of the background document was to highlight the current understanding of the sustainable natural management options to arrest land degradation in the desert margins of sub-saharan Africa that could be used to guide our discussions during this International Planning Workshop. Certainly, there will be other options that some of you, specially the national research programs and NGOs, recognize as being important for your specific conditions. This Workshop provides the opportunity for a comprehensive discussion on our proposal and decide on the best course of action.

Desertification according to article 1 of the International Convention on Desertification, is defined as land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. By land degradation we mean the loss of biological or economic productivity resulting from land uses or a combination of processes including those of human activities and habitation patterns, such as soil erosion caused by wind and water erosion, deterioration of the physical, chemical and biological or economic properties of soil and long term loss of natural vegetation. Since land degradation is the basic problem we are addressing, let me amplify this aspect a bit further.

The assessment and characterization of the soil resource base indicated that the soils of sub-Saharan Africa are inherently low in fertility which is expressed through their low levels of organic matter, total nitrogen and effective cation exchange capacity. The nutrient base of soil is being progressively depleted through more intensive cropping without fertility restoration. Progressive deforestation, desertification, erosion, improper farm management, overgrazing, biomass burning, and numerous socio-economic constraints threaten the environment and contribute to alteration of the global climate. Currently, some arable agricultural systems are not sustainable as a result of declining soil fertility and deterioration of the physical conditions and accelerated soil erosion by wind and water. The practices of fallowing to maintain and generate soil productivity is decreasing and grazing land are diminishing as more lands are brought under cultivation. Population growth and periodic drought are pushing farmers and herders to exploit marginal lands. As land deteriorates and/or is at the limits of its livestock carrying capacity, farmers and herders migrate southward in search of better natural resources.

We know from the existing data in the Sahel that wind erosion is increasing in its intensity, as indicated in this slide, where the number of days with visibility < 5 km has shown a siginificant increase in the 80s in comparison to the 70s and 60s. In the beginning of the rainy season, enormous amount of sand gets lifted into the air and is transported over long distances due to wind erosion. This can significantly affect the establishment of crops and in some cases lead to mortality of the young seedlings. Due to poor soil and water management practices, significant amount of rain is lost as runoff through water erosion and can lead to soil losses of upto 20 tons per hectare thereby affecting the productivity of the land. On a global scale, 3.6 billion hectares or 70% of the potentially productive drylands are currently threatened by desertification, mostly by the degradation of the natural vegetation partly accompanied by serious deterioration of soil. In Africa, some 1.3 billion ha comprising arid, semi-arid and dry sub-humid areas support a population of about 400 millions or two thirds of the African continent. Desertification threatens these areas at a moderate or high degree. It has been estimated that about 72% of the African arable land and 31% of the pasture land has already been degraded as a result of soil erosion. Dr. Andre Bationo is going to elaborate on this issue in his presentation later in this session.

Hence in combatting desertification as per article 1 of INCD, we include activities which are part of the integrated development of land for sustainable development that are aimed at prevention and/or reduction of land degradation, rehabilitation of partly degraded land and reclamation of desertified land. This then is at the heart of the Desert Margins Initiative.

The overall objective of this initiative is to arrest land degradation by promoting improved and innovative technologies that integrate effective nutrient management strategies with improved soil and water conservation techniques that are ecologically sound, economically viable and socially acceptable to farmers in the dryland areas of Sub-Saharan Africa. Through this objective, we also are addressing article 2 of INCD which emphasizes long term integrated strategies the focus simultaneously on improved productivity of land and conservation and sustainable management of land and water resources.

To halt the trend of land degradation, subsistence agriculture must be replaced with systems that promote higher production per unit area and per person on a sustainable basis. These systems should be based on improved soil and water conservation practices and integrated nutrient management methods including the use of organic manure, inorganic fetilizers, crop residues and crop rotations with legumes.

A review of the state of art of the research on integrated soil fertility management in the region shows that on-station research has shown promising results but very few of these technologies have reached the small scale farmers. Too little account has been taken of farmers' views, of indigenous knowledge, of social and economic realities, and of enabling policy environment. Therefore, future research should focus on involving researchers, farmers, extension agents, non-governmental organizations and government policy makers at the design, implementation and evaluation stages. This way the technologies generated have a better chance of adoption by the small scale farmers.

It is for this reason that this Initiative brings together national agricultural research programs and NGOs from Botswana, Burkina Faso, Kenya, Mali, Namibia and Niger along with a number of International Agricultural Research Organizations, regional organizations CLISS, SADC-SACCAR and IGADD and other organizations such as IFDC, IBSRAM, USDA-WRS, UK-NERC etc. This sort of multi-institutional, multi-regional and multi-disciplinary collaboration is one of the principles of INCD which emphasizes improved cooperation and coordination at subregional, regional and international levels and by better focussing financial, human, organizational and technical resources.

The specific objectives are to develop a better understanding of the extent of land degradation through water and wind erosion and through mining of soil nutrients in the traditional crop production systems in the desert margins and the impact of and distinction between causal factors, both natural and human with a view to combat

land degradation and achieve improved productivity as well as sustainable use and management of soil resources. We need to evaluate with the participation of farmers, NGOs, and NARS, past and current indigenous and improved soil management programs for arresting land degradation in order to identify the causes of misuse and design effective strategies and elaborate activities to test improved options to enhance soil resilience in the desert margins.

We need to overcome negative nutrient balances and increase biomass at the farm level through developing integrated systems of nutrient management incorporating use of locally available agrominerals combined with recycling of manure/urine from livestock, crop residues, city wastes, farmer acceptable agroforestry systems and crop rotations involving the use of legumes to improve biological nitrogen fixation. Another specific objective is to combine improved, farmer-acceptable, soil and water conservation techniques such as stone bunds, wind breaks, hedge rows, field ridges, etc., with the integrated nutrient management systems to enhance soil resilience.

Livestock movement across the arid and semi-arid boundaries exploits the different seasonal potential of pastures in these two zones. Hence evaluation of the role of livestock in the ecological and economic linkages between arid and semi-arid zones in order to control land degradation and loss of vegetation biodiversity in the arid zone is an important issue. Adoption of any improved technologies at the farm level needs presence of effective policies and we need to identify, evaluate and assist in the design of policies that will enhance the adoption of improved soil management options for greater soil resilience.

The overall success of this initiative depends on a long term and sustained effort by NARSs and one of the specific objectives is to enhance the institutional capacity of the participating countries in the project for land degradation research and extension of the improved technologies, with particular attention to multidisciplinary and participative socio-economic research.

Research proposed in this initiative focusses on rainfed crop and livestock production in the dryland areas receiving between 100 and 600 mm rainfall per year, often poorly distributed. Depending on the rainfall amount and distribution, mixed cropping or livestock production is dominant. The arid zone, receiving between 100-400 mm of annual rainfall, lying between the semi-arid and the desert zone, is an important livestock producing region (transparency). This transparency shows the different rainfall zones Africa. We are emphasizing the the 100-400 mm zone shown by the green color and the 400-600 mm zone shown by the blue color. By the selection of appropriate benchmark locations in the six countries during this workshop, we hope to target our research to a range of agroenvironments.

Activities in this initiative fall into eight major categories. We propose to concentrate on characterizing the biophysical and socio-economic constraints of the current land-use systems with particular attention to the parkland systems, livestock feeding and soil conservation systems. Diagnostic studies will be conducted to provide a better understanding of the traditional management options for soil fertility maintenance and soil conservation systems and the socio-economic benefits of these systems to the resource poor farmers. The research would focus on the impact of policies, programs and institutional options that influence the incentives of farmers and communities to adopt improved technologies and resource conservation and management practices. Farmer adoption of the improved options is governed by a set of constraints such as lack of effective research and extension system, credit facilities for farmers and input/output dealers, input procurement, monitoring and control agencies and marketing boards. Dr. Peter Hazell of IFPRI will elaborate on this topic later in this session.

Historically there are strong trade, demographic and productive linkages between the arid and semi-arid zones. We will focus on the role of livestock in the ecological and economic linkages between the arid and semi-arid zones. Dr. Pierre Hiernaux of the International Livestock Research Institute will discuss this issue further in his presentation in this session. Lack of adoption of appropriate methods of soil and water management and lack of integrated nutrient management strategies are two major source of soil resilience problems at the farm

level. Hence one of the major activities in this initiative is to develop management techniques that enhance soil resilience and arrest land degradation. We need to assess the costs associated with loss of soil resilience and the likely impact of improved soil fertility maintenance practices at the farm level. Later in this session, you will hear Dr. Andre Bationo who will describe some of the research imperatives to arrest soil mining in his presentation.

Collection, evaluation, and selection of appropriate multipurpose forages, legumes and tree species/provenances for the parkland system, fodder production, soil conservation and wind break technologies will receive a priority in our Initiative. At the end of this session, Dr. Edouard Bonkoungou of ICRAF will describe promising indigenous agroforestry practices for improved resource management. We will also place considerable emphasis on strategic research that will contribute towards understanding the interactions between the different components so as to assist in the development of a predictive capacity for assessing the environmental benefits and long term sustainability of technologies. The activity on development and evaluation of improved technologies will draw on the output of the other activities and will focus on the development and evaluation of the long term biophysical and economic impact of alternative management strategies in crop/tree/livestock production technologies which mitigate wind and water erosion, enhance soil fertility and address the problems of fodder and fuelwood shortages.

The activities we are proposing in this initiative are consistent with the preamble statement of INCD which states that strategies to combat desertification and mitigate the effects of drought will be most effective if they are based on sound systematic observation and rigorous scientific knowledge and if they are continuously reevaluated.

Article 17 on Research and Development in the INCD also places emphasis on studies that contribute to increased knowledge of the processes leading to desertification and drought. It also stresses the conduct of joint research programs between national, sub-regional, regional and international research organizations in the development of improved, affordable and accessible technologies for sustainable development. The activity on institution building directly addresses the INCD article 19 that calls for strengthening the training and research capacity and for training in participatory approaches for the conservation and sustainable use of natural resources.

The major outputs expected at the end of the project are availability of improved, conservation-effective production technologies that would be socially and economically acceptable to the indigenous population to meet their food, fodder and fuel needs and improved methods of sustaining long term fertility in sub-Saharan Africa. Another output is improved soil and water management techniques for increasing water use efficiency and for arresting land degradation. Our activities should help improve our understanding of the impact of livestock production and cropping on vegetation composition, resilience and soil erosion in the arid zone and the economic and policy measures needed to improve management of natural resources for livestock production in the arid zone.

The multidisciplinary approach emphasized here should result in collecting minimum data sets of climate, soil and water, land use and socioeconomic variables in support of practical dryland development programs and in the dissemination of improved methodologies of climate monitoring, data capture and analysis and crop monitoring. It should also help create a better awareness among policy makers and the scientific community of the importance of multipurpose forages, legumes, and tree species in maintaining the productivity and sustainability of the fragile lands and the need to undertake the necessary measures for preservation of biodiversity in the region through effective conservation strategies. An important expected output is improving the skills and mechanisms in the national programs to undertake production systems research and provision of guidelines for the design and implementation of policies and policy tools for arresting land degradation. The background document also provides sufficient information regarding the strengths of various partners likely to be involved in the Initiative.

Acknowledgement:

I express my grateful thanks to all the national programs, NGOs, regional organizations, International Institutes and other organizations that have expressed their keen interest in participating in this collaborative initiative and for their continued support in one of the concerted efforts to address the issues raised in the INCD.

Interactions of desertification and climate: present understanding and future research imperatives

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Introduction

At the 1992 UN Conference on Environment and Development held in Rio de Janeiro, desertification was formally defined as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities" (UNCED 1992).

Desertification is now a direct threat to over 250 million people around the world, and an indirect threat to a further 750 million people. In the last 25 years, desertification has become increasingly apparent in the dry sub-humid regions of the world, where mean annual rainfall ranges from 750 to 1500 mm, and where the majority of the human inhabitants of the drylands now live. Current best estimates suggest that roughly 70 per cent of all agriculturally used drylands are to some degree degraded, especially in terms of their soils and plant cover (UNEP 1992a, b). The total area concerned is 3.5 billion hectares, and over a hundred countries are now suffering from the adverse social and economic impact of dryland degradation (Table 1).

Manifestations of desertification include accelerated soil erosion by wind and water, increasing salinisation of soils and near-surface groundwater supplies, a reduction in soil moisture retention, an increase in surface runoff and streamflow variability, a reduction in species diversity and plant biomass, and a reduction in the overall productivity in dryland ecosystems with an attendant impoverishment of the human communities dependent on these ecosystems. Additional impacts include an increase in particulate and trace gas emissions from biomass burning in drylands and an increase in atmospheric dust loads. A combination of climatic stress and dryland degradation can lead in turn to extreme social disruption migrations and famine.

Impact of Climate on Desertification

Both climate and desertification interact at a variety of scales through a complex and still only partially understood series of feedback loops. Climate has an important but often subtle influence on desertification processes through its impact on dryland soils and vegetation, on the hydrological cycle in drylands, and, ultimately, on human land use in that forty per cent of the land area of the globe classified as "drylands".

Unlike the organically rich soils of more humid regions, dryland soils often have a low organic matter content and are frequently saline and/or alkaline. As such, they are often highly susceptible to accelerated erosion by wind and water.

Both field observations and remote sensing data have confirmed very large spatial variations in dryland plant density and biomass, as well as equally important temporal fluctuations in biomass in response to seasonal and interannual fluctuations in rainfall (Tucker *et al* 1985, 1991; Nicholson *et al* 1990). This variation in time and space of dryland plant cover is well known to pastoralists in these regions, and is one dryland plant response to the limiting factors of water and soil nutrients.

A preliminary study by Dregne and Tucker (1988) used satellite NOAA AVHRR satellite imagery to monitor changes in vegetation along the semi-arid margins of the Sahara in relation to variations in annual rainfall. Later work by Tucker *et al* (1991) confirmed the earlier findings and demonstrated the highly elastic response of vegetation cover to growing-season rainfall, with the desert margin vegetation cover expanding or contracting from year to year depending on the annual variations in rainfall.

Between 1980 and 1990, the southern limit of the 200 mm annual rainfall boundary (arbitrarily taken to define the southern limit of the Sahara) fluctuated considerably, and showed significant differences between different regions on a longitudinal basis, some areas showing a high degree of variability and others very little. The rainfall boundary was based on average vegetation index values which were inferred from satellite spectral data in the red and near-infrared wavelength bands, that together provide a measure of total primary production when averaged over the growing season.

In 1984, which was the driest year this century in the Sahel, this "Normalised Difference Vegetation Index" (NDVI), which shows a statistically significant linear relation to mean annual rainfall, had the lowest value of the decade, and the Sahel/Sahara boundary was even further south than in previous years. During the dry years 1980 to 1984, the inferred 200 mm isohyet moved 240 km to the south, averaging a 60 km southward shift per year. During the next two years (1984 to 1986) the desert retreated north, 110 km on average from 1984 to 1985, and a further 33 km from 1983 to 1986. The overall conclusion of Tucker *et al* (1991) was that a study extending over decades would be required to determine whether there was any long-term expansion or contraction of the Sahara.

Impact of Desertification on Climate

Biomass burning is a common practice in the tropics and sub-tropics, and dryland fires are significant sources of atmospheric aerosols and tract gas emissions. Savanna burning contributes significantly to global emissions of soot, as well as nitrogen, carbon and ozone. It is difficult to distinguish the net contribution of dryland fires to atmospheric particulates and trace gases. Total smoke emissions from tropical biomass burning are estimated to range between 25 and nearly 80 x 10^{12}g/yr, which is comparable to estimated smoke emissions produced by fossil fuel burning (22.5 to 24 x 10^{12}g/yr). Ozone from global biomass burning furnishes 38 per cent of all tropospheric ozone. During burning, nearly half of all nitrogen in the biomass is released as N_2 causing a major loss of fixed nitrogen in tropical ecosystems amounting to 10 to 20 x 10^{12}g/yr.

While few figures exist for the contribution of emissions from burning of drylands specifically, estimates of carbon and nitrogen emitted from savanna burning are that this source contributes 30 per cent and 20 per cent, respectively (Crutzen and Andreae 1990). Given that total biomass burning contributes about 40 per cent of gross emissions from all sources (Crutzen and Andreae 1990; Cachier 1992), the contribution from dryland burning is conservatively estimated to be around 10 per cent.

Arid and semi-arid regions are widely recognised as sources for crustal-derived aerosols (dust) that are transported by the atmosphere. The impact of atmospheric dust on the surface and atmospheric energy balance is complex, and is related to its size distribution, source strength, deposition rate, extinction, scattering, absorption, single scattering albedo, asymmetry factor and optical depth of the dust. Warming generally occurs in the dust layer and cooling generally occurs beneath them near the surface (atmospheric heating rates can be 2°C per day while the surface cooling rates can be 10 to 15°C per day). The major change to the surface energy balance is a substantial decrease in incoming shortwave solar radiation in the presence of an absorbing dust layer. An important secondary change is the stabilisation of the atmosphere that occurs when dust differentially warms a layer of the atmosphere at the expense of near-surface cooling.

The overwhelming effect of desertification on the surface and atmospheric energy balance comes from disruptions to the hydrological cycle. In many cases, removal of vegetation leads to increased runoff and potential evapotranspiration rates due to higher surface and near-surface temperatures, higher near-surface wind speeds and lower near-surface atmospheric moisture levels. The increase in runoff and evapotranspiration rates then leads directly to a decrease in soil moisture and a rapid decrease in amount of energy used to evaporate or transpire water into the atmosphere. When less energy is consumed in the latent heat term, LE, of the energy balance equation, more energy is available for heating the ground, G, or heating the air, H. The Bowen ratio, defined as H/LE, typically increases in areas where desertification is occurring. These changes to the energy balance associated with modifications to the hydrological cycle, in many cases dwarf the effects associated with albedo, surface roughness and dust in the atmosphere. Phillips (1993) summarised this by suggesting that soil moisture levels in drylands are directly related to vegetation cover, precipitation and water erosion, and negatively related to albedo, temperature and aeolian erosion.

Desertification and global climatic change

First, recent warming has dominated the dryland areas. The western United States, southern South American, southern African and Australian dryland regions all show pronounced warming in this century. Warming has also occurred in the eastern portions of the Middle East and western sections of the Asia Desert region described earlier. However, a region of cooling this century is centred in the Asian deserts.

Most drylands show no statistically significant changes in precipitation levels. There is a tendency for wetter conditions both in the southwestern deserts of North America and the western deserts of Australia. However, by far the most pronounced change in precipitation levels in any of the dryland areas is seen in the Sahelian region. Here, precipitation levels have dropped sharply since the mid 1950s and the decrease in precipitation has contributed to enormous human and economic loss in the region. Recognising the need to understand the causes of the observed decline in Sahelian rainfall, climatologists have proposed many causal mechanisms that may be associated with the downward trend in rainfall. Interrelated changes in sea-surface temperatures (including linkages to El Niño/Southern Oscillation events), land-surface conditions, general atmospheric circulation patterns and atmospheric concentrations of various greenhouse gases have all been proposed to explain at least some of the variance in the observed regional precipitation levels.

The significance of future global warming for dryland climates is difficult to assess with confidence at the present time. Predictions based on many general circulation model experiments suggest that temperatures will rise in all dryland regions in all seasons. There is some evidence that the warming will be more rapid in the middle to higher latitudes. Predictions of future precipitation changes, including the impact on rainfall variability, vary widely from model to model and region to region, and consequently, the confidence limits on the predictions of precipitation changes in dryland areas are lower than those for temperature.

The predicted increase in temperature would most probably have the effect of increasing potential evapotranspiration rates in the drylands, and in the absence of any large increases in precipitation, many drylands are accordingly predicted to become more arid in the next century.

Conclusions

The single biggest impediment to quantifying the interactions between desertification and climate stems from the variable quality of the data relating to the extent, severity and trends of the various forms of dryland degradation collectively contained within the general term desertification. There is a particular and increasingly urgent need for uniform and objective methods of data collection relating to the characteristics and status of dryland ecosystems, soils, water resources, salinity and micro-climates, and for the evaluation and dissemination of such data on an integrated basis.

Although there are some excellent monitoring networks already in existence in different dryland regions, there is a very real need for the strengthening of existing centres and for the establishment of a more extensive international monitoring network with personnel equipped and trained to collect base-line data relevant to all aspects of desertification. This infrastructure would support regional analyses and the consequent detection of any long-term trends and their causes.

Notwithstanding the variable and the often poor quality of much of the primary observational data relating to the extent and severity of desertification processes, a range of well-defined human impacts on the surface characteristics and atmospheric composition of various dryland regions can now be clearly identified.

The more visible manifestations of desertification include:

- accelerated soil erosion by wind and water,
- salt accumulation in the surface horizons of dryland soils,
- a decline in soil structural stability with an attendant increase in surface crusting and surface runoff and a concomitant reduction in soil infiltration capacity and soil moisture storage,
- replacement of forest or woodland by secondary savanna grassland or scrub,

- an increase in the flow variability of dryland rivers and streams,
- an increase in the salt content of previously freshwater lakes, wetlands and rivers, and
- an overall reduction in species diversity and plant biomass in dryland ecosystems.

Not all of these processes are caused solely by human activities; short-term climatic variability, longer term climatic desiccation, and occasional very severe floods and droughts all play an important role. Furthermore, the diverse processes of dryland degradation are not all active at the same time and in the same place. For that reason, when attempting to quantify the causes and consequences of desertification it is crucial to specify which process is operating, over what area, and over what timespan. As yet, our knowledge of the magnitude and frequency of such ubiquitous processes as wind and water erosion in drylands is still very patchy and, for some regions, is altogether deficient.

Relatively slight interannual variations in sea-surface temperature leading to periodic floods and droughts reflected in ENSO events tend to be amplified in dryland rivers. As a result of the innately more variable flow regime of dryland rivers, management practices appropriate in more humid catchments may be inapplicable in the drylands. Attempts to manage dryland rivers as if they were fully comparable to their humid temperate counterparts may have an adverse impact on arid, semi-arid and sub-humid freshwater ecosystems. The aquatic biota in dryland streams and wetlands show a wide range of behavioural and physiological adaptations to the "floods and droughts" flow regime characteristic of dryland drainage systems. Artificial modification of the flow regime may negate the survival value of such adaptations.

The resilience of dryland ecosystems to innate climatic variability is becoming better understood, but we still lack an adequate understanding of the thresholds of different ecosystems to regional deficits in soil moisture and to temperature extremes and salinity. We also lack adequate information about the role of disturbance in the maintenance of long-term ecosystem viability, and the environmental thresholds above which dryland ecosystems can no longer retain their ability to cope with external stress. It is for these reasons that desertification is best defined as dryland degradation caused by both climatic variability and human activities. In practice, there will be many instances when the relative role of climate and humans in bringing about desertification remains equivocal, especially in rangelands and the more arid regions of the world. In the case of salinisation caused by faulty irrigation practices, the role of human activities far outweighs that of climatic variability.

Short-term remedial programmes for dealing with immediate problems such as soil erosion, salinisation or famine are designed to alleviate their more immediate manifestations. Of far greater ultimate value are longer term strategies which aim to attack the root causes underlying dryland degradation. Such long-term strategies must fulfil four main requirements:

- Any community action must be suited to the ability of the people directly affected by the degradation to finance and carry out appropriate conservation and restoration programmes, which often presupposes the use of relatively inexpensive, simple and appropriate local technologies.

- The nature of the degradation processes concerned must be thoroughly understood, the problems clearly diagnosed, and careful initial assessment made of the most suitable options for prevention and rehabilitation. It is no solution to resolve one degradation problem by creating new problems, such as widespread salinisation caused by irrigated shelter belts designed to stabilise sand movement.

- Long-term ecological sustainability must be paramount. Short-term considerations based solely on narrowly defined economic criteria will seldom be useful in treating the ultimate causes of dryland degradation in that they only treat the symptoms.

- The maintenance of soil quality is essential. If the soils become degraded so too will the dryland ecosystems. The ultimate viability of all dryland human communities depends ultimately on the quality of the soils and water resources which sustain the plants and animals upon which they depend.

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Recommendations

Based on our assessment of the state of science on the interactions of desertification and climate, we offer the following ten recommendations:

1. Adoption of uniform criteria and methods to assess desertification

Recognising the variable quality of the data relating to the extent, severity and trends of desertification processes in different parts of the world, we recommend that greater urgency be given to the adoption of uniform criteria and methodologies to assess and delineate dryland degradation.

2. Establishment of regional training centres to monitor dryland degradation

Further to the need for uniform assessment and mapping of degraded drylands, we recommend that an integral part of capacity building in these areas should be to strengthen existing regional facilities and establish international training centres at regional levels, for imparting training and for implementing regional programmes to assess the status and extent of dryland degradation.

3. Identification of sources and sinks of dryland carbon

An important factor relating to interactions between desertification and climate concerns the role of dryland soils and plant communities as sources or sinks of organic and inorganic carbon. We recommend that greater efforts be made to quantify the biogeochemical cycling of dryland carbon using a combination of field monitoring and applicable geophysical models.

4. Identification of sources and sinks of aerosols and trace gases in drylands

Drylands represent important sources of trace gases, and dust and other particulates associated with a variety of human activities including devegetation and biomass burning. We recommend that substantial effort be devoted to evaluating dryland sources and sinks of various particles and trace gases. Such baseline data are essential in evaluating the potential impact on climate of dryland rehabilitation projects.

5. Evaluation of dryland rehabilitation projects

The long-term sustainability of many apparently successful dryland rehabilitation projects is often poorly understood. We recommend that a cost-benefit appraisal of successful projects

include long-term ecologically sustainable principles, rather than on short-term and purely economic criteria.

6. Enhancement of regional climate monitoring networks

Given the paucity of primary meteorological, agrometeorological and hydrological data for many dryland areas, we recommend that national and regional climate monitoring networks be strengthened and expanded in all dryland regions, and that the important role of existing regional drought-monitoring centres be recognised through appropriate funding arrangements.

7. Coupling of numerical modelling studies with empirical field measurements

Our understanding of the climate impact of human activities in drylands has often been based predominantly on separate numerical model sensitivity studies and empirical measurements made in field experiments. We recommend that research programmes be encouraged which combine these two approaches. Sensitivity studies can become more realistic simulation efforts given realistic inputs regarding surface characteristics and fluxes, atmospheric composition, and other meteorological and climatological information. Combining the two approaches should yield more information on the processes which govern climate response to human activities in drylands.

8. Assessment of biogeophysical models of Sahelian drought

Interactions between devegetation, albedo changes and Sahelian rainfall have been a focus of scientific inquiry since the publication of Charney's biogeophysical feedback hypothesis in 1975. However, many of the conclusions remain equivocal. We therefore recommend that numerical simulation using realistic values of albedo, surface roughness and plant cover be used specifically to test the possible impact of changes in dryland surface cover on local and regional climates in the Sahel as well as elsewhere.

9. Application of seasonal climate forecasting in dryland management

Given the recent advances in using ocean-basin and global sea-surface temperature anomalies to predict seasonal precipitation, river flow, crop yield and possible disease outbreaks in specific dryland areas, we recommend that greater efforts be encouraged to exchange information between different dryland forecasting centres as to the appropriate methodologies for using forecast information to enhance regional dryland management.

10. Provision of natural resources information to local communities

Recognising the power of integrated remote sensing, Geographical Information Systems and other systems in cataloguing and evaluating natural resources data from drylands, we recommend that greater efforts be made to provide information in an accessible and useable form to local farming and pastoral communities. The regional centres discussed in previous recommendations would be appropriate vehicles for providing such information to local communities.

Technologies for combating land degradation in the Sudano-Sahelian region of West Africa

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According to the International Convention on Desertification (INCD), land degradation means reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land use or from a process or combination of processes, including processes arising from human activities and habitation patterns. Desertification is defined as land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variation and human activities. From global studies of the United Nations Conference on Desertification (UNCOD) it has been concluded that excluding the irrigated lands, 90% of the land in the Sudano-Sahelian zone and 80% of the land of the rest of Sub-Saharan Africa is to some extent affected by desertification.

Chemical, biological and physical land degradation are the most serious threats to food production in Sub-Saharan Africa. Intensive cropping without restoring fertility depletes the nutrient base of soils. A recent FAO study defines nutrient mining as the continual and inexorable removal of plant nutrients without replacement or compensation through fertilizer use. For example, nutrient mining in Senegal was estimated at 14 kg N, 8 kg P_2O_5 and 14 kg K_2O ha^{-1} in 1983 and are projected to be 20 kg N, 8 kg P_2O_5 and 21 kg K_2O ha^{-1} by the year 2000. For Burkina Faso, current estimates indicate that in 1983 alone, on 6.6 million ha of land cultivated, soil nutrient mining amounted to a total loss of 95,000 tons of N, 28,000 tons of P_2O_5 and 79,000 tons of K_2O, equivalent to U.S. $ 159 million worth of N, P and K fertilizers.

Results from long-term soil fertility management experiments showed that continuous cultivation of these soils has led to a reduction in the organic matter levels, decreasing base saturation, lowering of pH and occurrence of Al toxicity. Continuous cultivation also decreases the soil

microbial population. Annual burning of crop residues results in considerable loss of carbon and nutrients. It has been reported that 20-40 kg N ha^{-1} and 5-10 kg S ha^{-1} are lost by annual burning, leading to physical and biochemical degradation of soil. Most of the soil microorganisms, particularly rhizobia, present in the soil surface are destroyed by the intense heat.

It is recognized that one way to counter the climatic variations is the use of irrigation. In recent years, the productivity of many soils of the major irrigated area declined due to rising water tables, followed by an alkalinization and sodification. Today, 30 to 50% of the irrigated land in the region is affected by alkalinization and yield reductions from 4 to 4.5 t ha^{-1} in rice and 75 to 25 t ha^{-1} in sugarcane have been reported for affected areas.

Deforestation has a severe impact on land degradation, wildlife habitat and biodiversity, and only about 3% of the annually deforested area is reforested every year. For example, the annual rate of wood consumption exceeds the mean annual incremental growth by 75%in Northern Nigeria and by 200% in Niger.

Several studies on soil erosion have documented that the productivity of African soils is potentially endangered by soil erosion and it is estimated that 72% of African arable lands and 31% of pasture lands have been degraded as a result of soil erosion which is at least 10 times greater than the rate of natural soil formation. Soil lost to erosion is about 2.5 times richer in nutrients than the soil that is *in situ*.

Wind erosion is a problem in the drier areas. In the Sahelian zone, it has been reported that the coverage of millet seedlings by windblown soil severely hampers millet establishment, reduces subsequent growth, and decreases grain yield by almost 50%.

For the past 30 years, technologies for soil fertility restoration and soil and water conservation have been developed to combat land degradation. It is now well-established that land quality in the region can only be maintained through efficient use of chemical fertilizers with recycling of organic amendments in combination with effective use of N_2-fixing legumes species in rotations. The increase in biomass availability is a prerequisite for sustainable land use in the region.

Some countries in Sub-Saharan Africa have phosphate rock (PR) deposits and direct application of PR indigenous to the region may be a viable alternative to the use of more expensive imported soluble P fertilizers. Studies on the use of PR from Tahoua, Niger and Tilemsi, Mali indicate that direct application of PR is both agronomically and economically feasible. Partial acidulation of the relatively insoluble rock phosphate effectively improves their agronomic potential.

A review of ongoing research for combating land degradation shows that although on-station research shows promising results, very few of the technologies from the research stations have reached the small-scale farmer. Future research needs to focus more on reasons for adoption and non-adoption of present technologies. It is also important to study the interaction effects of different factors such as population pressure, land tenure, national economic policies, and climate change on land degradation. Data on fallow and livestock management in relation to land degradation are limited. Future research should also examine the use of alternative cropping systems to combat land degradation.

Evaluation of development projects in soil and water conservation indicates that with some exceptions, results from most projects have been disappointing because of the top-down nature

of the approaches used. The priorities and perceptions of the intended beneficiaries of agricultural technologies have not always been appreciated by project designers. Too little account has been taken of farmer's views, of indigenous knowledge, social and economic realities and the importance of an enabling policy environment. However, development projects carried out by Non-Governmental Organization (NGOs) working with farmers have already established that indigenous soil and water conservation techniques, soil tillage, mulching and agroforestry can play a key role in combating land degradation.

Therefore future research and development programs should focus on involving researchers, farmers, extension agents, NGOs and policy makers in the design, implementation and evaluation stages. This way the technologies generated have a better chance of adoption by the intended beneficiaries. While most of the research in the past has been undertaken at the plot-level, it is suggested that future research should be focussed more at the village land-use level using a multidisciplinary approach to allow cross-fertilization of ideas, knowledge and experiences.

Ecological and economic linkages between the arid and semi-arid zones: the role of livestock

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Introduction

The arid zone lies between the semi-arid zone and the desert, receiving on average 100-400 mm of annual rainfall. Its potential for agriculture is low due to the high probability of crop failure. It is an important livestock producing zone, not only because of the greater expanse of rangelands but because of the lower prevalence of important disease vectors and higher forage quality compared to the semi-arid zone (van Keulen and Breman, 1990). The productivity of arid rangelands, while spatially and temporally quite variable, show a high resilience to drought. However, the ability of these rangelands to regenerate after heavy grazing, land clearance and tillage is less well documented.

Historically, there are strong trade, demographic, and productive linkages between the arid and semi-arid zones of Africa (Lovejoy and Baier, 1975; Sutter, 1982; Little, 1983). The extent and specific nature of these linkages vary significantly between the semi-arid/arid regions of West, East and Southern Africa. Livestock movements across the semi-arid/arid boundary exploit the different seasonal potential of pastures in these two zones, thereby increasing the overall productive potential of livestock husbandry for the region. Pasture availability in the semi-arid zone is often restricted by cultivated fields and sensitive to grazing during the rainy season, while a shortage of water during the long dry season is a major limiting factor in the arid zone. In response to these constraints, a portion of the livestock in the semi-arid zone of West Africa are trekked to arid zone pastures during the rainy season, while arid zone livestock visit the semi-arid cropped zone during the dry season. These reciprocal movements benefit crop production in the semi-arid zone by reducing crop damage, increasing cash income to livestock-owning farmers through greater livestock productivity, and increasing the manuring potential of cropland during the dry season.

The past two decades of recurrent drought have shown how interrelated the development futures of these two zones are. Semi-arid cultivators, pushed by demographic pressure, expanded the cultivated front into the arid zone prior to the drought. Since the drought, there has been a reverse movement of people from the arid to the semi-arid zone, leading to an expansion of cultivated area and a shrinkage of local pastures in the semi-arid zone (Gorse and Steeds, 1987; Bassett, 1988). Concurrently, there has been a growth in the fraction of regional livestock found within the semi-arid zone due not only to movements of people but regional shifts in livestock ownership (Little, 1985; Bonfiglioli, 1990). As a result of these and other changes, there is growing concern about: a) the non-optimal and inefficient

utilization of the arid zone by existing agropastoral and pastoral systems of production; and b) the sustainability of existing agropastoral systems of production in the semi-arid zone. Three key research areas need to be investigated. The first is the identification of technologies, policies, and local-level institutional innovations directed at sustaining livestock-derived income in arid zone production systems and improving the effectiveness of indigenous coping mechanisms to production and capital shortfalls. The second is the potential for improving the beneficial interzonal interactions, in order to improve regional livestock and crop productivity. The third is the identification of livestock management practices that preserve biodiversity and resilience of natural vegetation in the arid zone and minimize land degradation caused by livestock production in the semi-arid zone.

In this document the International Livestock Centre for Africa proposes a set of six researchable issues pertaining to the three broad themes mentioned above. A brief description of the researchable issues proposed is presented below.

Researchable issues

1. Economic and policy measures to improve the management of natural resources for livestock production in the arid zone

Economic parameters (prices, incomes, interest and exchange rates) and government policies (on land tenure and resource rights, institutional organization, regional trade, etc) directly affect natural resource management (Perrings, 1989; Barrett, 1991). In sub-Saharan Africa, available evidence indicates that resource degradation is partly a function of the set of relative prices confronting resource users (Larson and Bromley, 1991). In many parts of the arid zone, state assumption of administrative rights over common property resources has reduced the ability of local communities to manage local pastures and water points and has encouraged resource degradation. A basic challenge in the arid zone is to achieve a significant and sustainable level of livestock productivity while minimizing environmental hazards. This calls for a better understanding of the environmental effects of policy choices. Research in this area can help to identify (i) environmentally destabilizing policies which need to be removed, and (ii) incentives, policies, and institutional arrangements that can be used to clarify user-group rights to specific resources.

This research will serve to reduce the confusion and uncertainty that create conditions for over use and rapid depletion of natural resources.

2. Coping mechanisms to minimize drought-induced production and capital losses in the arid zone

Prolonged drought frequently precipitates huge livestock losses in the arid zone. The decimation of livestock herds and fluctuations in food prices during periods of drought have had a major impact on rural welfare in recent decades, increasing production and marketing risks for pastoral and arable producers alike (Little, 1983; Starr, 1987). These risks are managed through a variety of strategies at the individual and communal level (Niamir, 1990; Perrings, 1993). The efficacy of these strategies, however, depends on the pervasiveness of the losses incurred and the degree of price volatility. Research is needed to gain a better understanding of (i) household objectives at times of crisis, (ii) the management of resources to meet these objectives, (iii) the limits to the effectiveness of traditional coping strategies, and (iv) to identify alternative risk management strategies.

This study will lead to the identification of policies and institutional arrangements

which can complement traditional coping mechanisms to reduce the vulnerability of arid zone producers so that they can get back into gainful production within a reasonable space of time after a period of crisis.

3. Potential for improving the security and effectiveness of seasonal livestock movements

Livestock mobility requires a high degree of cooperation among groups of relative strangers with respect to regional, ethnic, and occupational affiliation. The facilitation of livestock movements between the arid zone and the semi-arid zone involves a web of contracts or agreements including the entrustment or wage contract between livestock owner and herder, manure contracts between herders and farmers, and usufruct conventions concerning passage, water and grazing rights. These contracts are often highly insecure due to a lack of information, tractability, and enforceability. In many cases, strategic outweigh productive concerns in the choice of herd movements (Turner, 1992). Research has shown that these relationships are highly unstable with their deterioration linked to a decline in herd mobility (Barral, 1982). Measures that increase the security of these contracts will allow greater mobility, reduced local conflict, and more effective grazing strategies. Socioeconomic survey work will be conducted along key transhumance corridors to analyze contractual relationships affecting herd mobility. Elements of these relationships that weaken contract security will be identified and policy, institutional and technical innovations to resolve these problems will be developed.

Livestock mobility strategies are risky because feed and water availabilities are spatially and temporally variable and the herder information on these availabilities is not sufficiently accurate and timely. To improve the effectiveness of livestock movements there is need for a better prediction of the gains and losses in animal performance that are likely to result from each mobility strategy option. There are tradeoffs between additional energy expenditure due to long distance trekking, lower watering frequencies and better nutritional conditions (Nicholson, 1987). Although some of the component relations are well understood, others (e. g. daily grazing regimes, watering frequencies) deserve more analysis in order to build operational models of these tradeoffs for each of the main animal species. The results of such models would improve the information available to local authorities when establishing agreements and regulations to organize local livestock movements. Regionally, these predictions would facilitate national planning and interstate coordination of ordinary and exceptional (drought, disease outbreaks, war) livestock movements.

The more secure organization of seasonal livestock movements resulting from this research will contribute to optimize the benefits of livestock mobility for animal and crop production.

4. Adaptation of the arid zone vegetation to drought and grazing to better control land degradation and improve reclamation of degraded lands

Vegetation and land degradation in the arid zones follow different pathways: some are chiefly induced by climatic events, while others are caused by deforestation, cropping, and livestock grazing (Dodd, 1994). In the arid zone, natural vegetation is adapted to low and irregular rainfall conditions, and is allegedly resilient to drought (Le Houérou, 1989). However, there is a need to analyze the ecological mechanisms of the vegetation adaptation to drought in order to better guide natural resource management and the reclamation of degraded lands. Moreover, convergences have been observed in the biological and morphological adaptation of plants to drought and grazing (Coughenour, 1985). Convergences have also been noted

in the dynamics of vegetation communities subjected to drought and heavy grazing (Hiernaux 1993). These ecological similarities and their potential applications to the control of rangeland degradation and to the reclamation of degraded lands should be further investigated. The analysis of existing long-term monitoring data bases (Ferlo in Sénégal, Gourma in Mali and Oudalan in Burkina Faso, among others) will provide insights into successional pathways of natural vegetation following a drought event under different situations of grazing pressure (Carrière, 1989).

Many herbaceous (e. g. *Alysicarpus ovalifolius*, *Cenchrus ssp*) and lignaceous (e. g. *Maerua crassifolia, Ziziphus mauritiana, Acacia raddiana*) plants in the arid zone show higher genetic potential with respect to nutritive quality and tolerance to disturbance and drought than semi-arid zone species. There is a need to evaluate the genetic potential of a selection of these high-potential species. This research will help identify grazing and drought tolerant species from the arid zone that are best suited for introduction in semi-arid and sub-humid zones as means to improve forage quality and facilitate the reclamation of degraded lands.

5. Optimal stocking rates and livestock mobility patterns to control land degradation and vegetation biodiversity losses in the semi-arid zone

In the semi-arid zone, there is a need to evaluate both the environmental impact of livestock and livestock associated with cropping and forestry. At the regional level, existing monitoring data will provide some of the information needed to document the history of land use and changes in vegetation cover. At the village level, existing ecological and socio-economic surveys will permit the appraisal of the contribution of livestock to these changes. The processes of livestock impact remain however insufficiently understood for the detailed assessment that is needed to guide natural resource management. Grazing defoliation, soil trampling and re-distribution of nutrients through defaecation and urination are the main processes involved. Their effects on vegetation and soils vary with plant life-type and phenology, season and climatic circumstances, grazing pressure and animal species (Milchunas and Lauenroth 1993). For example, the vegetation response to defoliation differs between herbaceous communities dominated by annual grasses, as in the Sahel, and perennials more common in the dry savannas of southern and eastern Africa (Pratt and Gwynne 1977; McNaughton, 1985; Rutherford and Westfall, 1986). A synthesis of existing experimental work done to quantify some of these relations (O'Connor, 1985) and the development of complementary experiments are required. Priority should be given to the study of wet-season grazing effects in the semi-arid zone where the confinement of the sedentary livestock at high stocking rates on restricted uncropped lands results in a rapid decrease in vegetation productivity, radical changes in species composition towards poorly palatable species, and severe soil erosion. One output of this study would be the determination of appropriate seasonal stocking rates, at the village scale, as a function of climatic conditions, land use, vegetation characteristics, livestock prices, and labor costs (de Leeuw and Tothill, 1993). These research activities will be realized in collaboration with national partners and will take advantage of physical infrastructure available at some of the national research stations to carry out complementary experiments.

Appropriate seasonal stocking rates can guide the mediation of agreements between herders and farmers, on the organization of livestock mobility, the management of key water resources and the regulation of other resource management practices such as savanna burning.

6. Potential for stratification of livestock production

Stratification of animal production, based on the comparative advantage of the different climatic zones in west Africa, has often been advocated as a strategy for regional livestock development (Shapiro, 1979). Under this strategy, the arid zone due to its low primary productivity, high seasonal variation in feed supply, low disease incidence and high levels of animal husbandry skills would concentrate on the production of young stock. The growing-out, fattening, and production of milk will be concentrated in the sub-humid and wetter parts of the semi-arid zone, where productivity of land is relatively high and demand for animal products is expanding. Studies conducted in the late 1970s and early 1980s on livestock and meat marketing in West Africa by the University of Michigan Centre for Research on Economic Development evaluated the feasibility of specific components of this strategy, particularly in the sub-humid and humid zones. An appraisal of the potential for stratification in this region, however, demands a holistic approach combining both biological and socioeconomic research across the different zones in which the different stages of livestock production will take place. Research is needed in the arid, semi-arid and sub-humid zones to:

a) Provide correct assessments of the incentives to which different producers (pastoralists and agropastoralists) will respond. Specific issues to examine will include the extent to which current price structure and non-price variables provide strong incentives for producers to keep animals till they are old rather than sell them at a younger age; species and sex of animals sold, the volume and direction of existing trade flows, and regulations guiding transactions at important sending and receiving points.
b) Develop technological packages for increasing weaning rates in the arid zone and the drier part of the semi-arid zone. Previous research suggests that opportunities to improve weaning rates of cattle include improved nutrition during late gestation and better management during lactation. The main constraints to increased weaning rates of small ruminants appear to be the high mortality of young stock and the low lambing/kidding rates possibly owing to sub-optimal nutrition (Wilson, 1986).
c) Develop technological packages that facilitate and improve fattening and milk production in the sub-humid and wetter part of the dry zone. These packages need to include increased production and quality of feeds (forages, crop residues, fodder trees, concentrate feeds), improved efficiency of use of available feeds and better health control.

The results from these studies will help identify technologies that can increase livestock production of the entire region, i. e. the arid, semi-arid and sub-humid zones.

Concluding remarks

The listed research themes are considered to be of critical importance for sustainable interzonal livestock and crop production. Some of the proposed themes are already partially addressed by the International Livestock Centre for Africa and other national and international institutions. The Desert Margins Initiative provides an opportunity for meaningful collaborative research on these subjects.

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Household and community resource management and investment decisions and the impact of policy in the desert margins

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Desertfication, like many other forms of resource degradation, arises primarily as a result of human activities. Farmers and other users of natural resources engage in activities that have detrimental consequences for their own collective interests. For example, farmers often over-graze rangeland, deplete soil nutrients and organic matter, and remove trees that control wind erosion, even though these actions lead to reduced income earning opportunities in the longer term for themselves, their children and other members of the local community.

Why do they do this? The answer lies with incentives. Farmers are not irrational; they degrade resources when there are good reasons for doing so; when the benefits they obtain exceed the perceived costs that they, as individuals, must bear. If the management of natural resources is to be improved, then it is first necessary to understand the incentives at the household and community levels to degrade resources, and then to identify appropriate ways of changing those incentives.

There are several factors that impinge on household incentives:

(i) Technology: Poorly designed, or inappropriately used, technologies can lead farmers to increase production in ways that degrade natural resources. Better technologies and management practices may already be available, but may be more costly, lower yielding or knowledge demanding, and hence less likely to be adopted by farmers.

(ii) Poverty: Poverty does not necessarily lead to resource degradation, and there is plenty of evidence to suggest that richer farmers degrade resources too. For example, many of the livestock that overgraze rangeland may be owned by the wealthier farmers. When households' subsistence needs are threatened, extractive activities that degrade resources may be the only way to survive in the short term. Poverty problems of this kind are exacerbated during stress periods such as drought. Perhaps the most severe resource degradation occurs during droughts, because households may be most dependent on extractive activities at the same time that resources are most vulnerable. In the longer-term, chronic poverty in concert with increasing populations can exert degrading pressures on natural resources.

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(iii) Property rights: The property rights that individuals have over resources can be crucial is determining whether they take a short-term or a long-term perspective in managing those resources. For example, farmers with insecure ownership rights are less likely to be interested in conserving resources, or in making investments that improve their long-term productivity. Property rights problems are common in dryland areas, especially during the transition to more intensive agricultural systems. They can also underlie the degradation of common property resources, such as open rangeland or forest, when the institutions that traditionally control and regulate such resources become weak.

(iv) Externalities: Externalities arise when the costs associated with resource degradation are not fully borne by the individuals causing the problem. For example, removing trees that prevent soil erosion can lead to high costs over time for a community, but may be privately beneficial to the individual farmers who do it. Externality problems also arise in valuing the benefits of conserving resources. For example, individual farmers may not appreciate the full value of their trees because many of the environmental benefits that trees provide to the community are not captured in the returns that farmers receive.

(v) Costs of collective action: Conserving or improving natural resources often requires collective action by groups of users. Examples include the management of common property resources, or organizing farmers to invest labor in land terracing or bunding. Organizing farmers into effective and stable groups for collective action is difficult and costly, and usually only succeeds when the benefits are substantial in relation to the costs.

(vi) Prices: Inappropriate prices for inputs and outputs can encourage farmers to degrade resources. Inappropriate prices can arise from externality problems which distort market prices from their socially correct values. For example, local market prices for fuelwood and charcoal generally undervalue the true cost of the wood, because the environmental benefits of trees for soil conservation and local climate effects are not captured in the market price. But governments also distort market prices. In many African countries, for example, agricultural prices have been kept too low through export taxes and overvalued exchange rates, reducing farmers' profits and their returns to investing in the conservation and improvement of natural resources.

(vii) Government interventions: Government interventions can have significant effects on the incentives and opportunities available to farmers in making choices about technology and resource use. Public investments in, for example, rural infrastructure, education, health, family planning, and soil erosion control, can create new opportunities in farm and nonfarm activities for rural people and reinforce positive incentives for sustainable resource management. Education can help increase opportunities for migration, reducing the population pressure on resources and providing capital flows through remittances for investments in agriculture. Drought relief interventions, such as food for work programs, can be particularly helpful in

relieving the pressure on resources when they are most vulnerable. But government interventions can also be environmentally destructive, for example, land settlement schemes in fragile areas, and inappropriate restrictions on land use.

(viii) Knowledge: Farmers may respond rationally to economic incentives, but their perceptions about the consequences of their actions may be poorly informed. For example, they may not be fully aware of the longer-term soil degradation consequences of particular farming practices, or of the effect of removing trees and shrubs on soil erosion on neighboring farms.

Given these incentive problems, it is highly unlikely that improved technologies alone can resolve resource management problems and lead to sustainable intensification in the desert margins. Incentive problems must be resolved before farmers will adopt more appropriate technologies. This will require an improved understanding of the incentive problems facing farmers and rural communities, the changes that need to be made, and by whom. It will also require that countries have the political will and effective public and local institutions to bring about the needed social and economic changes.

To address the issues cited above, the Desert Margins Initiative should include a strong research module on the determinants of household and community resource management and investment decisions and the impact of policy. This will be essential for "bottom-up" approaches that seek to strengthen the ability of households and communities to spontaneously respond to resource degradation. Three sets of issues should be explored:

(i) The role and impact of government policies on economic incentives for sustainable resource use -- including the impact of sectoral policy; the pricing and marketing of agricultural inputs and outputs; public investment policy; credit policy; drought relief measures; and trade and exchange rate policy.

(ii) The role of institutional options on the incentives for households and communities to manage resources in sustainable ways -- including the impact of property rights; the effects of land use regulation and legislation; and the role and effectiveness of local government and community management initiatives.

(iii) The impact of improved technologies and resource management practices on the poor -- including direct impacts on their own-farm productivity as well as indirect impacts arising through changes in off-farm employment, nonfarm earnings, and food prices.

This will require undertaking research (a) to understand the dynamics of household and community responses to resource degradation under fragile land conditions, and to identify successful patterns of resource investment through technical, policy, and institutional innovation; (b) to identify local and national policies which will support

the transformation to more sustainable landscapes; and (c) to enhance the ability of policymakers and local communities to monitor and evaluate effects of policies and programs on human welfare, economic activity and natural resource conditions.

The operational side of the research will need to include the following elements: (a) community resource mapping and analysis of aerial photo series to characterize patterns of resource access, use, and quality and the role of resources in different livelihood strategies; (b) collection of household and community specific data relating to resource management decisions; (c) modelling of household decision-making with respect to resource-augmenting investments, technology choice, and participation in communal action for resource management to simulate the effects of alternative policies on production, poverty, and resource quality; (d) developing practical systems for monitoring resource and landscape change, and their welfare effects, using both participatory methods and formal surveys.

If the DMI research program is to lead to effective changes in the way resources are managed, then the research will need to be followed by a proactive program of policy training and outreach designed to help persuade governments, NGO's and donors of the kinds of technology, policy and institutional changes needed to arrest degradation. This outreach might even extend to the design and development of pilot projects to experiment with different approaches, including working with implementing agencies in monitoring and evaluating such pilot experiences. This kind of outreach and dissemination is far more challenging than the kind of farmer extension associated with commodity focused research, and reflects the much greater social complexities associated with natural resource management.

The International Food Policy Research Institute (IFPRI) strongly supports the objectives of the DMI, and stands ready to play an active role in developing the policy and socio-economic components of the work program. We would be particularly interested in a) helping to develop the needed research methods, b) undertaking intensive empirical research in selected sites, c) developing and running a research support network for the policy and socio-economic research to be undertaken by DMI partners at other sites, and d) helping to organize workshops and other outreach activities to communicate with policymakers in governments, NGOs, and donor agencies.

Pratiques agroforestières traditionelles et gestion des ressources naturelles dans les zones semi-arides de l'Afrique de l'Ouest

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1. Introduction

Les ressources naturelles des zones semi-arides de l'Afrique de l'Ouest sont confrontées à des problèmes de dégradation rapide dont la désertification constitue probablement la manifestation la plus visible. La crise s'est aggravée au cours des trente dernières années en raison de sécheresses répétées et de pratiques inappropriées de gestion des terres, limitant sérieusement l'accroissement de la production agricole et aggravant les problèmes de sécurité alimentaire.

Les stratégies engagées dans le passé pour accroître la production agricole et lutter contre la désertification n'ont pas produit les résultats espérés. Au sahel par exemple, l'accroissement annuel de la production agricole est resté faible, de l'ordre de 2%. Cette augmentation est nettement insuffisante au regard de l'accroissement démographique qui atteint 3% environ, d'où un déficit alimentaire chronique qui contraint de nombreux pays sahéliens à investir des devises dans l'importation de produits vivriers ou à dépendre de l'aide alimentaire.

Les conséquences humaines de cette crise de l'environnement sont tragiques, avec des coûts élevés pour les familles et pour la société. appauvrissement continu des sols et baisse des rendements agricoles, disparition d'importantes ressources phytogenétiques du fait des déboisements, migration de populations pour occuper de nouvelles terres souvent marginales, aggravant ainsi la spirale de la pauvreté.

Dans le cas du Sahel, les insuffisances des stratégies passées de lutte contre la désertification portent en grande partie sur des problèmes d'approche:

- premièrement, le savoir et le savoir-faire des paysans sur la gestion des ressources naturelles n'ont pas été suffisamment étudiés ou pris en compte;

- deuxièmement, beaucoup d'actions ont été menées de manière sectorielle (secteur forestier, secteur agricole, etc.) alors que le système de production le plus largement répandu dans la région est un système intégré avec des arbres dispersés dans les champs de cultures.

Au moment où la Communauté Internationale et les Gouvernements des pays des zones arides et semi-arides s'apprêtent à lancer des initiatives majeures pour engager ensemble de nouvelles stratégies de lutte contre la desertification, il est important de s'informer davantage sur les pratiques traditionnelles de gestion des ressources naturelles pour en évaluer les insuffisances et les mérites.

Cette communication analyse les pratique agroforestières traditionnelles au Sahel et présente les stratégies et les priorités de recherche du Centre International pour la Recherche en Agroforesterie (ICRAF) dans cette région.

2. Les Systèmes Traditionnels d'Utilisation des Terres

L'utilisation traditionnelle des terres en Afrique semi-aride de l'Ouest est caractérisée par deux activités dominantes:

- le pastoralisme nomade, un élevage extensif qui exploite de vastes superficies de pâturages naturels constitués par une végétation mixte herbacée, arbustive et arborée dans les zones où la pluviometrie annuelle inférieure à 300-400 mm n'est pas suffisante pour pratiquer des cultures pluviales;
- l'agriculture sédentaire pluviale pratiquée dans les zones moins sèches recevant 400 à 1000 mm. Il s'agit d'un système intégré de production dans lequel les cultures annuelles sont associées à des arbres dispersés dans les champs. Pendant la saison sèche, ces champs supportent également des animaux (gros bétail et petits ruminants) qui pâturent les résidus des récoltes.

L'espace rural est généralement organisé comme suit:

- l'espace cultivé dans les environs immédiats du village, ("champs de village" et "champs de case"), est cultivé chaque année, avec peu de jachère. Ces champs bénéficient d'un apport plus ou moins important de fertilisation organique: ordures

ménagères, fumure animale, paillage, etc.;

- l'espace cultivé loin du village. Cet espace comprend ce qu'on appelle les "champs de brousse", exploités par intermitence avec des temps de jachère. Ces champs ne bénéficient généralement pas de fertilisation en dehors de la fumure animale au moment du pâturage des résidus de récolte par les animaux du village ou des pasteurs nomades;
- la "forêt" ou "brousse" regroupe l'ensemble des espaces non cultivés. Ces espaces ne sont pas cultivés soit parce qu'ils sont trop loin du village, soit parce qu'ils occupent des terres marginales correspondant à un stade de jachère. Cet espace a une grande importance sylvo-pastorale. Il constitue une réserve commune de bois d'oeuvre et de service pour le village et alimente également les populations en pâturage et en produits de cueillette et de chasse;
- les bois sacrés sont des lieux de culte et de sacrifices. Il s'agit de petits bosquets densément boisés qui peuvent se rencontrer à l'intérieur de l'un quelconque des espaces précédents, mais qui ne sont pas exploités à des fins de production. Ils ont une fonction religieuse et sont intégralement protégés par les règles et coutumes du village.

Une caractéristique commune des systèmes traditionnels de production et d'utilisation des terres est l'importance que ces systèmes accordent aux arbres, qu'il s'agisse de l'élevage ou de la production agricole. L'importance socio-culturelle des arbres est réfletée dans les sacrifices que les populations offrent à diverses especes et aux bois sacrés, probablement en raison des nombreux bénéfices économiques que les paysans tirent des fonctions multiples de ces arbres.

3. Fonctions Multiples des Arbres et Arbustes au Sahel

Depuis plusieurs générations, les populations ont appris à connaître et à utiliser les nombreuses vertus des ligneux à usage multiples (LUMs). Certains aspects de cette contribution des ligneux à la vie des population sont résumés ci-dessous.

3.1 Importance des Ligneux dans l'Alimentation et la Nutrition Humaine

Diverses parties des LUMs, notamment des jeunes pousses, des fleurs, des fruits et des

graines apportent aux populations une alimentation vitaminique et minérale vitale pour leur santé. Par exemple, le karité (*Butyrospermum paradoxum* subsp. *parkii*) produit des fruits commestibles très appréciés. Ces fruits deviennent même l'alimentation de survie pour de nombreuses familles pendant les périodes de soudure lorsque les réserves alimentaires de l'année antérieure sont épuisées et que les nouvelles récoltes ne sont pas encore mûres. Il arrive alors que des familles entières dépendent des fruits de karité comme source de nourriture. Le néré (*Parkia biglabosa*) et le dim (*Cordyla pinnata*) fournissent des fruits et graines dont la teneur élevée en protéine est si bien appréciée qu'on appelle ces produits "viande du pauvre". Les fruits du tamarinier (*Tamarindus indica*) très riches en vit.C sont très recherchés dans la fabrication familiale et industrielle de boissons (jus et sirop). Le baobab (*Adansonia digitata*) dont l'écorce fournit par ailleurs des fibres d'excellente qualité, produits des fruits riches en vit.C et des feuilles très appréciées pour la cuisine (haute teneur en fer et en calcium).

En raison de cette importante contribution des LUMs à l'alimentation humaine, les arbres participent directement à la stratégie de sécurité alimentaire des populations.

3.2 Importance des Ligneux dans l'Alimentation et la Nutrition Animale

Les ligneux fourragers apportent une contribution déterminante à l'alimentation du bétail au Sahel, surtout pendant la saison sèche lorsque les pâturages herbacés sont desséchés ou brûlés par les feux de brousse. La part du fourrage produit par les LUMs peut atteindre alors 45% dans la ration alimentaire des animaux. Pendant ces périodes, les feuilles de certains fourragers comme *Pterocarpus lucens* et *P. erinaceus* ainsi que les gousses d'autres espèces comme *Acacia albida* sont même vendus sur les marchés des centres urbains.

Les populations sahéliennes, et surtout les pasteurs nomades, ont une excellente connaissance des ligneux fourragers. Ces populations connaissent les différentes especes et peuvent même reconnaître différentes variétés à l'intérieur d'une même espèce. Les populations connaissent également les aires de répartition de ces espéces dans le terroir villageois ou sur les terrains de parcours, leur phénologie qui détermine la disponibilité du fourrage, la qualité nutritionnelle de leur fourrage, et leur efficacité vétérinaire pour la santé des animaux.

3.3 Importance des Ligneux dans la Santé Humaine et Animale

Il serait fastidieux de vouloir résumer ici l'ampleur de la contribution des ligneux dans la pharmacopée traditionnelle. Signalons simplement que les feuilles, les racines et les écorces de presque tous les LUMs sahéliens sont utilisées d'une manière ou une autre dans les soins de santé humaine et animale.

3.4 Importance des Ligneux dans la Gestion des Sols et la Protection de l'Environnement

Les ligneux jouent un rôle important dans la gestion de la fertilité des sols. Dans certaines régions du Mali par exemple, on peut noter les aspects suivants:

- lors du défrichement, les arbres servent à repérer les terres fertiles. *Isoberlinia doka, Pterocarpus erinaceus, Detarium microcarpum, Prosopis africana, Piliostigma sp. et Pteleopsis suberosa* sont utilisées par les paysans comme espèces indicatrices de fertilité dans ces régions.
- les feuilles de *Butyrospermum paradoxum, Acacia albida, Khaya senegalensis, Daniella oliveri, Isoberlinia doka, Pterocarpus erinaceus et Afzelia africana* sont reputées être de "bons engrais". Elles sont récoltées et mélangées à la fumure des compostières avec les tiges de mil et les bouses des animaux.

Un autre exemple classique bien connu des populations sahéliennes est celui de *Acacia albida* dont la présence permet de doubler ou même tripler les rendements de céréales sous son couvert. De nombreuses civilisations agraires au Sénégal, au Mali, au Niger et au Burkina Faso ont pratiqué des cultures continues sans jachère pendant plusieurs générations grâce à la présence de peuplements de cette espèce.

3.5 Importance des Ligneux comme Source de Revenus Monétaires

Le beurre de karité est vendu sur tous les marchés. Avant l'introduction de l'arachide en Afrique, c'est le beurre de karité qui était la seule source importante de matière grasse végétale dans les zones semi-arides et sub-humides, jouant pour ces régions le rôle que joue l'huile de palme pour les zones humides. Les fruits de nombreux arbres locaux sont vendus sur les marchés des centres urbains et le long des grands axes routiers: karité, néré, tamarin, jujube (*Ziziphus mauritiana*),"raisin sauvage" (*Lannea microcarpa*), détar (*Detarium*

microcarpum), etc. Les amandes des noix du "prunier sauvage" (*Sclerocarya birrea*) ainsi que les jeunes pousses et fleurs de *Balanites aegyptiaca* et de plusieurs especes de la famille des capparidaceae (ou Capparaceae) sont également vendues pour la consommation humaine. Les gousses et les feuilles de certains ligneux fourragers sont également vendus sur les marchés, comme indiqué plus haut pour *Pterocarpus erinaceus* et *P.lucens.*

En plus de cette commercialisation sur les marchés locaux, certains produits de ligneux font l'objet d'un commerce régional et international. Par exemple, les noix de karité sont exportées en Europe et au Japon et occupent, selon les années, le 3^{e} ou le 4^{e} rang des ressources d'exportation du Burkina Faso et du Mali. Les graines de *Parkia biglobosa* font l'objet d'un important commerce régional entre pays africains pour la fabrication du soumbala, un condiment alimentaire très riche en protéine. Des industries de fabrication de jus de tamarin existent au Burkina Faso, au Mali et au Niger. La gomme de l'*Acacia sénégal*, premier produit d'exportation du Soudan, est également produite dans quelques pays sahéliens et commercialisée à l'exportation par le Sénégal, le Tchad, le Mali etc.

Les exemples ci-dessus montrent que les ligneux locaux génèrent des ressources financières pour les paysans qui parfois n'ont rien d'autre à vendre pour avoir des revenus monétaires. En outre, les produits de ces ligneux représentent des sources de devises pour le budget de l'Etat, comme c'est le cas pour le Burkina et le Mali avec l'exportation des noix de karité en Europe et au Japon.

Les paysans sahéliens ont développé une forme élaborée de valorisation de l'importance sociale, économique et écologique des ligneux en les intégrant à la production agricole sous forme d'arbres dispersés dans les champs de culture. C'est le système parc.

4. Un Exemple de Pratique Agroforestière Traditionnelle : Le Système Parc

L'agroforesterie regroupe tous les systèmes et pratiques d'utilisation des terres où des ligneux pérennes sont volontairement intégrés aux cultures ou à l'élevage sur une même parcelle de terre, simultanément ou de manière sèquentielle.

Dans les zones semi-arides d'Afrique de l'Ouest, le système traditionnel de production le plus largement répandu est le système parc dans lequel les paysans préservent délibérément des arbres dispersés dans le champ en association avec des cultures ou des animaux. Ce système se rencontre partout chez les agriculteurs sédentaires et occupe 90 à 95% de l'espace cultivé. Les parcs à *Acacia albida* et à karité/néré sont les mieux connus, mais il existe de nombreux autres types de parcs dominés par d'autres espèces.

Les arbres préférés par les paysans varient selon les localités, selon les groupes ethniques, et selon le sexe. Dans certaines localités, c'est *Acacia albida* qui est préféré par les populations alors que dans d'autres localités l'espèce préférée peut être le baobab, le néré, le karité ou une autre espèce. Dans beaucoup de cas, les préférences des hommes sont différentes de celles des femmes. Par exemple, dans un village du Niger, les hommes ont classé *Acacia albida* au 1er rang de leur préférence, alors que les femmes ont classé cette espèce au 4^{e} rang. Les hommes prennent plus en compte les préoccupations de fertilité et de lutte contre l'érosion dans les champs alors que les femmes pensent surtout à l'approvisionnement en bois de feu et à divers produits pour la vente ou pour les usages domestiques. Les produits des arbres du parc appartiennent généralement à la famille propriétaire du champ. Cependant, selon les localités, certaines espèces comme *Parkia biglobosa* font l'objet d'une propriété privée et peut appartenir à une personne différente du propriétaire du champ.

En plus des ligneux, les animaux constituent également une composante importante du système parc. Pendant la saison des cultures les animaux font l'objet de gardiennage par leurs propriétaires, mais après les récoltes, les animaux envahissent les champs et pâturent librement les résidus des récoltes. Dans certains cas, le paysan agriculteur passe un contrat avec un éleveur pour que celui-ci garde son troupeau dans le champ pour une durée determinée afin d'assurer une bonne fertilisation du champ. Ces pratiques sont moins fréquentes aujourd'hui car le paysan utilise également les résidus de récoltes pour de nombreaux autres usages: clôture, feu de cuisine, etc.

Le système parc est important à cause de sa très large distribution géographique et des importantes ressources phytogénétiques qu'il renferme, mais aussi parce que c'est dans ce système que les paysans produisent l'essentiel des cultures vivrières et des cultures de rente. Pendant des siècles, ce système a permis à plusieurs générations d'agriculteurs sédentaires de gérer les ressources

naturelles de leurs terroirs de manière productive et durable. Les résultats des études scientifiques confirment aujourd'hui l'éfficacité de ce système traditionnel de production:

- sur le plan économique, une étude de 22 exploitations agricoles avec parcs à karité et néré au Mali a montré que le parc était plus rentable qu'un système de monoculture dans les conditions du paysan. En tenant compte de la diminution des rendements des cultures sous les arbres mais aussi des fruits et du bois produits par ces arbres, le parc présente des bénéfices par rapport à la monoculture se chiffrant entre 6500 FCFA/ha pour une densité moyenne de 1 karité et 1 néré/ha et 13600 FCFA/ha pour une densité moyenne de 8 karité et 1 néré/ha.

- sur le plan biophysique, les connaissances actuelles indiquent que la présence des arbres a un effect bénéfique sur le microclimat, le bilan hydrique et la fertilité des sols. On sait également que les arbres servent de source d'inoculum de michorizes sur les sols dégradés. La présence de ligneux peut alors aider à restaurer la population michorizienne et la productivité de tels sols.

Tous ces bénéfices sont perdus s'il y a déboisement. L'équipe de l'Institut d'Ecologie Tropicale (ITE) du Royaume Uni a fait récemment des découvertes suprenantes dans une zone dégradée de la région de Louga au Sénégal: des teneurs d'azote (N-NO3) exagérement élevées ont été trouvées en profondeur, sous des arbres isolés. Sous un pied d'*Acacia senegal* par exemple, les chercheurs ont mesuré une teneure allant jusqu'a 180 mg d'azote par litre dans une couche se trouvant entre 15 et 22 m de profondeur. Ces résultats illustrent les conséquences des désoisements et de la dégradation des terres. Non seulement les éléments nutritifs ne sont plus ramenés en surface, mais en plus ils peuvent poser des problèmes graves de santé publique. Par exemple, la concentration d'azote de 180 mg/litre citée plus haut pourrait bien contaminer les eaux souterraines. Si l'on considère les normes européennes de 11 mg/litre d'azote (NO_3) pour l'eau de boisson, une telle contamination serait une véritable catastrophe écologique en matière de santé.

Dans les zones semi-arides du Kenya, le Centre International pour la Recherche en Agroforesterie (ICRAF) a montré qu'un champ de monoculture de maïs exploite seulement 30% de l'eau de pluie, alors qu'un champ de maïs avec des arbres dispersés dans le champ exploite jusqu'à 76% de cette

eau. Une culture sous convert arboré valorise donc mieux l'eau de pluie qu'un champ de monoculture de céréales.

Le système parc représente donc un système efficace de production agricole adapté aux conditions de sécheresse et de faible fertilité des sols dans les zones semi-arides. Ce système mérite une attention particulière dans les interventions futures de recherche et de développement car le système est menacé de disparition ou de dégradation importante dans plusieurs localités de la région.

5. Stratégie de l'ICRAF et Priorités de Recherche pour les Zones Semi-Arides de l'Afrique de l'Ouest

Le but du Centre International pour la Recherche en Agroforesterie (ICRAF) est de contribuer à atténuer la déforestation des régions tropicales, l'épuisement des terres et la pauvreté des populations rurales par le biais de systèmes agroforestiers améliorés.

Les objectifs de l'ICRAF consistent à mener une recherche stratégique et appliquée, en collaboration avec les institutions nationales, en vue d'élaborer des technologies agroforestières appropriées pour une utilisation des terres plus durable et plus productive; à renforcer la capacité des systèmes nationaux afin qu'ils puissent mener à bien leur propre recherche agroforestière; à encourager la collaboration entre diverses institutions et à promouvoir la formation, l'éducation, la documentation et la communication en agroforesterie.

Dans les zones semi-arides de l'Afrique de l'Ouest l'ICRAF travaille en collaboration avec les gouvernements et les systèmes nationaux de recherche de 4 pays sahèliens (Burkina Faso, Mali, Niger et Sénégal) dans le cadre du réseau de recherche agroforestière SALWA (Semi-Arid Lowlands of West Africa). Le réseau a été créé en 1990 et bénéficie de l'appui financier du Fonds International de Développement Agricole (FIDA) et de l'Agence Canadienne de Développement International (ACDI). En plus des SNRA, le programme collabore avec ICRISAT Centre Sahélien et ILRI (ex.ILCA) ainsi qu'avec des institutions régionales de coordination de la recherche, notamment l'Institut du Sahel/CILSS et l'OUA/CSTR-SAFGRAD.

Les problèmes majeurs de la production agricole pour lesquels des technologies agroforestières pourraient apporter des solutions ont été identifiés comme suit au cours de la phase de planification du réseau:

- faible fertilité des sols;
- problèmes d'érosion éolienne et hydrique;
- déficit fourrager de saison sèche;
- protection des cultures de contre-saison contre la divagation des animaux;
- problème d'approvisionnement en bois de feu et de service;
- problème général de la dégradation des parcs agroforestiers traditionnels.

Les recherches en cours portent sur l'étude des parcs et sur l'évaluation biophysique et socio-économique des technologies banques fourragères, haies vives dèfensives et brise-vent avec une centaine de LUMs dans une dizaine de stations de recherche et plusieurs champs paysans au Burkina Faso, Mali, Niger et Sénégal. Des résultats très prometteurs ont été obtenus avec *Ziziphus mauritiana* en haie vive et comme espèce fruitière, ainsi qu'avec *Gliricidia sepium* en banque fourragère.

Le programme de recherche est complèté par d'importantes activités de formation universitaire, de stages de perfectionnement, et de diffusion de l'information et de la documentation en agroforesterie.

Les objectifs majeurs de la stratégie sont:

- diversifier les produits pour réduire les risques;
- générer des revenus monétaires pour les paysans;
- gérer de manière optimale de l'eau et la fertilité des sols pour lutter contre la dégradation des ressources naturelles et accroître la production de manière durable.

Les priorités de recherche pour le moyen terme continueront de mettre l'accent sur les parcs comme cadre de production des cultures vivrières (mil, sorgho, légumineuses à graine) et des cultures de rente (arachide et coton) et comme réservoir de ressources phytogéniques de LUMs.

En raison de l'importance du bétail et des cultures de contre saison comme sources de revenus monétaires pour les ménages, les activités sur les parcs seron menées de pair avec des recherches

sur les banques fourragères et les haies vives.

Les activités de recherche seront pluridisciplinaires socio-économique et biophysique.

Les activités de recherche porteront sur les thèmes suivants:

- Caractérisation socio-économique et biophysique des parcs, identification/cartographie des différents types de parcs, identification des facteurs qui déterminent la dynamique de ces parcs, étude des pratiques traditionnelles de gestion des parcs;
- Marché et filières de commercialisation des produits des parcs;
- Etude d'impact des technologies banques fourragères et haies vives;
- Tenure des arbres dans les champs (codes forestiers);
- Connaissances traditionnelles sur les LUMs;
- Domestication des LUMs prioritaires pour la production de fruits et de fourrage et pour la génération de revenus monétaires;
- Introduction de germplasme d'autres zones semi-arides;
- Role des ligneux dans l'économie de l'eau et la gestion de la fertilité des sols;
- Interactions arbres/cultures/animaux;
- Formulation de modèles sur le fonctionnement des systèmes parcs et des technologies banques fourragères et haies vives.

Les priorités pour la formation, l'information et la documentation porteront essentiellement sur les aspects suivants:

- Sensibilisation des décideurs politiques à l'approche agroforestière;
- Développement des ressources humaines;
- Renforcement des liens entre les centres de recherche et les universités;
- Renforcement de la diffusion de l'information et la documentation.

La stratégie adoptée est l'approche collaborative avec les SNRA, les autres Centres du GCRAI, les ONG et les Services et Projets de Développement.

6. Contribution Possible de l'ICRAF dans l'Initiative "Zones en Marge du Désert".

Le plan d'action de l'ICRAF est organisé autour de sept (7) programmes:

- quatre (4) programmes de recherche portant sur: la dimension sociale et économique, la gestion et l'amélioration des LUMs, les interactions arbres/cultures/animaux, la mise au point de systèmes agroforestiers améliorés;

- trois (3) programmes sur le dévelopment des ressources humaines et la dissemination de l'information agroforestière.

L'ICRAF intervient dans les zones humides, sub-humides et semi-arides. Le programme pour les zones semi-arides offre un cadre de travail et de collaboration avec d'autres partenaires pour la mise en ouvre de la présente initiative sur les "Zones en n. du Désert".

La contribution scientifique de l'ICRAF à cet effort collectif serait d'aider à intégrer les connaissances pour développer des technologies agroforestières appropriées pour les zones semi-arides, notamment les arbres dispersés dans les champs, les banques fourragères et les haies vives dèfensives en vue d'évaluer l'impact rèel de telles technologies sur les ressources naturelles et les conditions de vie des population, notamment les aspects suivants:

- maintien et gestion de la fertilité des sols et réduction de l'erosion

- rôle des arbres dans l'utilisation optimale de l'eau dans les systèmes agraires

- rôle des arbres dans le recyclage des éléments nutritifs du sol, notamment le pompage d'éléments nutritifs en profondeur pour les remonter à la surface

- rôle microbiologique des arbres dans le maintien de la microflore du sol (michorize et rhizobium) pour le benèfice des cultures

- rôle des systèmes agroforestiers dans la réduction des risques, l'amélioration de sécurité alimentaire, et l'accroissement des revenus monètaires pour les paysans

On pourrait envisager des sites en zone sahèlienne et aussi en Afrique semi-aride de l'Est ou en Afrique australe pour des études comparatives.

7. Conclusion

Les paysans sahéliens ont depuis longtemps intégré l'arbre à leurs systèmes de production sous forme d'arbres dispersés associés aux cultures dans les champs. Ce système est encore aujourd'hui le plus largement répandu pour la production des cultures vivrières et des cultures de rente au Sahel, mais il est menacé de dégradation.

Les connaissances scientifiques actuelles confirment l'éfficacité écologique et la rentabilité économique de ces systèmes mixtes par rapport aux monocultures dans les conditions paysannes en zone semi-aride.

Les activités de recherche menées par l'ICRAF dans le cadre du réseau SALWA visent à mieux comprendre ces systèmes traditionnels et à développer des systèmes agroforestiers améliorés. Les résultats acquis par l'ICRAF pourraient contribuer significativement à l'élaboration de solides stratégies de lutte contre la désertification, dans le cadre de l'objectif stratégique d'attenuer la déforestation, l'épuisement des terres et la pauvreté des populations rurales à travers le développement de systèmes intégrés et durables d'utilisation des terres appropriés pour la restauration des agrosystèmes dégradés et la réduction de la pauvreté.

Session 4: Institution Building and Enhancement of Human Resource Capacity: TOPP

Session 4: Renforcement des institutions et de la capacité des ressources humaines: TOPP

Training needs of national programs

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Problems and solutions

The success of agricultural research and management depends on the availability of trained manpower, the components of which comprises the quality, composition, and deployment of staff (ISNAR, 1992). Training efforts of most of the national programs are commendable. But the major problem lies with identifying priority/key areas in order to develop competent research personnel who can address problems confronting agricultural production. In particular, staff composition seems to pose a crisis, especially when the high turnover of staff in most national programs is considered. Too often there is a problem in capacity-building due to difficulty in retaining staff for various reasons. The need for training covers different levels (induction, on-the-job, advanced, short-term) in research management and technical skills.

In recognition of the scarce financial and human resources in most countries, it will be worthwhile to have training plans that have a bearing on agricultural development and sustenance. Thus effectiveness and success in research manpower use will depend on periodic evaluation of research activities, priorities, and available resources to provide a base for training, analysis, and planning. Such skills are not available in most national programs, but they can be acquired through in-service training at management level.

National programs are characterized by a limited number of well-trained staff, who often lack experience. The problem is especially pronounced when the strength of individual disciplines is assessed, and when continued training is hindered by the need to release staff to go on courses without replacement backup in their programs. As a result, on-the-job training, which exposes staff to new research methods and techniques for the improvement of their productivity, will be necessary. Such training includes short-term travel to enable staff to acquire new skills and knowledge, and develop proper attitudes towards agricultural research as a profession.

Postgraduate and specialized training

Some effort has been directed at giving staff advanced training at Masters and PhD level. But there is a general deficiency in providing young researchers opportunities to gain experience after graduation through fellowships. These expose them to high standards of research proficiency, which help them to improve their leadership, knowledge, and technical skills. However, fellowships are a luxury that most national programs cannot afford because, even before studies are completed, the services of such staff members are desperately awaited in the institution from whence they came.

Many research scientists are not familiar with global scientific information networks, further limiting their ability to access current scientific information---which, additionally, is too expensive for some institutions to acquire. Poor communication skills pose a problem in exchanging ideas and information in a manner that is readily understandable, thus limiting the use of new information by others.

Lack of in-country collaboration between universities and research institutions hinders the integration that makes possible the avoidance of duplication, the sharing of responsibilities, and interdisciplinary approaches to problem- solving. Overall, little importance is attached to

training in social sciences, or preparation of support staff to become highly qualified professionals. Training in monitoring and evaluation of research (relevance, usefulness, and impact) is lacking, even though these skills are necessary components in priority-setting.

Other areas of specific training needs are: data/information management, monitoring and evaluation, training of extension personnel in issues relating to land degradation and resource management---all probably in the form of in- country workshops/courses.

Reference

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Session 6: Institutional Mechanisms: TOPP

Session 6: Mécanismes institutionnels: TOPP

The Consortium on Alternatives to Slash and Burn

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1. CONCEPTION

1.1 Goal and Objectives

The Initiative on Alternatives to Slash and Burn (ASB) is a consortium of National and International Research Centres, Institutes, Programmes and NGO's. The consortium was formally inaugurated at a conference held in Porto Velho, Brasil in February 1992 at the culmination of a year-long preparatory period (see Table 1 for chronology).

The decision to form the consortium was a response to a proposal which had been formulated by a group of international agricultural research institutions. The proposal was founded on a relatively simple but powerful idea: that of linking the concerns of environmentalists for the global consequences of tropical deforestation with the mandate of the international agricultural research community to find means for food sufficiency within the farm communities of the forest zones (see Appendix for a resume of the evidence). The proposal argued that the lack of availability, to those dependent on the forest for their food and livelihood, of sustainable land use practices is one of the major factors driving deforestation and environmental degradation as well as maintaining the farmers and other land users in perpetual poverty. A concerted attack at a global scale to accelerate the development of sustainable land-uses to replace degraded forms of slash and burn agriculture would contribute to both targets of environmental conservation and poverty alleviation. This basic concept was recognised by a range of potential participants as being consistent with their own institutional and national objectives. It was the definition of the concept which gave the impetus to the project and constituted the basis and justification for formation of the consortium.

The Alternatives to Slash and Burn Project was thus formed at the Inaugural Workshop in 1992 with the following goal:

to reduce global warming, conserve biodiversity, and alleviate human poverty by promoting the development of alternatives to slash-and-burn agriculture that are ecologically sound, economically viable and culturally acceptable.

and three project objectives:

1. To identify, evaluate and, where necessary, modify and develop land-use systems and technologies that lead to sustainable alternatives to slash-and-burn agriculture and the reclamation of degraded lands;

2. To identify, evaluate, and design policies, as well as the tools and methods by which they are implemented, that will protect the environment by reducing the area deforested by the practice of slash-and-burn and promote the establishment of sustainable systems;

3. To enhance the human-resource capacity for informed policy decision making and the dissemination and application of research results.

2. THE CONSORTIUM

2.1 Membership

The project was initially implemented by a consortium consisting of sixteen member agencies (four CG Centres, three non-CG international research institutions and nine national research institutions - see Table 2). Subsequently (in 1993) two additional CG Centres were admitted to the consortium. The costs for the preparatory stage were borne by the original international agencies but one important key to success came with the provision of 'seed' money by UNDP for the Inaugural Global Workshop and to enable the national members to participate in the first two global planning meetings (Table 1).

The different members of the consortium offer distinct strengths and comparative advantages to the research programme. The ASB project is not just an initiative on natural resource management research but has a systems perceptive with full integration of disciplines spanning soil science to policy research. It thus requires a fully multi-disciplinary approach; the broad mix of participating agencies brings great strength in this respect providing different combinations of expertise through inter-institutional collaboration at national, regional and global levels.

The membership of the consortium has remained flexible with a number of changes having been made since its inception. The Global Steering Group has however exercised considerable selectivity with respect to increasing membership, one of the main criteria being that of provision of a new range of expertise. The GSG may have to consider, at a future stage, whether the current membership is perpetuated in total.

2.2 Benchmark Sites

The multidisciplinary and multi-institutional teams involved in the ASB activities are located at eight benchmark sites. Benchmark sites are bases of operations (including in some cases a research station run by a consortium member) from which on-farm research is conducted in nearby target areas. Each benchmark "site", therefore, consists of several on-farm areas.

The eight benchmark sites were selected to represent the major regions where slash-and-burn is important and encompass a broad range of biophysical and socioeconomic conditions. In Africa, a site in Cameroon (M'Balmayo) represents the equatorial Congo rainforest, a zone of rapid social and environmental change, and the one in Kasama, Zambia represents the dystrophic Miombo woodlands where *chitemene*[1] is practised. In Latin America, there are two sites in the Amazon: one in Rondonia/Acre, Brazil, characterized by semi-deciduous rainforests with rapid immigration of population, and the other in the humid rainforest of Peru (Yurimaguas, Pucallpa, Iquitos) with poor infrastructure and spontaneous migrations from the Andean region. A third site in Latin America is a buffer-zone region around the remains of the forests in Southeastern Mexico, in the Yucatan Peninsula and the state of Chiapas. In Asia, one site in Indonesia represents the equatorial rainforests, where both primary-forest clearing and degraded lands with *alang-alang*[2] are abundant (Sitiung and Lampung, Sumatra), another in the tropical monsoonal forests of the Philippines, (Claveria, Mindanao) and a third in the hill country of mainland South-east Asia, north of Chiang Mai, Thailand, an area of extremely rapid deforestation and associated soil erosion.

Activities have focused initially on three countries: Brasil, Cameroon and Indonesia. During the second phase (1995-1997) activities will continue in those sites along with characterization studies in Peru, Zambia and Thailand, and possibly Mexico and Philippines. Training and information activities will encompass all sites.

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[1] A form of shifting cultivation practised in the Miombo woodlands of Southern Africa.

[2] A local name used in South-east Asia to describe unproductive grasslands (*Imperata cylindrica*) which develop as the land becomes degraded.

3. IMPLEMENTATION

3.1 Phase I: Implementation

In 1993 the Global Environmental Facility (GEF) ratified funding for ASB for a Phase I project in three benchmark sites, Brazil, Cameroon and Indonesia. The Phase I project document has a number of specific objectives spanning the broad targets of the project (policy research, carbon cycling, etc.) each of which have been disaggregated into site-specific and/or disciplinary targets. Each member of the consortium thus has specific goals to be attained within the grant period, the synthesis of which represents the overall project goals for Phase I. During Phase I the project document for the second (three-year) project period has been prepared. This contains a second tier of objectives building on the assumption of attainment of the Phase I goals. These may of course need to be modified in the light of experience.

Two financial factors strongly influenced the success in obtaining Phase I funding. The first was the 'seed money' obtained in 1992 and 1993 from UNDP and UNEP which strengthened the capacity of many institutions to participate in the preparatory process. The second was the willingness of all the consortium members to co-fund the project to 140% of the GEF funding.

3.2 Costs, Benefits, and Challenges

Working as a consortium, particularly one with as many members as ASB, and where the member institutions differ greatly in size and resources, necessitates facing a number of problems. Most fundamental of these is the question of consortial hegemony. A significant cost to participants is the loss of individual "sovereignty" which is implied by subscription to common goals and methods. All the agencies concerned have their own institutional or national priorities for research in the humid forest zone. Membership of the consortium implies that its goals, objectives and working method are consistent with those of the members. This is often not an easy matter to reconcile when implemented at the level of research activity. Inevitably some compromises have to be made. For instance a high priority for the consortium to characterise Benchmark sites by a standard methodology prior to initiating system-development research may not coincide with the current research plan for some sites. The standardisation of methods is essential to a collaborative project; this often entails changes to current protocols by some partners. Compromises may even have to be made in relation to resources, including staff; one gain in a consortium is that it provides access to a range of expertise that is lacking at any one site; this may however diminish the justification for having comprehensive disciplinary cover at all the sites.

Communication between all members of a large consortium is obviously a complex matter but absolutely essential to its functioning. Pathways of communication have to be established, which respect the requirements of protocol for all participants but are still effective in reaching the essential individuals. Blockages in the communication flow have to be identified and avoided.

There is a substantial transaction cost associated with the need to provide coordination services for a consortium. This is a real financial cost to the donor and a cost in terms of commitment of personnel and resources (eg for communication) by the participating institutions, particularly the lead agency.

These costs are only worthwhile if membership of, or support for, the consortium brings advantages. The essential test should be that the impact of the consortium's programme is greater than would be achieved by the individual agencies working independently; the whole should be greater in terms of achievement than the sum of the parts. This gain is already apparent in ASB where characterisation by standard methods is enabling global comparisons to be made across sites.

Within the consortium responsibilities have been allocated and paths of communication established to anticipate and meet some of the problems.

3.3 Global Coordination

A full-time senior scientist is responsible for the coordination of the ASB initiative. The Global Coordinator serves as secretary of the Global Steering Group, follows up activities, communicates with participating institutions, organizes meetings, drafts proposals to donors, and organizes other global activities such as workshops and publications. This position reflects the high transaction costs of multi-institutional endeavours. Dale Bandy, Principal Scientist at ICRAF, serves as the ASB Global Coordinator.

3.4 Steering Groups

The ASB initiative has adopted a fully participatory mode of operation. The process for generating ideas, setting priorities and implementing activities is guided by four levels of Steering Groups.

- **The Local Steering Groups**: chaired by the NARS-ASB representative, comprise farmer-producer organizations, NGOs, community leaders, state governments and others. This group is charged with implementing the identified and prioritized project goals at the local level and is responsible for maintaining research quality and execution of training and dissemination activities.

- **The National Steering Groups**: chaired by the NARS Director General for each country, focuses on maintaining unequivocal government support and ensuring the participation of other government research and extension institutions, local NGOs and universities. AARD chairs the NSG in Indonesia, IRA in Cameroon and EMBRAPA in Brazil.

- **The Regional Steering Groups**: led by IARCs, are ecoregional, to ensure regional coordination, setting of priorities and sharing of institutional responsibilities among the region's benchmark sites. CIAT chairs the RSG for Latin America, IRRI for Asia and IITA for Africa.

- **The Global Steering Group**: comprising representatives of the ASB consortium, sets general policy guidelines, including financial allocations and determines consortium membership. It is chaired by the Director General of ICRAF and is currently composed of designated representatives of AARD, EMBRAPA, CIAT, CIFOR, IFDC, IITA, IRA, IRRI, IFPRI, TSBF and WRI.

It is yet too early to assess the effectiveness of this structure but initial involvement at all levels has been high and enthusiastic. The Local Steering Groups in Indonesia and Cameroon have introduced procedures of peer reviews for activity proposals within the ASB structure. The GSG was responsible for preparation of the first proposal to GEF in 1992, which was successful in gaining funds to implement the first phase of the project in 1994 (see Table 1). Proposals for subsequent phases will however be prepared from contributions at all levels of the Steering Group structure.

The Steering Group structure combines two essential needs for the project. It provides a means of 'scaling-up' the project activities from the activities of individual scientists to the policy decisions of the Global Steering Group. And it provides an opportunity for the participation of all contributors to the project in the discussions leading to formulation of policy and division of responsibility.

3.5 Working Groups

Participants of the third GSG meeting which took place March 1994 in Yaounde, Cameroon, resolved to form thematic working groups to further coordinate specific technical activities of the participatory institutions. The working groups have the following responsibilities:

1. To synthesise benchmark site data to answer questions or hypotheses at the regional or global levels required for the project reports. Each working group has the responsibility for one or a set of the outcomes on which the project is required to report.

2. To develop appropriate conceptual frameworks for their designated area of the project, identify research priorities and contribute to the planning of the future activities of the project.

The project outputs for Phase I have thus been grouped into four categories for consideration by the multi-disciplinary working groups: (1) Characterisation and diagnosis; (2) Sustainability research; (3) Strategy and synthesis; (4) Training and information. An additional group to formulate policy research priorities was also established at the same meeting. The group differs from the others in being unidisciplinary and it is intended that it be disbanded, and the membership absorbed by the Working Groups, once its defined and finite task is accomplished.

The membership of the working groups is drawn from all institutions participating in data collection for the activities concerned. This ensures collaborative participation of scientists from all participating institutes in the synthesis of data and on-going planning and project design. A lead institution and/or scientist was designated for each group whose responsibility it is to ensure that the group's work is completed and the Phase I report submitted to the global coordinator by the due date.

The working groups are thus intended to complement the Steering Groups by providing a cross-project and global perspective of technical and conceptual issues. As the research task increases it may be necessary to provide more formal support to the synthetic activities currently assigned to the working groups.

3.6 Standardisation of methods

Research methods and data collection are being standardised across all sites. In the first phase the most urgent requirement has been the standardisation of methods for the joint biophysical and socioeconomic characterisation and diagnosis of the benchmark sites, currently underway

in Brazil, Indonesia and Cameroon. This was given great impetus by an early decision by the GSG to commission three of the consortium members to prepare guidelines for this aspect of the programme. Once again 'seed' funding, from both UNDP and UNEP, as well as willingness of institutions to commit personnel and time, enabled this to progress before Phase I funding was in place. As the research proceeds it will also be essential to adopt standardised procedures for the investigation of key processes such as those associated with nutrient cycling, above-and below-ground competition for resources, farmers' decision-making and policy-making.

A geo-referenced data base is being developed to facilitate the synthesis of results and the sharing of information among benchmark locations. Such an approach will improve the project's ability to synthesise results at the regional and global levels for extrapolation to the appropriate ecoregions and for linkage to the global change community, farmers, policy makers and investment decision makers.

In collaborative projects there is always a potential danger of disputes arising over rights to data and publication of data. At the Third Global Steering Group meeting a Data-Sharing Policy was proposed based on that used in the TSBF Programme (Table 3). This will be tested during the first phase of research and revised if necessary.

3.7 Resource Allocation Process

GSG is to arrive at a consensus of research priorities, institutional responsibilities and the funding needs required to meet them. The budget is assembled by the Global Coordinator on the basis of these agreements and submitted to the donors. Co-financing from other sources is identified by the participants and included within the project's budget presentations. Co-financing for the first phase was approximately 1.4 times the core resources.

ICRAF has been designated by the ASB Consortium as the coordinating agency and receives the Block Grant. ICRAF then establishes sub-contracts with the other members of the Consortium for their agreed responsibilities within the project. ICRAF is therefore responsible to the GEF for the programmatic and financial aspects of the project. In order to accomplish this, ICRAF has established mechanisms with the participating institutions for the flow of funds and reporting requirements. In Phase I, 70% of the funds will be spent at the sites, the remaining 30% going to global activities. In the same phase there are four IARCs and four NARS/NGO's receiving direct funding in the ratio of 60:40 respectively.

4. CONCLUSIONS

On the basis of the experience of the ASB Consortium a number of general conclusions can be drawn:

1. The success in establishing a viable consortium lay firstly in the clear formulation of a project concept and goal which was attractive to participants and donors alike. In order to achieve the above it was necessary for a number of institutions and individuals to commit considerable time and resources to a preparatory phase. This investment was sufficiently successful to attract seed funding to enable a wider participation at the stage of the Inaugural Workshop. We believe that a clearly-articulated consensual goal and conceptual structure is the *sine qua non* for the existence and establishment of a multi-institutional research programme.

2. The main issue to be faced in developing a consortial project is the reconciling of project goals and agenda with those of the participating agencies. This is only possible when the objectives of the project and the expectations of the members are clearly articulated. This is facilitated by careful preparation (see 1) but it should not be expected that this becomes a settled issue upon initial agreement. The differing roles of the various participants require almost constant re-negotiation and this is likely to be a major activity of the coordinator.

3. Problems likely to arise from these potential conflicts may be minimised if appropriate and effective communication mechanisms are put in place to ensure that every participant is kept informed and that the flow of contribution is as much 'bottom' to 'top' as the reverse.

4. Safeguards are also needed to assure participating scientists of their rights to data and to the credit to be gained from participation.

The ASB consortium has tried to put mechanisms in place to deal with these various issues. The project is scarcely six months into its implementation phase and the test of its capacity to deliver research results which make it worthwhile (ie proving that the whole is more than the sum of the parts) is yet to come.

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TABLE 1: TIMETABLE OF MAJOR EVENTS IN THE PREPARATION, FORMATION AND IMPLEMENTATION OF THE ASB PROJECT

January 1991, Initiative proposed by UNDP

March 1991, First Preparatory Meeting, Lome, Togo
(IFDC/IITA/ICRAF/TSBF)
Output · First African Region Proposal

July 1991, Second Preparatory Meeting, Martinique
(ICRAF/TSBF/IFDC/IITA/ IRRI/CIAT)
Output · Global Strategy Proposal drafted

February 1992, ASB Inaugural Global Workshop, Rondonia, Brasil
Output · Governmental support for initiative in target countries
· ASB put on UNCED Agenda
· Global Steering Group (GSG) established
· Global Strategy revised
· Global Research Proposal drafted

May 1992, 1st GSG Meeting, Nairobi, Kenya
Output · Consensus on GEF as target donor
· GEF Project Brief submitted to GEF
· Four level Steering Group instituted
· Characterisation guidelines commissioned
· Global Strategy finalised
· UNDP Proposal drafted

December 1992, GEF Response
Output · GEF recommends Phase I funding

February 1993, 2nd GSG Meeting, Bogor, Indonesia
Output · UNDP Proposal finalised
· Characterisation Guidelines presented
· First field exercise
· National Steering Groups formed

March 1994, 3rd GSG Meeting, Yaounde, Cameroon
Output · Local Steering Groups established
· Technical Working Groups established
· Draft GEF Proposal - Phase II
· ASB/CGIAR Proposal
· UNDP Contract signed
· Institutional Contracts drafted

TABLE 2: MEMBERS OF THE ASB CONSORTIUM

Benchmark Nation Members

- Agency for Agricultural Research and Development (AARD), Indonesia
- Department of Environment and Natural Resources (DENR), Philippines
- Empresa Brazileira de Pesquisa Agropecuária (EMBRAPA), Brazil
- Fundación para el Desarrollo del Agro (FUNDEAGRO), Peru
- Institut de Recherches Agronomiques (IRA), Cameroon
- Instituto Nacional de Investigación Agropecuaria (INIA), Peru
- Instituto Nacional de Investigación Forestal y Agropecuaria (INIFAP), Mexico
- Ministry of Agriculture and Cooperatives (MAC), Thailand
- Ministry of Agriculture, Food and Fisheries (MAFF), Zambia

International Members

- Centro Internacional de Agricultura Tropical (CIAT), Colombia
- Centre for International Forestry Research (CIFOR), Indonesia
- International Centre for Research in Agroforestry (ICRAF), Kenya
- International Fertilizer Development Centre (IFDC), U.S.A.
- International Food Policy Research Institute (IFPRI), U.S.A.
- International Institute of Tropical Agriculture (IITA), Nigeria
- International Rice Research Institute (IRRI), Philippines
- Tropical Soil Biology and Fertility Programme (TSBF), Kenya
- World Resources Institute (WRI), U.S.A.

TABLE 3: DATA SHARING POLICY

1. The contract between ASB and the donor requires that the consortium report at the end of each phase of the project on a series of outcomes. This places on the members of the consortium the obligation to collect the data required, and to conduct such syntheses, as are required to satisfy this contract.

2. All raw and derived data collected at the sites remain the property of the scientist(s) who obtained them. No attempt to use such data in ASB publications will be made other than with the permission of the scientists concerned, under the conditions specified in paragraphs 5 and 6 below.

3. Scientists participating in the ASB project are encouraged to publish their work in the open literature in the normal way. They are also encouraged to make reference to ASB in their publications where appropriate. Scientists are requested to send reprints of their publications to the coordination office. ASB would also wish to use reference to such publications as support for applications to funding agencies.

4. Synthesis of site data to answer questions or hypotheses at the regional or global levels required for the project reports will be conducted by working groups appointed for each phase by the GSG. Each working group will have the responsibility for one or a set of the outcomes on which the project is required to report. The membership of the working groups will be drawn from all institutions participating in data collection for the activities concerned. A lead institution and/or scientist will be appointed for each group whose responsibility it is to ensure that the group's work is completed and the report submitted to the global coordinator.

5. All scientists participating in the project have an obligation to make available to a working group such data as may be necessary to conduct the analyses necessary to their task.

6. Synthesised data may be published in any appropriate form, including in the open literature. Authorship will lie with those participating in the analysis of data and writing of the paper, observing the normal practices of scientific authorship. All such publications will acknowledge the origins of the data and the authors are obliged to notify and seek permission of the scientists with data rights and to circulate drafts of the papers in advance of publication.

APPENDIX: SOME MAJOR COMPONENTS OF THE ASB CONCEPTUAL FRAMEWORK

THE PROBLEM:

Slash and burn (or shifting cultivation), the traditional farming system over large areas of the humid tropics for centuries, today remains the dominant land use practice on about 30% of the arable soils of the world and provides sustenance for an estimated 250 million of the world's poorest people and additional millions of migrants from other regions.

Recent estimates indicate that about 23% of global warming is due to greenhouse gas emissions resulting from the clearing of tropical rainforests. Most of current deforestation is in tropical America and tropical Asia, accounting for 40 and 37% respectively of estimated net carbon emissions from deforestation in 1980. Tropical Africa ranks third, with 23% of the emissions. Deforestation rates have almost doubled during the last decade: from 7.6 million hectares per year in 1979 to the current estimate of 15.4 million hectares per year. Two thirds of the clearance is estimated to be for purpose of opening up land for slash and burn or other agricultural practice. Tropical forest destruction has major effects on biodiversity illustrated by the estimated annual loss of 5 800 species of plants. After deforestation, soil organic matter may act as an additional source of carbon dioxide to the atmosphere or as a sink where carbon dioxide may be sequestered depending on how the land is managed. Soil erosion rates of up to 200 t/ha have been estimated for recently cleared land, with resultant siltation of major rivers.

There is little reliable quantitative knowledge about fluxes of carbon dioxide, nitrous oxides or methane due to shifting agriculture. Hard data from well-replicated experiments and surveys are needed to determine the current extent and nature of the environmental impact of these systems. The contribution of tropical land use to global change is one of the uncertainties in current models.

Tropical deforestation is also a major human equity concern, because slash and burn is largely practised by the poorest rural populations of the tropics who also bear the major environmental costs of deforestation.

The process of deforestation is driven by a complex set of demographic, biological, social and economic forces. Population growth in developing countries continues at a high rate, while most of the fertile and accessible lands are already intensively utilized. Government policies often exacerbate land scarcity by allowing inequities in land tenure. These factors result in an increasing landless rural population that essentially has three choices: stagnate in place, migrate

to the cities, or migrate to the rainforests that constitute the frontier in a number of developing countries. Although urban migrations are spontaneous, national policies in some countries such as Brasil, Peru and Indonesia include the occupation of their tropical rainforests through colonization programs. Migration is less significant in Africa than in Latin America and Asia.

Traditional systems of shifting cultivation are ecologically and environmentally sound but guarantee perpetual poverty: there is no such thing as a prosperous shifting cultivator in the humid tropics. The traditional systems are sustainable but only for low population densities with low incomes and low crop yields. The traditional systems are consequently being rapidly replaced by shifting cultivation in disequilibrium, often practised by migrants from other regions who are unfamiliar with the humid tropics and ignorant of the sophisticated practices of indigenous cultures that make shifting cultivation a sustainable system. Shifting cultivation is not sustainable when significant increases in land productivity are required to support higher human population densities and increased demand for food and fibre. Recent increases in population growth, as well as transmigration to areas with less fertile soils, have placed great pressure on farmers to increase the productivity of limited land resources by expanding the length and intensity of the cropping period and decreasing the fallow period.

As the time available for secondary forest fallow growth decreases, the fertility and productivity of the soils continues to decline. Furthermore, when the fallow period is shortened, it generates a disequilibrium of carbon input-output ratios and intensifies nutrient mining. Complex and often adverse ecological changes occur, such as invasion of *Imperata* grasslands and reductions in the number of viable native seeds left for regrowth. Re-establishment of secondary forest fallow vegetation is slowed or stopped, some soil becomes bare, and erosion begins. This situation is typified by the so-called "derived savannas", which occupy more than three-fourths of the previously tropical moist forests of West Africa. Soil erosion is seldom a significant problem in traditional shifting cultivation, because the land area is relatively small and is always covered by some sort of vegetative cover such as fallen logs, ash, crops, weeds or forest fallows. When shifting cultivation is practised by newcomers to the humid tropics, the land is often devoid of soil cover for considerable time. This can lead to major erosion and siltation of rivers, particularly in hilly areas.

The trends towards expansion of the cropping cycle and a decrease in the fallow period are central to the problem of non-sustainable production. They are also the key trends affecting the contribution of slash and burn to global warming. In particular the net reduction in soil organic matter and plant biomass through intensification and modification of traditional systems are the

main mechanisms by which slash and burn is, if anything, increasingly contributing to the greenhouse effect.

The two problems, environmental degradation and human poverty and their solution, go hand in hand.

THE RESPONSE:

The implementation of policies to combat tropical deforestation is a relatively new field, but some strategies are beginning to emerge. The environmental community generally cites four major approaches to decrease tropical deforestation. These are:

a) promoting economic development and more equitable land tenure in densely populated tropical areas;
b) encouraging migration away from forest margins to less fragile areas;
c) preserving the remaining forests by a network of well-protected national parks; and
d) promoting the sustainable use of the forests as extractive reserves.

All these policies are necessary but none alone, or even all four together, is sufficient to mitigate deforestation if no account is taken of the food production needs of the forest dweller. A fifth strategy, which links environmental protection with alleviation of poverty, the twin problems identified above, is advocated as the missing component. The guiding principle of this strategy is:

control deforestation in situ by eliminating the need to clear additional land.

This should be done by both: (i) providing sustainable alternatives to destabilised slash and burn practices, and (ii) reclaiming abandoned and degraded lands that are declining in productivity, including secondary forest fallows and unproductive grasslands.

Sustainable land-use management options are urgently needed that improve the economic status of subsistence farmers, maintain agricultural productivity on deforested lands and recuperate productivity of degraded lands. Such options will provide sustainable development of the forest margins in a way that satisfies human needs and preserves the ecosystem. These options must be compatible with the different socioeconomic needs of specific areas so that they are readily and widely adopted. In addition we should be concerned with how and why deforestation occurs, how the people living in and around forests are affected by deforestation processes, how

they react individually and collectively, and what role is played by government policies. Research activities should focus on the interactions of slash and burn processes at the local level, but also take into account broader processes and systems at zonal, national and regional scales. In this context, the agroecological and economic foundations of sustainable agriculture will be established, as a basis to develop biologically-based management systems, which answer farmers' needs.

No land use technology, however, is likely to be used without significant policy changes that provide adequate market and infrastructure development and at the same time protect the remaining rainforests from being cut. The need for solid policy research on tropical deforestation is thus as important as biophysical research. Furthermore, there is a need to assess how economic growth affects rates of forest clearance, how agricultural intensification affects migration, and how new technology affects both aspects.

Linking environmentally oriented strategies with economic ones provides a practical, realistic approach. New efforts in this direction are beginning to emerge. A few deforesting countries have developed policies to contain deforestation primarily in response to national and international environmentalist pressures. Some of these policies are unworkable however and in some cases have had severe negative effects on the economy. Linking poverty alleviation with forest protection provides a mechanism for avoiding these conflicts.

Rice-Wheat Consortium for the Indo-Gangetic Plains

J G Ryan

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International Crops Research Institute for the Semi-Arid Tropics

Introduction

In August 1994 ICRISAT, at the invitation of TAC, submitted a proposal requesting seed money for a Systemwide Initiative 'Sustainability of Rice-Wheat Based Cropping Systems in the Indo-Gangetic Plains'. This proposal was submitted by ICRISAT (the Convening Center) on behalf of the National Programs in Bangladesh, India, Nepal, and Pakistan, IRRI, and CIMMYT, and other regional and international institutions. This proposal arose from meetings in Islamabad, Pakistan in April and New Delhi in May 1994 involving the National Programs, the concerned International Centers, and donors. This proposal builds on the R-W Initiative established in 1990 with funding by ADB but with greater responsibility for planning and supervision given to the NARS. A brief review of the activities and organization of the Consortium is given in the sections 'Some details of the partnership' and 'Responsibilities and linkages' in the present proposal.

The original proposal was reviewed at the Special Meeting of TAC in Davis, California in August 1994 and their evaluation included in the Review of Proposals for Systemwide Initiative and Ecoregional Initiative (Ref: AGR/TAC:IAR/94/11 dated 8 September 1994) presented at the International Centers' Week (ICW), Washington DC, 24-28 October 1994. In its evaluation TAC considered this proposal to be potentially very powerful and on the methodology and activities well thought through. They considered it to be a good example of a Center accepting Convening responsibilities while other institutions led the research. TAC recommended, however, that IIMI and IFPRI be given a clear role in the Consortium and that the collaborative links as agreed to by these Centers be spelled out in a revised proposal.

In addition TAC requested that the functions and responsibilities of all partners be specified and related to expected outputs and benefits and that a reporting process be laid out.

The present document takes into consideration the progress made since the August 1994 proposal and the recommendations made by TAC in its evaluation of the earlier document. The document was circulated to the Consortium participants and their suggestions incoporated. The revised version was reviewed by the Regional Technical Coordination Committee, and passed by the Regional Steering Committee. It was also presented to the ICRISAT Board of Governors. The budget continues to be based on the one prepared by the NARS representatives in the April 1994 meeting and cleared by them at subsequent meetings. The present budget reflects Donors' insistence that IARC inputs into this Consortium be funded from their own core budgets and that the National Programs demonstrate their interest by committing facilities and funds to national R-W research.

Their substantial commitment has been summarized in the proposed budget document. The funds requested in the budget are to support the regional collaborative activities of the Consortium. These activities are intended to link the resource of the Consortium members to make the strength of the whole greater than that of the parts.

The Problem and Its Relationship to CGIAR Goals, Priorities, and Strategies

There are early indications that the productivity of the 12 million hectares of rice-wheat cropping systems in the Indo-Gangetic Region, which were central to the Green Revolution of the 1960s and the 1970s, is running into sustainability problems. The threat that these problems pose to overall food security in the region, and to the livelihood of millions of small farm families, has prompted an initiative among the countries in South Asia to strengthen their collaboration in research. Their goals are to find ways of increasing food production and to introduce new technologies suitable for the farmers of the region. The initiative between senior agricultural administrators of Bangladesh, India, Nepal, and Pakistan, together with the CGIAR centers, IRRI, CIMMYT, ICRISAT, IIMI, and IFPRI, and other NGOs with the support of the Asian Development Bank, UNDP, and the World Bank, is designed to guide both policy and the strategic research framework in addressing sustainability and productivity issues, as well as to facilitate collaboration between the agricultural researchers and technicians of the region.

The Indo-Gangetic plain is one of the most productive agricultural areas in the world, feeding many millions of people more than the vast resident population. During the past 25 years, the threats of crop failure and famine in South Asia have been kept at bay by the Green Revolution in rice and wheat production. Despite expanding populations, production of rice and wheat in Bangladesh, India, Nepal, and Pakistan has kept pace with demand. Rice and wheat now constitute a major proportion of the food supplies in South Asia. In the early 1950s, rice and wheat accounted for only a third of the grain production in India. However, by 1989 their share had risen to more than 80% In Bangladesh and Pakistan, the share of rice and wheat is more than 90% of the total cereal grains produced, while in Nepal they constitute approximately 70% of grain production[1]. Imported cereals have shrunk to a small fraction of the total consumption.

A third of the irrigated rice and half the irrigated wheat in South Asia comes from the rice-wheat cropping system. Under this system, farmers grow rice in the *kharif* (monsoon) season and follow it with wheat in the *rabi* (winter) season. Farmers use this system on 12 million ha in South Asia, stretching over large areas of Pakistan, northern India, Nepal, and Bangladesh. China has an additional 10 million ha of rice-wheat cropping. Hundreds of millions of poor farm families rely on this cropping system for a large share of their income and employment.

Technical changes introduced through the Green Revolution led to a rapid expansion of the rice-wheat system, increased its productivity, helped increase farmers' incomes, reduced food costs for low-income consumers, generated employment for landless laborers, and indirectly stimulated rural small industry. The widespread use of new rice and wheat technologies, often associated with farmers' adoption of the rice-wheat

1. FAO Production Year Book, 1990

system, played a leading role in the agricultural development of many parts of South Asia. Despite its enormous accomplishments, this Green Revolution is now showing signs of fatigue.

Regional food production must increase by 2.5% every year to meet the demand of growing populations, raise their incomes, and reduce malnutrition. In 1990 over half the world's 192 million underweight children under 5 years of age lived in South Asia. With currently available germplasm and technologies, productivity growth of the rice-wheat system in the high-productivity areas is unlikely to exceed current levels of about 2% per annum, below the rate of population growth. During the 1980s, in the rice-wheat areas where technical innovations were most widely applied, yields per hectare did not increase so rapidly as they did in the first decade or so of the Revolution. An analysis of the production statistics for the high-productivity zones of Punjab and Haryana in India shows that the peak yield growth rates of 10-12% that characterized the Green Revolution, are now over. In other regions of India, yields are still at a much lower level than those of the northwest, and the potential remains to further exploit the available germplasm.[2]

This decline in the rate of productivity growth is shown by comparing Punjab, Haryana, and all-India rice yield trends over the period 1956 to 1989. A very rapid growth occurred in rice yields between 1965 and 1977, but subsequently the yield growth rate slowly declined in Punjab and Haryana in the late 1980s. For the rest of India, yields have increased steadily, but to levels well below those in high-productivity zones. In Bangladesh, average wheat yields have declined since the peaks in 1983 and 1988. For the Terai region of Nepal—although no single set of data unambiguously confirms any long-term decline in productivity—the emerging reports from various sources also give cause for concern[3]. In the Punjab of Pakistan, the story is the same, showing a familiar pattern of rapid growth in rice yields between the mid-1960s and mid-1970, followed by a plateau and decline in the 1980s.

Along with the fall in the rate of yield increase, the indications are that the productivity of resources devoted to the rice-wheat system is also weakening. Water-induced land degradation (salinization, sodification, ground-water depletion) in the western (high cropping intensity) part of the rice-wheat belt has become a major problem. Problems such as the slow loss of soil fertility (possibly from changes in the way farmers manage organic matter in combination with a more sustained removal of nutrients associated with more intense cropping) may also be occurring. In addition, the damage caused by certain pests, diseases, and weeds seems to be increasing. Many of these processes (e.g., nematode build-up) are obscure and puzzling. The consequence of all of these processes, however, is clear: increasing levels of input use are needed merely to maintain crop yields. Total factor productivity is declining.

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2. Makin, Michael C., and Rao, Mangina V. Rice and Wheat Production and Sustainability of the Irrigated Rice-Wheat Cropping System in India. World Bank Internal Report (unpublished), June 1991.

3. Harrington, L., Hobbs, P., Pokharel, T., Sharma, B., Fujisaka, S., and Lightfoot, C. The Rice-Wheat Pattern in the Nepal Terai: Issues in the Identification and Definition of Sustainability Problem. Journal for Farming Systems Research Extension, Vol. 1, No. 2, 1990.

At present, little information is available on the extent of any degradation that might have already taken place in the rice-wheat systems. The quantification of sustainability parameters is exceedingly difficult (e.g., measurement of regional trends in factors associated with declining soil fertility). Nonetheless, the possibility of soil and water degradation must be taken seriously for several reasons:

- Long-term experiments on continuous rice-wheat cropping have shown that, over time, yields of both crops decline at constant input levels.
- Surveys reveal that farmers who have recently adopted the rice-wheat pattern tend to be enthusiastic about initial observed yield increases. However, farmers who have a decade or more of experience with this system are becoming concerned about stagnant crop yields, even with higher rates of inputs.

Two ominous signs are therefore emerging:

- The rates of productivity growth for rice and wheat are declining.
- The quality of the soil and water devoted to the rice-wheat cropping systems may be declining (from over-mining of soil nutrients, decline of organic matter levels, increasing salinity, etc.), coupled with a build-up of weed, pathogen, and pest populations, all of which might be leading to stagnating yields.

These problems are exacerbated by rapid population growth, loss of land to urbanization, a slowing in the growth of fertilizer use, dwindling availability of new agricultural land and water resources, increased demand and competition for water for non-agricultural uses, and the need to increase production from land that is already double- and even triple-cropped. Urgent action is needed to ensure adequate future supplies of rice and wheat.

It is also noteworthy that the Technical Advisory Committee (TAC) of the CGIAR recognized the importance of the rice-wheat system and recommended in its 1993 Priorities and Strategies paper (Chapter 13) that IRRI and CIMMYT work with national agricultural research systems (NARS) in the region on a rice-wheat program as part of the CGIAR ecoregional program for the warm arid and semi-arid tropics and subtropics for which ICRISAT has been made the Convening Center. TAC has subsequently suggested that IIMI and IFPRI be included in this ecoregional initiative. Many of the guiding principles that TAC enunciated for the ecoregional approach to research are relevant to this initiative and form a valuable framework for it.

In summary, problems associated with the rice-wheat system of Bangladesh, India, Nepal, and Pakistan are appearing that threaten the sustainability of this vital component of the food security of these populous countries.

Research Methodology and Approach

One of the major tasks of the collaborative initiative proposed in this document will be to locate the specific areas most seriously threatened in these countries, identify the biological, physical, and socioeconomic causes of the problems, and develop, test, and promote the implementation of more sustainable, high productivity cropping systems.

At a meeting sponsored by the World Bank, held in New Delhi in January 1993, the heads of agricultural institutions from the Indo-Gangetic Plains region met with the directors general of IRRI and CIMMYT. The consensus of that meeting was the need to establish a collaborative research management mechanism to:

- **Foster vision** by enabling researchers from different institutions, backgrounds, and disciplines to perceive the complex of rice-wheat problems in a similar way, with a shared sense of what must be done, and with an equivalent sense of the comparative advantage of each participant in the common research process
- **Operate flexibly** by being able to draw on an array of specialists as needed to support high priority research activities
- **Avoid isolation** by linking rice-wheat research specialists to other branches of research and extension
- **Offer incentives** by making inter-institutional (and international) collaboration attractive to participants and by fostering quality work among scientists
- **Introduce new methods** such as farmer participatory research, which may have been developed elsewhere, which could be relevant to the problems at hand
- **Set priorities** by focusing research on problems affecting many farmers, with an emphasis on solutions most likely to be attractive to farmers
- **Enhance the transfer of improved technology** to farmers through established institutional linkages with the various Departments of Extension and Agriculture

This shared vision forms the basis for the collaborative research initiative.

Projected Activities and How They Will Help to Solve the Problem

The research model of the Green Revolution era focused on increasing productivity within a single crop. The model was an improvement on the discipline-oriented model because it organized a multidisciplinary team of scientists to address issues of increasing productivity of a single commodity. The results of the Green Revolution decades of the 1970s and 1980s are evidence of the success of this commodity approach. The research was mainly dominated by breeders, had short-term time horizons, and benefitted from developing packages of technology that could be tested over a wide range of environments.

The commodity research model is proving insufficient to solve the post-Green Revolution system level research issues. These post-Green Revolution problems require the evolution of national research programs that promote team work that focuses on system issue constraints at specific research sites. This requires rethinking and reorganizing existing research systems to address these new issues. It needs program planning to be done by a multidisciplinary team that should include social, biological, and physical scientists.

The planning process requires a more detailed diagnosis of farmer production constraints including a good characterization of the targeted site and detailed analysis of the prob-

lem-cause relationships so that appropriate solutions can be developed. The diagnosis, like the program planning, must be done by the multidisciplinary team keeping system interaction perspectives as guidelines and ensuring strong links with, and participation of, farmers and extension staff. The identified farmer problems are prioritized and responsibilities for key research components of the research agenda assigned to scientists with the necessary expertise.

New skills and methodologies are identified, when available, to improve the efficiency of the research. Training and strengthening of national program staff is organized to attain these new skills. Links are developed between national, regional, and international programs to attain the goals of the research.

This improved ecoregional model has a system perspective that requires both short- and long-term research agendas that look not only at productivity but also sustainability and natural resource degradation. Also required are the quantification and direction of rice-wheat productivity trends and the identification of those soil, biological, and other factors responsible for these trends. This requires research to look at farmer production constraints over a much longer time frame than the old commodity model.

Research Projects

During the meeting of the Steering Committee of the former ADB-funded Rice-Wheat Project in April 1994 in Islamabad, the following research projects were formulated:

Project 1 *Productivity trends* – quantification and characterization of factors leading to changes in trends; includes monitoring the farm resource base and environmental pollution

Project 2 *Crop establishment* – development of appropriate and improved methods (because of changes in soil structure) including varieties, land preparation, fertilizer application, equipment, and evaluation of long-term consequences

Project 3 *Sustaining soil fertility* – understand long term processes by monitor soil fertility, develop analytical indicators, and analyze the role of crop rotation, organic amendments, crop residues, balanced fertilization, and management of macro and micro nutrients on soil fertility.

Project 4 *Water management* – in intensive rice-wheat systems including salinity and water pollution

Project 5 *Ecological consequences* – of intensive rice-wheat systems including salinity, water pollution, pest ecology, nematodes, and soil microbiology

Project 6 *Policy options* – that enhance sustainable resource management including analysis of output/input prices (including water), subsidies, credit, marketing, implications of trade policies, and increased migration to urban areas

The comparative advantage (as assessed by each country at the Islamabad Meeting) in addressing the various research projects is shown in Table 1.

Proposed Research Focus

The Regional Technical Coordinating Committee (RTCC) met in Kathmandu, Nepal, 22-24 November 1994 to identify the research thrusts of the Consortium for the near and long term. The National Conveners from Bangladesh, India, and Nepal, representatives from CIMMYT, IRRI, ICRISAT, and IIMI and the Interim Facilitator participated. In addition there were observers from each country and institution plus China, IBSRAM, and Cornell University. This meeting developed a strategic plan using a problem-solving process. This strategic plan is being used as a guide for developing detailed collaborative projects for submission to donors for funding. A description of the problem-solving process and the strategic plan follow.

Table 1. Comparative advantage in addressing research projects for international collaboration by country, IARCs, and other institutions.

Projects	Bangladesh	India	Nepal	Pakistan	IRRI/CIMMYT	Other Institutions
1. Productivity trends	***	**	**	**	***	
2. Crop establishment	***	***	***	***	**	
3. Sustaining soil fertility	***	**	***	***	***	IFDC, Cornell, ACIAR, ICRISAT
4. Water management	**	*	*	*	*	IPTRID, IIMI
5. Ecological consequences	*	***	*	*	*	
6. Policy options	***	*	***	***	***	IFPRI

Note: These were prioritized based on the capabilities and resources of each country as follows:
* = medium advantage,
** = high advantage,
*** = highest advantage.
The last column indicates some of the international and national institutes in developed countries that might supplement the efforts of the NARS, IRRI, and CIMMYT; amongst others, ICRISAT, IIMI, and IFPRI will also play a role.

The Problem-solving Process

A problem-solving process was suggested as a framework for linking the various kinds of research activities being launched in the name of the rice-wheat initiative. The process was helpful in many ways, particularly in broadening the perspective of participating scientists, many of whom tend to focus on only one or two of the functions described in the framework (e.g., strategic technical research on degradation processes, and on possible prototype interventions). It was noted that caution is needed to ensure that interactions among problem areas are not ignored.

The following is a summary of the process and how on-going rice-wheat research activities fit into it.

Function	Research activity
1. Problem definition – physical, chemical and biological *processes* underlying the various problems	• Modeling of plant growth, nutrient cycling, water balances, e.g., by IRRI, Cornell, others. • Some long-term trials where adequate technical data is gathered in a time series (NARS, CIMMYT)
2. Problem definition – *causes* of problems, leading back to the effects of farming system interactions, and institutional and policy considerations	• Diagnostic surveys involving CIMMYT, IRRI, and NARS
3. Problem definition – *consequences* of the various problems	• Analysis of secondary data on long-term trends in system productivity (CIMMYT, IRRI) • Some information from long-term trials (NARS, CIMMYT) • Farmer monitoring (NARS, CIMMYT) • Modeling (IRRI)
4. Problem definition – *incidence* of the various problems	• Early efforts at definition of production environments, or rice-wheat ecologies (IRRI, NARS) • GIS (little investment in this at present)
5. Problem definition – *pace of change* in system productivity or land quality associated with the various problems	• Modeling (little investment in this at present) • Farmer monitoring (little investment in this at present, too early to be able to measure the pace of change in system productivity or resource quality)
6. Development of prototype solutions – *crop establishment* (especially for the *rabi* season)	• Strategic technical research on surface seeding, zero or reduced tillage, ridge tillage systems, new machinery and implements, improvements in seed management and seed quality (CIMMYT, NARS)
7. Development of prototype solutions – *integrated nutrient management*	• Strategic technical research on fertilizer use efficiency, green manures, break crops (e.g., sugarcane, legumes, potatoes), crop residue and compost management, livestock management and alternative fuel sources. (Some earlier work on fertilizer management and green manures – not very encouraging, otherwise little work done on these prototypes – NARS, IRRI, CIMMYT, ICRISAT)

8. Development of prototype solutions – *water control* and *water use efficiency*	• Strategic technical research on efficient plot-level water management (e.g., dry seeding of rice, ridge tillage systems for *rabi* season crops, drainage – CIMMYT, IRRI, NARS) • Strategic technical research on efficient system-level water management (conjunctive use of water resources, drainage, water pricing policies – NARS, IIMI) • Strategic technical and associated policy research on strategies for controlling salinity and sodicity (NARS, IIMI)
9. Development of prototype solutions – *system ecology*, soil health, and build-up of pests, diseases and weeds	• Strategic technical research on approaches to maintenance of soil health, e.g., break crops, crop residue and compost management, etc. (unclear how much of this has been done) • Strategic technical research on alternative methods for controlling weeds in *rabi* season crops, e.g., ridge tillage systems
10. *Adaptation of prototypes* to specific farming systems and farmer groups	• Some farmer participation in adapting tillage equipment in some sites in India (NARS, CIMMYT) • Some farmer participation in developing water management strategies (NARS, IIMI) • In general, inadequate investment in adaptive research – NARS need to take the lead but IARCs and other actors (e.g., IBSRAM) may need to help with methods
11. *Accelerating adoption*	• Some adoption studies done on the effect of price policy on water management (IFPRI, NARS, others), green manures (NARS, IRRI), etc. • Otherwise, inadequate investment in studies to understand factors shaping adoption, and the opportunities to accelerate adoption through institutional and policy change
12. *Monitoring and evaluation* of progress being made through investment in rice-wheat research through the ecoregional structure	• Little thought is being given by anyone to this function, apart from some conceptual work being done on sustainability indicators (IRRI, CIMMYT, IIMI)

The 'Demand' Side – NARS Suggestions and Requests

NARs participants were given the opportunity to meet among themselves, with no international representatives present, to determine the kinds of skills and services they feel that they need from international actors. Here is a summary of their findings.

Request	Addressed to	Function
Tillage equipment, including zero-till machinery, seed cum fertilizer drills, etc.	CIMMYT, other IARCs, China	6
Access to genotype/genetic resources to suit changed requirements of tillage, crop duration, diversification, etc. including legumes and green manures	CIMMYT, IRRI, ICRISAT	6, 7, 9
Collaborative research on soil fertility maintenance, including nutrient dynamics and organic matter management and utilization, crop diversification, etc.	IARCs, China, developed-country institutions, e.g., Cornell	1, 7
Collaborative research on water management issues, including efficient drainage systems at the macro- and micro-levels (particularly in high rainfall ecosystems), enhancing water use efficiency (e.g., synchronization of water supply with requirements), water conservation (e.g., policy change), conjunctive use, etc.	China, IIMI, IRRI, IFPRI (?)	1, 8
Collaborative research on IPM, including monitoring of pest resistance, biology and dynamics of change, studies on pest resurgence, biological control systems, rotational studies, etc.	Appropriate international organizations	1, 9
Collaborative research on integrated nutrient management, including the role of micronutrients in crop and soil health, status and availability, animal and human health, etc.	Appropriate international organizations	1, 4, 7, 9
Opportunities for graduate and post-graduate training, need-based equipment and spares, short-term capability upgrading programs for NARS staff, etc.	Appropriate international organizations	na

Use of roving seminars, workshops, joint publications to promote better communication	Appropriate international organizations	na
Improved research management, including monitoring efficiency of sites and site coordinators, improving communications, etc.	Appropriate international organizations	12

Strategic Plan

The outlines of a strategic plan were developed during the final part of the RTCC Meeting by matching the 'demand' side put forward by the NARS with the 'supply' side offered by the IARCs (listed later). The issues and activities fell into four major groups:

Soil Fertility

A. Nutrient dynamics and simulation modeling

- Identify consultant(s) to take stock of existing long term R-W experiments (6 months). Organize a workshop of the scientists involved in these experiments to discuss ways to standardize data collection and analysis and produce publication(s). Identify necessary modifications to the existing set of experiments.
- Develop, at one or two chosen sites, suitable models to explain production trends and key indicators of sustainability. Test the model at other sites.

B. Organic matter recycling and enrichment

- Convene a workshop to develop innovative approaches to study soil organic matter in R-W based cropping systems including the dynamics of organic matter content, options for animal and crop residue use, and farmer management systems and recycling methods. Research on inclusion of legumes, green manures, and other break crops is also needed. Such research will be strengthened by farmer participation to identify reasons and solutions for enhanced adoption.

C. Micronutrients

- Identify cultivars and, if necessary, breed plants that are more tolerant to micronutrient deficiencies, can scavenge more efficiently, and store greater amounts of micronutrients in their seeds. Use systems diversification. Apart from increasing yields, improved micronutrient efficiency can also enrich the nutrition of poor people.

D. Soil testing and analysis

- Develop a methodology to calibrate fertilizer use to meet target yields and share the data at a workshop.
- Monitor soil fertility trends on station and in farmers' fields using benchmark sites and standardized methods. Organize an on-farm methods course for scientists.
- Upgrade facilities and human resources in laboratories for soil/plant/water analysis.

E. General

- Link the four soil fertility activities to overall productivity and sustainability across the ecoregion using GIS.
- Farmer participatory techniques need to be improved to define problems more clearly and identify adoption rates of solutions.

Water Management

- Identify and measure indicators of productivity and sustainability in relation to progress and impact of existing irrigation schemes, water tables, salinity and sodicity, waterlogging, and water distribution.
- Improve water-use efficiency at crop, farm, and system level.
- Determine the value of efficient drainage in relation to crop establishment after rice and on the system's productivity. Initiate trials on permanent ridge and furrow systems.
- Study the effects of policy issues on water management efficiency at selected sites.

Integrated Pest Management (IPM)

The focus of IPM is on the interaction between pests (diseases, insects, rodents, weeds, and other biological organisms) and IPM interventions. The aim is to provide pest control in the cropping system with minimum chemical use and minimum impact on the environment. Activities include:

- Spatial characterization of pest complexes.
- Assessment of pest problems in long-term trials.
- Diagnostic monitoring of farmers' fields to provide hypotheses for testing cropping patterns on pest levels.
- On-farm experiments to identify pest carryover between crops.
- Identify IPM components.
- Propose rational pesticide policies to help prevent development of pesticide resistance or contamination of the environment.

Ongoing Activities

- **Continue crop establishment** trials designed to reduce the turnaround time between crops and provide timely seeding. This includes the introduction of appropriate tillage and seeding equipment and innovative seeding practices.
- **Breed** to introduce genotypes that better fit existing cropping patterns and ones to enhance new patterns.
- **Monitor productivity** trends in farmers' fields, conduct long-term trials, and strengthen the use of GIS.
- **Identify innovative policy options** by including on each research team scientists knowledgeable in policy matters. These options will be considered when putting forward any research recommendations.
- **Maintain intellectual exchange** among the participants in the Initiative through workshops, roving seminars, country to country consultancies, and training.
- **Emphasize the importance of the systems approach** where research is conducted by multidisciplinary teams that include scientists from all disciplines.

Next Steps for the Strategic Plan

It was agreed that the issues in the above strategic plan would need to be fleshed out as proposals for funding. These proposals are to be developed by groups meeting in designated countries. A lead center would be selected to coordinate the regional, strategic research to be done. Funding proposals would be developed, where needed, to complement existing funds and help promote research in areas where knowledge gaps exist and new resources are needed. Suggestions of possible national and international actors and sites for all the three main groups of issues were made. There is need for immediate seed money to bring the groups together to prepare the proposals for research and for funding for each group of issues. It was suggested that work be done on one document first (perhaps micronutrient or IPM) as a model for the others. Suggestions were given as to which of the national and international groups might be involved in developing detailed work-plans and the locations for the trials. The strong point of these proposals will be that they will be an integral part of a region-wide agenda determined jointly by all research partners.

Major Problems, Research Themes, and Possible Interventions

The following are major problems with their possible interventions based on the work and experiences with rice-wheat systems over the past several years. Priority research topics and candidates for incremental funding support under the collaborative initiative would need to be identified.

Problem	Research themes	Possible interventions
Soil fertility decline	Integrated nutrient management	• Break crops (sugarcane, legumes, potatoes) and development of new rice and wheat varieties compatible with new cropping systems • Improvements in crop residue and compost management • Development of alternative forage sources (to free up crop residues for compost) • Development of alternative fuel sources (to free up farmyard manure for compost) • Improvements in inorganic fertilizer use efficiency (e.g., later application) • Assessment of the role of micronutrients in crop and human health • Green manures
Groundwater depletion and water-induced land degradation (salinity and sodicity)	Water control, water use efficiency, and water pricing	• Improvements in plot-level water management (dry seeding of rice, ridge tillage systems for winter crops, drainage) • Improvements in system-level water management (conjunctive water use, drainage infrastructure, water and electricity pricing policies, community participation in water system management) • Wider use of techniques for controlling salinity and sodicity (conjunctive water use, drainage infrastructure, gypsum application)
Problems associated with system ecology, e.g., declining soil health, build-up of pests, diseases and weeds	Integrated pest and weed management	• Development of practices to help maintain soil health (break crops, improved crop residue and compost management) • Development of new rice and wheat varieties with tolerance to biotic stresses • Ridge tillage systems to improve weed control while reducing herbicide use • IPM, including monitoring of pest resistance, pest resurgence, effects of alternative cropping systems and biological control systems

Problems associated with stagnant productivity (apart from those associated with the natural resource issues discussed above)	Crop improvement and crop establishment	• Development of highly productive, stress-tolerant varieties of rice and wheat • Zero tillage or reduced tillage for winter crops, including surface seeding and ridge tillage practices to reduce costs, accelerate sowing, and improve yields, while reducing input use • Improvements in seed management and seed quality

Participating Research Organizations

I. NARS

Bangladesh	Bangladesh Agricultural Research Institute Wheat Research Centre Bangladesh Rice Research Institute
India	Indian Council of Agricultural Research (ICAR) several ICAR institutes several state agricultural universities
Nepal	National Agricultural Research Council Rice Research Program Wheat Research Program National Agricultural Research Institute
Pakistan	Pakistan Agricultural Research Council National Agricultural Research Centre
China	Chinese Academy of Agricultural Sciences (as an observer)
IARCs	ICRISAT (Convening Center) CIMMYT (Lead Center) IRRI (Lead Center) IIMI (Water management) IFPRI (Policy)

Advanced Research Institutes

We will be seeking intellectual contacts with other national programs and international groups who can contribute to the Rice-Wheat Consortium. Preliminary contacts have already been made with the following groups:

IBSRAM	Cornell University
IFDC	CIP

Some Details of the Partnership

An initial meeting, convened in January 1993 by the World Bank, involved key national agricultural research representatives from the region, IRRI, and CIMMYT. Participants considered a proposal for a collaborative effort to follow through on the shared vision detailed above. That proposal was substantially improved upon by the ADB project Steering Committee in their meeting held in Islamabad in April 1994 and reflects the consensus of the NARS in South Asia. It now requires the support of the international donor community for it to become effective.

The long-term objective of the initiative is to form an alliance of scientific and technical experts of NARS with backstopping by IARCs to address issues of sustainable productivity in rice-wheat farming systems in the Indo-Gangetic Plain. The main attractiveness of the Initiative is that it will improve the cost-effectiveness of research and technology transfer by minimizing the duplication of work, encouraging complementarity and efficiency, and promote synergy within and between countries as they jointly resolve the common problems of natural resource degradation and productivity decline. The collaborative arrangements proposed are relatively flexible and informal.

The organization and management of the regional system will be based upon the earlier collaborative effort supported by the ADB. The next stage calls for greater leadership by the NARSs and a much longer commitment than has existed in the past, by providing for a management structure designed for a longer term. All parties to the collaborative initiative will consider participating in a program of at least a 10-year duration, subject to annual review and reconfirmation. The initial time period for which funding is being sought, however, is four years.

Responsibilities and Linkages

A. National level

- Research is aimed at site-specific, national, and regional sustainability problems. It is the responsibility of the national program to identify and prioritize their research problems and how they can benefit from collaborative activities in the Initiative.
- The national programs have identified and provided as part of the earlier project two test sites in each country (3 in India) with contrasting ecosystems. These sites have been characterized by diagnostic surveys. Monitoring of farmers' fields around the sites is ongoing. A multidisciplinary team of national program scientists carried out the survey with input from CIMMYT and IRRI. These teams are also involved in the research at each site.
- A national Rice-Wheat Research Convener has been designated by each national program. They have an overview of their national program and also have the authority to allocate research tasks, and share information and resources across national institutions.
- Rice, wheat and other commodity sectors are being linked to provide broad systems research.

- Multidisciplinary research efforts that address system-level biological and socio-economic problems are being encouraged and supported.
- To do this a National Rice-Wheat Research Committee has been established by each of the four NARS. These Committees have met with some support from IFAD to review the needs for rice-wheat research, and based on past results have identified problem priorities.

B. Regional level

Regional Steering Committee

The Regional Steering Committee (RSC) consisting of senior personnel has been established to promote integration of national and regional efforts. The RSC consists of one senior NARS executive from each of Bangladesh, India, Nepal, and Pakistan, one representative for the IARCs, one Donor Representative and the Facilitator as an ex-officio member/secretary. The RSC may invite resource persons to participate at their meetings if required.

The RSC has the following key responsibilities:

1. Provide policy guidance and direction for the overall Initiative.
2. Endorse research priorities, work programs, and budgets for the collaborative work as prepared by the RTCC.
3. Monitor the effectiveness of the Initiative in achieving its goal of improving the cost-effectiveness of the research effort to develop technologies for enhancing the sustainable production of rice-wheat based cropping systems in the Indo-Gangetic region.
4. Select and approve the Facilitator and commission an international research agency which would be responsible for providing the logistical support for the Facilitation Unit and the administration of funds provided for supporting the Initiative.

The RSC meets at least once each year under the Chairmanship of the host country for each particular meeting. The Chairman retains this responsibility until the appointment of the next Chairman at the subsequent meeting of the RSC. The Facilitator, as an ex-officio member, is responsible for reporting the decisions of the RSC and for initiating the follow-up actions.

Regional Technical Coordinating Committee

The Regional Technical Coordinating Committee (RTCC) consists of one senior representative (convener) from each of the four NARS together with the Facilitator and one representative from each of IRRI, CIMMYT, and ICRISAT assigned to rice-wheat activities in the region. The RTCC may invite other resource persons to participate. The RTCC has the following main responsibilities:

1. Review and discuss the national agricultural research programs, their deficiencies and constraints as presented by the national conveners. Develop collaborative programs in research and related activities to strengthen the cost-effectiveness of the

research effort so as to improve the sustainability and high productivity of the rice-wheat based cropping systems of the Indo-Gangetic region.

2. Prepare and approve, subject to endorsement by the RSC, the workplan and budget for collaborative activities in areas such as research, training, networking, and workshops.

3. Develop ways to strengthen and promote linkages between national programs and ensure the integration of collaborative activities among the national programs.

4. Serve as a forum for exchange of information between the key participants in the Initiative, and seek ways to facilitate the exchange of know-how and research results across the region.

5. Identify and bring to the attention of the RSC issues relating to the collaboration that may arise from time to time, and provide feedback to the RSC on the effectiveness of the ongoing work.

The RTCC meets not less than twice a year. Meetings are chaired by the host country representative. The Chairman retains this responsibility until the appointment of the next Chairman at the subsequent meeting of the Committee. The Facilitator is responsible for reporting the outcome of the meeting and for initiating follow-up collaborative actions.

Convening Center

At the First Meeting of the Regional Steering Committee (RSC) of the Collaborative Initiative, held 19-20 May 1994 at New Delhi, ICRISAT was commissioned as the convening Center. The responsibilities of the convening Center are as follows:

1. Recruit an interim Facilitator to be selected by the RSC, and subsequently, on behalf of the RSC, undertake an international search and recruit the Facilitator for the Initiative under terms and conditions acceptable to the RSC. (The Facilitator has been appointed.)

2. Provide, on a cost recovery basis, administrative, office and logistical support for the Facilitator and a small facilitation unit. The details should be spelled out in a specific agreement with the RSC. (The office has been established in ICRISAT's Delhi Office.)

3. Establish and provide the financial accounting of a multidonor account in a bank acceptable to the RSC for the receipt of donor funds made available in support of the Initiative. (A special separate account has been established within ICRISAT's accounting system.)

4. Authorize the Facilitator to draw on the multidonor account in accordance with the directions of the RSC, and provide to the RSC and donors an annual report by independent auditors of the use of these funds. (ICRISAT's accounts are audited by an independent auditor.)

Facilitation Unit

A small Facilitation Unit (FU) has been established by ICRISAT to support the RSC. It is being run by an internationally selected manager well respected in the region. The Unit is working closely with national conveners, and has technical backstopping from IRRI, CIMMYT, ICRISAT, IIMI, and IFPRI. The FU provides logistical support for the activities of the RTCC and RSC, publishes the Rice-Wheat Information Sheet, and acts as a communication node among the participants in the Initiative for both scientific and administrative matters.

C. International level

The Initiative has been established to:

- Strengthen collaboration of NARS with both the international agricultural research centers and other relevant institutions outside the region, especially in long-term, strategic research on rice-wheat system sustainability and productivity.
- Upgrade skills of collaborating NARS scientists through short-term training, post-doctoral fellowships, and exchange of scientists.

Contributions

Specific activities of various international institutions which may contribute to the Initiative were spelled out and discussed at the 22-24 November 1994 RTCC meeting in Kathmandu; they include:

Center	Offer	Function
CIMMYT	• Wheat germplasm development and exchange in relation to rice-wheat needs • Pathology studies on diseases in rice-wheat systems and identification of suitable cultivars or management practices • Studies related to tillage efficiency and crop establishment • Tracking productivity and sustainability trends at site level through farm monitoring • Development of methods with NARS for participation of farmers in adaptive research • Studies on seed viability and vigor and methods to improve germination and crop establishment • Work with NARS on ways to get new cultivars to farmers more quickly • Work with NARS research managers through regionally based scientists to adopt a systems-based, problem-solving perspective in rice-wheat research	1, 2, 3, 5, 6, 9, 10
Cornell	• Research on organic matter management and soil quality • Research on micronutrients • Research on seed quality • Research on soil health and root systems	1, 7, 9

CIP	• Role of potatoes in R-W systems	
IBSRAM	• Methods for monitoring of individual sites for changes in soil fertility and other sustainability indicators • Methods for implementing and analyzing long-term trials • Quality assurance for laboratory analysis • Research on organic matter management and soil fertility replenishment • Training in farmer participatory research	1, 3, 5, 7, 9, 10
ICRISAT	• Role of legumes in improving soil fertility and soil health • Crop establishment activities related to legumes • Germplasm exchange with NARS on legume crops including ICRISAT mandate legumes and if possible other grain legumes (lentil), green manures, and fodder legumes • Studies on efficiency of rhizobia use • Use of GIS and modeling for characterization of rice-wheat ecosystems • Adoption and impact assessment in relation to legumes • Work on a uniform regional database, linked to GIS	4, 6, 7, 9, 10, 12
IFPRI	• No representative was present from IFPRI, but it was understood that this institution would be interested in research on water pricing issues	2, 11
IIMI	• Conjunctive use of water and improvement in water use efficiency in both surface and ground water • Work on indicators of sustainability in relation to water resources • Policy analysis regarding water pricing in relation to product pricing • Work on issues related to drainage	2, 8, 11, 12
IRRI	• Research on long-term nutrient dynamics, especially the capability of soils to supply nitrogen • Modeling of maximum system yields • Characterization of national-level productivity trends and how these are affected by input and output prices • Core rice issues involving germplasm and rice crop establishment	1, 6, 7, 8

Function refers to the numbered list in the problem-solving process outlined earlier in the text.

Evaluation

The structure of the Initiative permits a continuous monitoring of the research progress. The site scientists monitor the situation on their farmers' fields; the National Conveners regularly visit the sites and review the progress with the site scientists; the scientists within each country meet at annual workshops to review their country program and their

involvement in the regional collaborative activities; the Conveners use this information to meet twice a year at their Regional Technical Coordinating Committee (RTCC) to review in detail the regional collaborative program; and the Regional Steering Committee (RSC) meets annually to review the reports from the RTCC and examine the budget statement. The Facilitator works with all these groups together with the IARC scientists stationed in the region through frequent visits, moving information among and within the groups, and working with them to critically review their programs and preparing progress reports. The Donor Support Group is kept informed through reports by the Facilitator and by their representative on the RSC.

Network evaluation by outside reviewers will be a continuing process with reviews being done biannually. Reports of external evaluation go to donors with copies to network participants and NARS administrators. Milestones of progress are developed at the time the research proposals and programs are set up and are kept in mind at all levels of the review process. These reviews will be the basis on which the network partners reaffirm their continuing participation.

Annexes of Participants and Supplementary Papers

Annexes des participants et des articles supplémentaires

Annex 1—Participants

Organizations represented

The 81 participants in the Workshop came from the following organizations. (Numbers in parentheses indicate participation by more than one representative.)

CGIAR and associated centers—IBSRAM, ICARDA, ICRAF (7), ICRISAT (7), IFDC (2), IFPRI (2), ILRI (3), IPGRI.

International organizations and specialized agencies—FAO, INCD, UNDP, UNEP (4), UNESCO/TSBF, UNSO (3), WMO.

Regional organizations—ACMAD, AGRHYMET (Niger), CILSS (Burkina Faso), IGADD (Djibouti), INSAH (Mali), SACCAR (Botswana).

National agricultural research systems (NARS)—Department of Agricultural Research (Botswana), IER (Mali), INERA (Burkina Faso), INRAN (Niger), KARI (Kenya: 2), NARO (Uganda).

National environment departments—Direction de l'Environment (Niger), Direction des Eaux et Forêts (Mali), Direction de la Météorologie (Niger), Institut de la Recherche en Biologie et Ecologie Tropicale (Burkina Faso), Kenya Meteorological Department, National Conservation Strategy Agency (Botswana), National Environment Secretariat (Kenya).

Nongovernmental organizations (NGOs)—Association Internationale Six "S" (Burkina Faso), Canadian Hunger Foundation (2), ELCI (Kenya: 2), ENDA-Zimbabwe.

Mentor and research institutions—CINADCO (Israel), CIRAD (France), CSIRO (Australia: 2), Institute of Hydrology/NERC (UK), ORSTOM (France), University of Adelaide (Australia), University of Copenhagen/SEREIN (Denmark), University of Wageningen/LAWOO (Netherlands), World Soil Resources (USDA).

Donor organizations—ACIAR (Australia), DANIDA (Denmark), GTZ (Germany: 2), IDRC (Canada), USAID.

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Annex 2

Sustainable Natural Resource Management Options to Arrest Land Degradation in the Desert Margins of Sub-Saharan Africa

A Proposal for a Systemwide Ecoregional Initiative

Submitted to TAC

by

The International Crops Research Institute for the Semi-Arid Tropics
(ICRISAT)
as the
Convening Center

On behalf of ILCA, ICRAF, IFPRI, ICARDA, IPGRI, NARS, Regional and International Institutes

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1. Background and Justification

1.1. Land degradation

On a global scale, 3.6 billion hectares or 70 percent of the potentially productive drylands are currently threatened by desertification, mostly by the degradation of natural vegetation partly accompanied by serious deterioration of soil. The most obvious impact, in addition to widespread poverty, is the degradation of the world's drylands: 3.3 billion hectares (or 73 percent) of the total area of rangelands, 215 million hectares (or 47 per cent) of the total rainfed cropland areas, and 43 million hectares (or 30 per cent) of the total irrigated areas.

In Africa, some 1.3 billion hectares comprising arid, semi-arid and dry sub-humid areas support a population of about 400 millions or two thirds of the African continent. Desertification threatens these areas at a moderate or high degree. An estimated 48.9 million ha of the total rainfed croplands, and 995.1 million ha of the total rangelands are prone to this risk.

Both soil erodability and erosivity are high in the semi-arid tropics and cause a decline in soil fertility. For instance, at Niangoloko in Burkina Faso, the increase in soil loss due to water erosion from 1.4 t ha^{-1} yr^{-1} to 13 t ha^{-1} yr^{-1} decreased yield of pearl millet from 729 kg ha^{-1} to 352 kg ha^{-1}. Loss of the surface soil results in loss of most plant nutrients especially basic cations, organic carbon and relatively immobile ions such as phosphorus. It has been estimated that 72% of African arable land and 31% of pasture land has already been degraded as a result of soil erosion.

Most of the soils in the semi-arid tropics are sandy and most cations and anions are subject to leaching losses. Losses of 23 N, 54.1 CaO, 13.6 MgO and 5.2 K_2O kg ha^{-1} yr^{-1} have been reported from the sandy soil of Bambey in Senegal. This situation is accentuated by a decreasing level of organic matter. Loss of cations in turn results in soil acidification and immobilization of soil phosphorus.

The assessment and characterization of the soil resource base indicated that the soils of sub-Saharan Africa are inherently low in fertility which is expressed through their low levels of organic matter, total nitrogen and effective cation exchange capacity. Crop production on these soils can be a function of both climatic and soil conditions. However, it has been concluded by various researchers that in the Sahel the low soil fertility is a more limiting factor to crop production than rainfall. The nutrient base of soil is being progressively depleted through more intensive cropping without compensating for the loss in fertility. A recent study attempted to quantify the extent of what has been described as "nutrient mining", namely the continual, inexorable depletion of nutrients from the soils by crops without any replacement or compensation through fertilizer or manure application. For example, the nutrient mining in Senegal was 14 kg N, 5 kg P_2O_5 and 14 kg K_2O ha^{-1} in 1993 and projections for the year 2000 are 20 kg N, 8 kg P_2O_5 and 21 kg K_2O ha^{-1}. Nutrient mining by crops which are increasingly being cultivated on marginal lands is promoting soil and environmental degradation at an alarming rate. However, for the Sudano-Sahelian zone where the rate of fertilizer use is the lowest in the world (10 kg ha^{-1} compared to 43 kg ha^{-1} in Latin America) and where farmers cite high cost as a major constraint to fertilizer use, the recent devaluation of the CFA franc will further reduce the use of this vital input and exacerbate the problem of land degradation. The consequence of this scenario on the sub-region's food security and fragile environment will be devastating.

It is important to recognize that, unlike rather abrupt catastrophes such as drought and locust infestation, soil fertility decline occurs gradually. This is why it is not linked to the food shortage of the recent past.

Land degradation has a considerable bearing on overall performance and prospects in most countries of sub-Saharan Africa, as they rely heavily on their drylands as the main resource base. The region's Gross Domestic Product (GDP) - excluding that of Republic of South Africa - is estimated to have grown by 1.8

percent in 1992. The GDP level indicates no improvement over the average annual growth of 2.6 percent in 1986-90 and is below the population growth rate of 3 percent.

Agricultural production per capita is stagnating or has even declined from the levels of the 1970s. Similarly, the average annual growth of GNP per capita, which in sub-Saharan Africa increased at 3.0 percent between 1965 and 1973, fell by 2.8 percent between 1980 and 1986, by 4.4 percent in 1987 and by 0.5 percent in 1989. Particularly in the Sudano-Sahelian zone, the population is well above the potential carrying capacity of the region.

1.2. Human dimensions of land degradation

Of the twenty most deprived countries, by UNDP criteria, all but six have a high proportion of territory in the drylands. Between 1980 and 2000, the amount of arable land available in these countries will fall from 0.37 to 0.25 hectares per head of population.

Increased intensity of cropping in West Africa has resulted in nutrient mining of the soil. Currently, some arable agricultural systems are not sustainable as a result of declining soil fertility and deterioration of the physical conditions and accelerated soil erosion by wind and water. The practice of fallowing to maintain and generate soil productivity is decreasing. Grazing land is diminishing as more land is brought under cultivation. Population growth and periodic drought are pushing farmers and herders to exploit marginal lands. As land deteriorates and/or is at the limits of its livestock carrying capacity, farmers and herders migrate southward in search of better natural resources.

An even more alarming situation is that traditional rural land use, especially in agriculture, may be approaching its limits of expansion, so that further increases in production may only be obtainable with improved agricultural technologies on currently cultivated land. The quality of the land under cultivation is also declining.

The World Bank has estimated that Africa's land under cultivation cannot be expanded by more than 1% per year without adverse environmental consequences. Increased cultivation of fragile soils contributes to land degradation. Pressures on arable land have worsened by the increasing demand for fuelwood and needs of livestock to graze.

To halt this trend, subsistence agriculture must be replaced with improved systems that promote higher production per unit area and per person on a sustainable basis. These systems should be based on improved soil and water conservation practices and integrated nutrient management methods including the use of organic manure, inorganic fertilizers, crop residues and crop rotations with legumes. A review of the state of art of the research in the region shows that on-station research has shown promising results but very few of these technologies have reached the small-scale farmers. Too little account has been taken of farmers' views, of indigenous knowledge, of social and economic realities, and of an enabling policy environment. Therefore, future research should focus on involving researchers, farmers, extension agents, non-governmental organizations and government policy makers at the design, implementation and evaluation stages. This way, the technologies generated have a better chance of adoption by the small scale farmers.

2. Proposed Research Methodology and Approach

This collaborative project is a direct response to UNCED Agenda 21, Chapter 12, Part B, calling for combating land degradation through, inter/alia, intensified soil conservation, afforestation and reforestation activities, particularly by introducing environmentally sound and economically feasible agricultural and pastoral technologies (para 12.18, a, ii). ICRISAT, ICRAF, ILCA, IFPRI, ICARDA and IPGRI, together with other CGIAR centers are addressing problems of desert margin areas.

Macro and Micro Diagnostic and Design exercises already undertaken by multi-disciplinary teams at the ICRISAT Sahelian Center (ISC) and national scientists in each country have identified the following major causes of land degradation in these countries:

- Soil erosion caused by both wind and weather
- Declining soil fertility and lack of external inputs
- Acute seasonal shortages of fodder for livestock
- Overgrazing by free ranging livestock
- Lack of fuelwood for household needs.

Major production technologies which could assist in mitigating these factors include: improved millet and sorghum production systems that incorporate integrated nutrient management strategies with improved soil and water conservation techniques and use of improved varieties and rotations with legumes; windbreaks, which also provide fodder and fuelwood; production systems to increase the sustained yield and output of livestock products; the potential for improving the beneficial interactions between the semi-arid and arid zones to increase the livestock and crop production; trees and shrubs to stabilize soil erosion control structures and provide sources of wood, fodder and indigenous fruit; improved management of the traditional 'parkland' system (scattered trees in cropland) for enhanced soil fertility and to provide wood, fodder, indigenous fruits, and traditional medicines; fodder banks; and live fences.

This initiative is for designing sustainable natural resource management options to combat land degradation through the use of indigenous and modern scientific principles integrated into improved production technologies. Integration of the basic knowledge available from ICRISAT, ICRAF, ILCA, IFPRI, ICARDA, IPGRI with UNEP's experience in the implementation of the UN Plan of Action to Combat Desertification (PACD) provide the necessary scientific/managerial input to the initiative.

The strength of this initiative lies in exploiting the comparative advantage of each research partner to address clearly identifiable components of the total system arresting land degradation (crop residues/cropping systems/rotations/soil erosion and soil conservation component by ICRISAT; livestock/manure/vegetation component by ILCA; forage legumes by ILCA and IPGRI; multipurpose tree species/shelter belts by ICRAF; and policy options by IFPRI).

More recently, Paragraph 24 of the Preamble of the Final Negotiating Text of the International Convention to Combat Desertification (INCD) stated that strategies to combat desertification and mitigate the effects of drought will be most effective if they are based on sound systematic observations and scientific knowledge. Through the planned experiments of this initiative, existing knowledge will be applied and new research information will be generated for the development of integrated farming technologies adapted to the regional/local socio-economic and environmental conditions at the experimental sites selected by the NARSs.

The importance of participatory approaches for dryland management and anti-desertification programs has recently been demonstrated in four case studies in Burkina Faso, Ghana, Kenya and Zimbabwe (INCD, 1993). The case studies were for:

- Stone bunds, afforestation and other environmental management activities in Burkina Faso's Yatenga Region;
- Forest protection and forestry programs in Ghana;

- Community irrigation in the Kerio Valley of Kenya; and
- Anti-desertification activities in low-income regions of Zimbabwe.

The overall findings are that participatory approaches to combating desertification can be highly effective. In particular, it was found that (i) substantial knowledge exists at the local level, (ii) participatory approaches to combating desertification can mobilize significant community resources and produce self-sustaining results, (iii) traditional social, religious and economic institutions often play an important role in protection of the natural environment, (iv) desertification should not be viewed as solely an environmental problem, but rather as both a symptom and cause of broader rural problems; (v) the local government can be a key official actor in supporting community-based efforts to combat desertification; and (vi) participatory and conventional approaches to combating desertification differ significantly.

NARSs of Kenya, Niger, Mali, Burkina Faso, Botswana and Namibia will collaborate in the design, management and execution of the project. Fortunately, several research networks coordinated by ICRISAT, ICRAF and ILCA in collaboration with the NARSs and regional institutions are already in place and operational. ISC will provide key scientific support and overall coordination. In addition, other organizations such as USDA-WSR; UK-NERC; and IBSRAM will provide specific input relevant to their fields of expertise.

The following regional institutions (and NGOs where practical) will be involved so that the activities under this initiative will be coordinated with their programs that cover distinct eco-political regions:

- SPAAR/CILSS-INSAH with NARSs of Niger, Mali and Burkina Faso;
- SPAAR/SADC-SACCAR with NARSs of Botswana and Namibia;
- SPAAR/IGADD with NARS in Kenya.

Through the involvement of the NARSs, regional institutions and where feasible NGOs, the expected output will facilitate the development of options for farmers to improve productivity of their lands. Thus, technical solutions will be linked to socio-economic priorities of the farming community and this eventually should lead to better living conditions, sustainable socio-economic development, and poverty eradication.

2.1. Objectives of the Initiative

The overall objective of this initiative is:

> To arrest land degradation by promoting improved and innovative technologies that integrate effective nutrient management strategies with improved soil and water conservation techniques that are ecologically sound, economically viable and socially acceptable to farmers in the dryland areas of sub-Saharan Africa.

The specific objectives are:

1. To develop a better understanding of the extent of land degradation through water and wind erosion and through mining of soil nutrients in the traditional crop and livestock production systems in the desert margins and the impact of and distinction between causal factors, both natural and human with a view to combat land degradation and achieve improved productivity as well as sustainable use and management of soil resources.

2. To evaluate with the participation of farmers, NGOs, and NARSs, past and current indigenous and improved soil management programs for arresting land degradation to identify the causes of misuse and design effective strategies and elaborate activities to test improved options to enhance soil resilience in the desert margins.

3. To overcome negative nutrient balances and increase biomass at the farm level by developing integrated systems of nutrient management incorporating use of locally available agrominerals combined with recycling of manure/urine from livestock, crop residues, city wastes, farmer acceptable agroforestry systems and crop rotations involving the use of legumes to improve biological nitrogen fixation.

4. To combine improved, farmer-acceptable, soil and water conservation techniques such as stone bunds, wind breaks, hedge rows, field ridges, etc., with the integrated nutrient management systems to enhance soil resilience.

5. To evaluate the role of livestock in the ecological and economic linkages between arid and semi-arid zones to control land degradation and loss of vegetation biodiversity in the arid zone.

6. To identify, evaluate and assist in the design of policies that will enhance the adoption of improved soil management options for arresting land degradation.

7. To enhance the institutional capacity of the participating countries in the project for land degradation research and extension of the improved technologies, with particular attention to multidisciplinary and participative socio-economic research.

3. Description of the Activities

Research proposed in this initiative focuses on rainfed crop and livestock production in dryland areas receiving between 100 and 600 mm rainfall per year, often poorly distributed. Depending on the rainfall amount and distribution, mixed cropping or livestock production is dominant. The arid zone, receiving an average 100 - 400 mm of annual rainfall, lying between the semi-arid zone and the desert zone, is an important livestock producing zone.

In Kenya, the important dryland crops are sorghum, pearl millet, pigeonpea, cassava, beans and cowpea. In Niger, cropping is more specialized; mixed cropping is dominant with millet as a staple food crop, but livestock production plays an important and interactive role. Animal manure is more important than animal traction. In Burkina Faso and Mali, cropping is more diversified; important food crops include sorghum, pearl millet and maize; cash crops include cotton and groundnut; animal traction is more important than manure. In Botswana, livestock, wildlife and forest products are the major resources, with arable farming limited to the south-eastern areas. In Namibia, livestock production (cattle and small stock) and wildlife are dominant providing a good potential for crop production improvement in the northern parts of the country.

The activities of this initiative fall into eight major categories:

1. Characterization and analysis of land use systems
2. Household and community resource management and investment decisions and the impact of policy.
3. Ecological and economic linkages between arid/semi-arid zones: the role of livestock
4. Development of management techniques to enhance soil resilience and arrest land degradation.
5. Selection of multipurpose forages, legumes and tree species.
6. Strategic research on component interactions.
7. Development and evaluation of improved technologies.
8. Institution building and enhancement of human resource capacity.

3.1. Characterization and analysis of land use systems

This research will concentrate on characterizing the biophysical and socio-economic constraints of the current land-use systems with particular attention to the parkland systems, livestock feeding, and soil conservation systems. Variables measured will include land use/production system, woody and herbaceous biomass, grain and residue yields of crops, number and density of livestock and livestock production. Socio-economic research will be conducted at micro and macro levels, focusing on socio-economic benefits of traditional systems for resource-poor farmers, and their ecological implications. Assessments would include the conservation of natural resources and biodiversity, costs to society associated with desertification, and impact of technologies on combating desertification and socio-economic benefits thereof.

3.2. Household and community resource management and investment decisions and the impact of policy

This research would focus on the impact of policies, programs, and institutional options that influence the incentives for farmers and communities to adopt improved technologies and resource conservation and management practices. Three sets of issues would be explored:

a) The role and impact of government policies on the economic incentives for sustainable resource use -- including the impact of sectoral policy; the pricing and marketing of agricultural inputs and outputs; public investment policy; credit policy; and exchange rate policy.

b) The role of institutional options on the incentives for households and communities to manage resources in a sustainable way -- including the impact of property rights; the effects of land use regulation and legislation; the role and effectiveness of local government and community management initiatives; and the provision of technical services.

c) The impact of improved technologies and resource management practices on the poor.

3.3. Ecological and economic linkages between arid/semi-arid zones: The role of livestock

Historically, there are strong trade, demographic, and productive linkages between the arid and semi-arid zones. Livestock movements across their boundary exploit the different seasonal potential of pastures in these two zones, thereby increasing the overall productive potential of livestock husbandry for the whole region.

Two key research areas will be investigated here. First, identification of technologies, policies, and local-level institutional innovations directed at sustaining livestock-derived income in arid zone production systems and improving the effectiveness of indigenous coping mechanisms to production and capital shortfalls. Second, investigation of the potential for improving the beneficial inter-zonal interactions, to increase regional livestock and crop production.

3.4. Development of management techniques to enhance soil resilience and arrest land degradation

Lack of adoption of appropriate methods of soil and water management and lack of an integrated nutrient management strategy are two major sources for soil resilience problems at the farm level. Studies on the traditional methods of soil and water management will be used as a guide for developing improved methods using the farmer participatory approach in the six countries. Data collected under the activities 3.1 and 3.2 above will be used to design integrated nutrient management strategies aimed at arresting nutrient mining and ensuring sustainable production. Efficiency of nutrient cycling through alternate uses of crop and tree residues and animal manures in balance with the prudent use of external inputs of nutrients will also

receive attention. Management strategies will be developed for efficient use of crop residues that satisfy nutritional demands of animals and requirements for soil management.

3.5. Selection of multipurpose forages, legumes and tree species

Collection, evaluation, selection of appropriate multipurpose forages, legumes and tree species/provenances for the parkland system, fodder production, soil conservation and windbreak technologies will receive priority. The IPGRI program located at ISC will emphasize the conservation and improvement of several forage legumes such as *Stylosanthes fruticosa, S. hamata* etc., In the Sahelian production systems, where fallowing is practiced, forage legumes can be more effective than native grasses in restoring soil fertility, thereby reducing the fallow requirements. Studies on within species genetic variation in form, phenology, growth, productivity and fodder quality of regionally important parkland species (e.g., *Faidherbia albida, Combretum aculeatum, Balanites aegyptiaca* and *Prosopis africana*) and geographic distribution of such variability will receive priority. Synthesis of indigenous knowledge of trees and its application to tree improvement and management is emphasized. Efforts will made to identify fruit trees adapted to this climatic zone to generate cash for small farmers through introduction of new species (e.g. *Ziziphus rotundifolia*) and evaluation of underutilized native species (e.g., *Z. mauritiana, Balanites aegyptiaca*).

3.6. Strategic research on component interactions

Competition between trees and crops for the limited available water is a major concern for improving the productivity of agroforestry systems in the semi-arid tropics of Africa. Wind and water erosion even on moderately sloping and light textured soils lead to soil degradation and further aggravate the moisture constraint. Wind and water erosion will be monitored on a continuous basis using the methodologies developed at ISC. This program will monitor (i) how soil erosion processes can be controlled through such agroforestry technologies as shelterbelts against wind erosion and shrub/grass strips alone or in conjunction which soil conservation bunds against water erosion, and (ii) how these conservation measures affect the micro-climate and hydrologic cycle. These measurements should assist the development of a predictive capacity for assessing the environmental benefits and long-term sustainability of the technologies. The second focal point will be the utilization of inexpensive sources of phosphorus for improving the establishment and early growth of trees, and improving their efficiency in combination with manure and organic residues.

3.7. Development and evaluation of improved technologies

This research will draw on the output of the activities described above and will focus on the development and evaluation of the long term biophysical and economic impact of alternative management strategies in crop/tree/livestock production technologies which mitigate water and wind erosion, enhance soil fertility and address the problems of fodder and fuelwood shortages. Development of these strategies would incorporate ongoing research on seasonal forecasts based on the date of onset of rains, reducing the water losses and increasing water use efficiency. This research will be undertaken both on-station and in farmers' fields. The on-station work will provide the necessary understanding required to predict long-term performance and the critical factors determining the success of these technologies. But the technologies that require farmers' acceptability for their success such as improved parkland systems, live fences and fodder banks would be evaluated on-farm from an early stage of development to achieve as rapid an impact as possible.

3.8. Institution building and enhancement of human resource capacity

The overall success of this initiative depends on a long term and sustained effort by all collaborative partners, and it is anticipated that NARSs will play an increasingly important role over time.

Under this project, we propose to supply automatic weather stations, ovens, balances and associated software to the research stations of the NARSs. This not only ensures standardization of equipment, but also of data quality. Automatic weather stations and improved systems of database management could greatly enhance their ability to collect and analyze the necessary data and provide simple summaries to users and policymakers. Through initial regional training seminars and continuing annual workshops, participants from the national programs in the region will be trained in the improved systems of climate and crop monitoring, data capture and analysis.

All the minimum data sets collected in this project will be integrated in a geographical information system (GIS). In cooperation with UNITAR and UNSO, training workshops will be organized to develop national and regional capabilities in the manipulation of GIS. The computerized databases that will be developed during the project implementation phase would be widely distributed in the region along with explanatory notes to encourage use of this information by the research and educational institutions in the region.

Considerable emphasis will be placed on enhancing national scientists ability to plan and execute research. Priority is given to short-term group training courses on specific topics related to the design and analysis of crop/tree/livestock production systems research, and to the provision of support to national scientists to undertake research towards their M.Sc. and Ph.D degrees.

4. Expected Outputs and Benefits from the Project

The major outputs expected at the end of the project are:

- Availability of improved conservation-effective production technologies that would be socially and economically acceptable to the indigenous population to meet their food, fodder and fuel needs.

- Improved methods of sustaining the long-term soil fertility in the semi-arid tropics of sub-Saharan Africa to effectively combat land degradation.

- Improved soil and water management techniques for increasing the water use efficiency and for arresting land degradation

- Improved understanding of the impact of livestock production and cropping on vegetation composition, resilience and soil erosion in the arid zone and the economic and policy measures needed to improve management of natural resources for livestock production in the arid zone.

- Availability of minimum data sets of climate, soil and water, land use and socioeconomic variables in support of practical dryland development programs.

- Dissemination of improved methodologies of climate monitoring, data capture, and analysis, and crop monitoring among the major scientific institutes in Africa.

- Better awareness among policy makers and the scientific community of the importance of multipurpose forages, legumes and tree species in maintaining the productivity and sustainability of the fragile lands in the semi-arid tropics and the need to undertake the necessary measures for preservation of biodiversity in the region through effective conservation strategies.

- Establishment of a cadre of skilled scientists and mechanisms within the NARSs to undertake production systems research, thus ensuring the sustainability of this initiative.

- Guidelines for the design and implementation of policies and policy tools that encourage farmers to adopt ecologically sound and economically viable production technologies. Key policy decision-makers,

farmers and scientists will be better informed about policies, investment and technologies that will help control land degradation.

5. Participating Research Organizations

This initiative is unique as it integrates for the first time:

- expertise available in the CG system through the involvement of at least six CG centers (ICRISAT, ICRAF, ILCA, IFPRI, ICARDA and IPGRI)
- UNEP's experience in the implementation of PACD
- national research operations of six NARS (Kenya, Niger, Burkina Faso, Mali, Botswana and Namibia)
- expertise from other international agencies such as IFDC, IBSRAM, CIRAD and mentor institutes including USDA-WSR and UK-NERC.
- research at regional institutions on the basis of the SPAAR Framework for Action in the Sahel (CILSS/INSAH), East Africa (IGADD), and southern Africa (SADC/SACCAR).

Other CGIAR centers addressing the desert margin problems throughout the world will be consulted as appropriate (WARDA, IITA, CIFOR and ISNAR).

ICRISAT

ICRISAT, the Convening Center, on behalf of the consortium will lead the development and implementation of this initiative. For over 20 years ICRISAT scientists have addressed the problems of desert margins. They have identified constraints to agricultural development and evaluated means of alleviating them.

ICRISAT conducts its activities in sub-Saharan Africa through two regional programs - the West and Central Africa Program with its headquarters in Niger, where scientists are actively involved with different national programs in the nine CILSS countries, and the Southern Africa Program in Zimbabwe, where ICRISAT works with the ten SADC countries.

ICRISAT also provides a worldwide service designed to provide efficient and wide access to information on research and has developed four networks that link collaborators throughout the sub-Saharan Africa.

- WCAMRN-ROCAFREMI in western Africa coordinated by ISC, Niger;
- WCASRN-ROCARS in western Africa coordinated by SAFGRAD and INSAH;
- EARSAM in eastern Africa coordinated by ICRISAT/EARCAL (terminated in 1993, and currently planning redevelopment); and
- SMIP in southern Africa coordinated by SADC/ICRISAT.

The eco-regional research programme at ISC brings together researchers in plant, animal, soil and social sciences. ISC host scientists from ILCA, IFPRI, IFDC and IPGRI. This provides a unique format for interdisciplinary research and inter-center collaboration. ISC has the capability to provide research input and logistic support to the operations of the initiative.

ICRAF

ICRAF leads major research programs on natural resource management in central and eastern Africa, and is coordinating a global initiative to find alternatives to 'slash and burn'. This research focuses on two main targets: (i) reclamation of already deforested and degraded lands, and (ii) prevention of damage by deforestation itself.

ICRAF's research in Africa is carried out through the Agroforestry Research Networks for Africa (AFRENAs). Collaborative research projects are under way in 13 countries following formal agreements signed between ICRAF and the government of each of the participating countries, plus Nigeria, where the work is conducted jointly with IITA. In all areas, ICRAF collaborates with NARSs, NGOs, universities and other national and regional agencies. ICRAF has posted a forest geneticist at ISC and plans to place three scientists at ICRISAT's research center in Samanko, Mali.

ILCA

ILCA has made major contributions toward improving animal production in sub-Saharan Africa during its 20 years of operations. ILCA expertise in the biological, ecological and socioeconomic aspects of livestock production will assist in identifying the factors contributing to land degradation and poor agricultural performance, and in developing interventions to improve agricultural productivity. ILCA has a mandate to assist national efforts in sub-Saharan Africa (SSA) to effect a change in production and marketing systems so as to increase the sustained yield and output of livestock products and improve the quality of lives of people in the region. This mandate together with ILCA's first hand knowledge of livestock-related resource management issues, and the effective working relationships already established with NARS through collaborative research networks make ILCA an indispensable partner in this initiative. ILCA will focus on identifying (i) technologies, policies and local-level institutional innovations that can improve livestock productivity, while minimizing the environmental hazards in the arid zone, and (ii) the potential for improving the beneficial interactions between the semi-arid and arid zones in order to increase regional livestock and crop production. ILCA will also provide overall guidance on livestock-related components such as the role of crop residues and manure for nutrient cycling in crop-livestock systems.

ILCA has established three collaborative research support networks: African Feed Resources Network (AFRNET), Small Ruminants Research Network (SRNET) and Cattle Research Network (CARNET). ILCA's scientists in Niger, working in close collaboration with scientists at the ISC are developing systems that manage crop residues and other potential livestock feeds to the benefit of soils, crops and livestock.

IPGRI

One of the major objectives of IPGRI is to strengthen and contribute to international collaboration in the conservation and use of plant genetic resources. IPGRI has a Regional Group in sub-Saharan Africa with its main office in Nairobi, and an officer in West Africa located at ISC. IPGRI activities at ISC commenced in 1987 with the appointment of a field officer, who left the Institute's services in 1992. A germplasm conservation scientist for conservation strategies and technologies was appointed the same year. Activities of the Sub-Saharan Africa Group concentrate on providing technical and professional support to the development of national programs in the region.

IFPRI

The International Food Policy Research Institute (IFPRI) has an agenda which integrates collaborative research with outreach activities. IFPRI's strategic research is organized around cross-cutting issues carried out with national collaborators in multiple countries. Research conducted under this initiative would comprise part of the broader research program on "Policies for Sustainable Development of Fragile Rainfed

Lands". Thus insights and methods from work being carried out in other parts of the world on similar issues can contribute to the project efforts.

IFPRI had done extensive research in the Sahel (Burkina Faso, Niger and Senegal) with outposted staff in each of these countries for two to four year periods. IFPRI's expertise in household and community level data collection, analysis and modelling as well as its past research experience in Africa on issues of tenure and property rights, determinants of productivity and investment, household income diversification, credit, growth linkages, market reform, and food consumption provide the basis for a strong IFPRI contribution to the consortium.

ICARDA

ICARDA's Medium-term Plan for 1994-98 places greater emphasis on research for the highlands as well as the drier lowlands; gives additional support to natural resource management; emphasizes research on animal nutrition and a shift from food to feed production; and extends diagnostic socioeconomic research to accommodate studies on pressures encouraging the mismanagement of resources, monitoring the adoption of technical solutions and understanding the role of social institutions and government policies. ICARDA, as the Convening Center for a systemwide initiative for an ecoregional programme for the Wana Region, is submitting a proposal on "Natural Resource Conservation and Management for Sustainable Improvements in Productivity in the Northern Sahel". Their proposal for the northern margins of the Sahara complement well this proposal. ICARDA along with ILCA will address the activity on ecological and economic linkages between arid/semi-arid zones and the role of livestock.

NARSs

This initiative will closely collaborate with the NARSs of the selected countries affected by land degradation. For the purpose of this initiative, NARSs will be the focal point of agricultural research in each country and initial contacts have been made with several of them. They are:

Kenya	Kenya Agricultural Research Institute (KARI),
Niger	Institut National de Recherche Agronomique du Niger (INRAN),
Mali	Institut d'économie rurale (IER)
Burkina Faso	Institut D'Etudes et de Recherches Agricoles (INERA),
Botswana	Department of Agricultural Research,
Namibia	Ministry of Agriculture, Water and Rural Development, Research and Training.

International and Regional Cooperators

Some international institutions, which already cooperate with the consortium, will provide within their fields of expertise specific input to the activities planned for the initiative.

UNEP

In 1972, the United Nations Conference on Desertification (UNCOD) adopted the Plan of Action to Combat Desertification (PACD). UNEP was entrusted with the task of following up and coordinating the implementation of PACD and assisting governments in their efforts to implement the PACD at the national

level. Within UNEP a Desertification Control Branch was established in 1978 and was later transformed into the Desertification Control Programme Activity Centre (DC/PAC).

To assist the Governments of the Sudano-Sahelian region of Africa in the implementation of PACD, a joint venture between UNEP and UNDP was created as part of the activities of the United Nations Sudano-Sahelian Office (UNSO). The major role in implementing the PACD was vested with the Governments of the countries affected by desertification.

IFDC

The new mandate of IFDC approved in October 1992 is to undertake research and provide assistance, advisory services, and training in response to the global needs, with special reference to the tropics and subtropics, for the transfer and use of improved fertilizer and related technology, and for the implementation of economic policies that promote open, competitive markets and market-led associated institutions for increased agricultural productivity and economic development, while conserving the natural resource base and the environment, and enhancing the efficient use of plant nutrients.

Since 1982, IFDC, in collaboration with ICRISAT, has adopted a research program to restore and maintain soil fertility as a way of increasing productivity through the development of sustainable soil fertility management technologies in the West African Semi-Arid Tropics (WASAT).

The immediate objective of this program is to promote greater and more efficient use of plant nutrients to increase food production by supplying information on fertility status of the soils, amounts of plant nutrients needed by the crops, economic sources of plant nutrients to be utilized with emphasis on fertilizers produced with indigenous materials, and the best management practices to ensure a healthy environment for sustainable agricultural production.

In 1987, IFDC-AFRICA division was created to conduct research and training leading to a systematic buildup of soil fertility as the basis for increased agricultural productivity in sub-Saharan Africa in general and in West Africa in particular.

Two programs have been designed to carry out this agenda. These are the Watershed Management Program and the Policy Reform, Market Research and Development Program. The IFDC Program at ISC is under the Watershed Management and Environment program.

IBSRAM

The International Board for Soil Research and Management (IBSRAM) conducts adaptive research in 23 countries in Africa and South-east Asia. IBSRAM has developed a unique approach to conducting research in regional networks and it has extensive cooperative programs with many NARSs in the Sahelian region. IBSRAM will be invited to consider collaboration with this project and to prepare a proposal for cooperative research on the themes of on-farm soil-water-nutrient management research and on indicators of sustainable land management.

USDA-WSR

The United States Department of Agriculture - World Soil Resources (USDA-WSR) has the larges database on soils of the world (though Africa is poorly represented) and a comprehensive climate database USDA-WSR has already made preliminary studies on the impact of global climate change in Africa. With the data generated by this project, a more reliable assessment can be made. USDA-WSR will characterize the major soils and evaluate the resilient characteristics of these soils and demarcate them on maps so that research and development priorities can be determined on a rational basis. The output from the

activities under this module will include digitized maps, reports and training material. On-site training, and if funds permit, training in the USA will enhance the skills of the host country scientists.

UK-NERC

The United Kingdom Natural Environment Council (UK-NERC), Institute of Hydrology, Hydrological Processes Division, located at ISC, will provide the necessary expertise on the water and energy balances of alternative land use systems. There is a wide range of skills and experience in UK-NERC that are appropriate to the study of dryland degradation, including hydrogeology, soil physics, microbiology, ecology, plant physiology, genetic conservation, meteorology, remote sensing and modelling. The UK-NERC unit at ISC could contribute to this initiative in several ways, e.g., by providing hydrological and ecological advice on the experimental design; by participating in the experimental program, bringing in NERC's broad range of appropriate skills and experience; by providing links with the WMO/ICSU/IOC World Climate Research Program initiatives such as the HAPEX-Sahel; by providing links with the UK Economic and Social Research Council (ESRC) Global Environment Change program.

CIRAD

Centre de Coopération Internationale en Recherche Agronomique pour le développement (CIRAD) is a French research organization that specializes in agriculture in the tropics and sub-tropics.

CIRAD is made up of seven departments: CIRAD-CA (annual crops), CIRAD-CP (tree crops), CIRAD-FLHOR (fruit and horticultural crops), CIRAD-EMVT (livestock production and veterinary medicine, CIRAD-Forèt (forestry), CIRAD-SAR (food technology and rural systems), and CIRAD-GERDAT (management, common services and laboratories, documentation). CIRAD operates through its own research centers, NARSs, or development projects. CIRAD has a team of five scientists working at ICRISAT's research center in Samanko, Mali.

SADC/SACCAR

The Southern African Development Coordination Conference (SADCC) was established in 1980 for sharing training and research facilities amongst its member states comprising of Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe and later joined by Namibia. In 1992, its members signed a treaty to transform the Union into the Southern Africa Development Community (SADC). In 1984, SADCC established the Southern African Centre for Cooperation in Agricultural Research (SACCAR) as a coordinating mechanism for agricultural research conducted within its 10 member countries. SACCAR's activities fall into two broad areas: core and coordinating activities. SADC/ICRISAT SMIP program in Zimbabwe works closely with SACCAR.

CILSS/INSAH

Comité Inter-Etat pour la Lutte contre la Sècheresse au Sahel (CILSS) is an inter-state permanent Committee to fight drought in the Sahel and was set up by the West African states to evolve a common strategy to deal with problems of drought in the region. The CILSS Secretariat is based at Ouagadougou, Burkina Faso. Two main organizations operating under the auspices of CILSS in West Africa are INSAH (Institut du Sahel) in Mali, and the Centre régionale de formation et d'application en agrométéorologie et hydrologie opérationelle (AGRHYMET) in Niger. AGRHYMET is the WMO Regional Center for training in Agricultural Meteorology and Hydrology. ISC closely collaborates with INSAH and AGRHYMET.

IGADD

The recurring and severe drought between 1974 and 1984 in the eastern Africa region argued strongly for a regional approach to supplement national efforts to cope with these disasters. In 1986 - six eastern

African countries (Djibouti, Ethiopia, Kenya, Somalia, the Sudan and Uganda) - signed an agreement which officially launched an Intergovernmental Authority on Drought and Development (IGADD). The objectives and functions of IGADD are designed to help member states to further their development despite the effects of drought and other adverse environmental conditions. One of the objectives is to identify projects of regional interest submitted by member states and assist in securing resources for project preparation and implementation.

The activities under this initiative fit well with IGADD's major thrusts, especially those for improving the efficiency of agriculture and food production, environment assessment monitoring and information system for environment management, rangelands management, and agricultural research, training and extension.

SPAAR

The Special Program for African Agricultural Research (SPAAR) was established in 1985 as a vehicle to strengthen NARSs in sub-Saharan Africa. SPAAR has two main objective

- To strengthen African agricultural research systems in the public and private sectors; and
- To increase the effectiveness of donor assistance to African agricultural research systems.

One way of strengthening the capabilities of NARSs is the "Framework for Action" (FFA) approach initiated by SPAAR. In adopting the FFA for the Sahel, the national directors identified three priority areas for regional cooperation. These are: sorghum to be hosted by Mali; small ruminants to be hosted by Senegal; and natural resources management to be hosted by Burkina Faso.

Significant progress has been made in strengthening the NARSs that are participating in the FFA for eastern Africa (Djibouti,Ethiopia, Kenya, Somalia, Sudan and Uganda). A Consultative Workshop on Coordination of Research in the Sectors of Food, Agriculture and Natural Resources in the SADC region was held in Zimbabwe in May 1993. A four-member SACCAR/SPAAR Task Force has prepared a Framework for Action.

This project will liaise with SPAAR and the respective regional organizations implementing the FFAs, thereby contributing to the strengthening of the NARSs in the selected sub-Saharan countries affected by desertification.

NGOs

NGOs also have a catalytic role to play in this initiative. They work best at the grassroots level and can work with farmers and farmers' organizations in helping to develop new approaches to agricultural and environmental problems. Unfortunately, NGOs in sub-Saharan Africa are not well developed. There have been examples of NGOs assisting Governments in experimenting with establishing community extension systems and transferring responsibilities to them. A few NGOs were contacted and they reacted positively to the proposals for designing improved crop/tree/livestock production systems, but argued strongly for an early involvement of farmers in planning these systems.

NATIONAL METEOROLOGICAL SERVICES

The National Meteorological Services (or the Weather Bureau) of Kenya, Niger, Mali, Burkina Faso, Botswana and Namibia will be approached for their advice and participation in this initiative with respect to the availability of climatological records, upgrading of weather stations, acquisition of equipment, and training of observers.

UN AGENCIES

UN Agencies with programs relevant to this initiative - such as WMO, FAO, UNDP, UNSO and UNESCO - will be kept informed.

6. Institutional Mechanisms

Following the initial consultations during 1993 by ICRISAT with the other IARCs and UNEP on the preparation of this initiative, UNEP engaged Dr. Wolfgang Baier of Agriculture Canada as a Consultant to develop a draft proposal after extensive discussions with the IARCs, NARSs, NGOs and Regional Organizations. During February - March 1993, Dr. Baier travelled to Kenya (for consultation with NARSs, IGADD, UNEP and ICRAF), Ethiopia (ILCA), Niger (ISC, INRAN, AGRHYMET), Burkina Faso (INERA, CNRST, NGOs), Botswana (DAR), and Namibia (Ministry of Agriculture). His draft proposal was circulated to all the IARCs for their comments in May 1994.

To facilitate an effective dialogue between interested participants in the Initiative, it is proposed to hold an International Planning Workshop on a Desert Margins Initiative, in January 1995, at Nairobi, Kenya.

The workshop will be convened with seven objectives.

1. To assemble those institutions and individuals interested in collaboration in this ecoregional Initiative.

2. To more precisely define and characterize the "agroecologies" for the purpose of the Initiative.

3. To design an effective experimental approach and research agenda tailored to the target agroecological zones of this Initiative, and to the socioeconomic conditions of the participating countries.

4. To discuss the proposed Initiative and develop effective collaborative arrangements that include interested NARSs, NGOs, regional institutes, IARCs, and other institutions.

5. To formulate work plans leading to specific project proposals that can be used to solicit appropriate funding.

6. To establish a Steering Committee to provide policy guidelines and to set priorities.

7. To identify the training needs and support required for the enhancement of human resource and institutional capacity in the NARSs.

The operational mechanism will be decided at the Workshop.

7. Other Contributing Actors (NGOs, Development Agencies, Farmer Groups etc.)

In our preliminary contacts, several organizations have expressed their interest in participating actively in this Initiative. In consultation with the NARS from the six countries, we will invite appropriate NGO's, development agencies and farmer groups for their participation in this initiative.

8. Staffing by Institution and Field Specialization, Location and Time Frame

Policy guidance on technical matters will be provided by the RTCC. The Coordinator will maintain liaison with donors and report to a Donor Support Group and will plan and manage the work of the Coordinating Unit. The appointee will be a catalyst to promote regional co-operation in technology generation and its dissemination in the member countries. The appointee will interact with Conveners of member countries

to ensure that research results are effectively synthesized and reported, and will also review the research, report to the Committees, and assist them in their work. The Coordinating Unit will be administered by ICRISAT and will be located at Niamey, Niger.

Details of staffing by institutions and field specialization will be worked out during the planning workshop in January 1995.

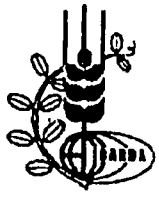
Annex 3

NATURAL RESOURCE MANAGEMENT FOR SUSTAINABLE IMPROVEMENTS IN PRODUCTIVITY IN THE DESERT MARGINS OF NORTH AFRICA

A PROPOSAL FOR AN ECOREGIONAL PROGRAM FOR THE WANA REGION

Proposed for incorporation in
The Desert Margins Initiative
prepared by ICRISAT

The International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria



January 1995

This is a revised version of the proposal for an Ecoregional Initiative for the WANA Region, entitled "Natural Resource Conservation and Management for Sustainable Improvements in Productivity in the Northern Margins of the Sahara", submitted to TAC by ICARDA, as the convening center for WANA, in August 1994.

PREFACE

In 1994, the Technical Advisory Committee (TAC) of the CGIAR proposed a number of Systemwide and Ecoregional Initiatives. The International Center for Agricultural Research in the Dry Areas (ICARDA) was identified as the convening center for an ecoregional initiative in West Asia and North Africa (WANA), characterized as the subtropics with winter rainfall.

In August 1994, ICARDA submitted to TAC a proposal for an Ecoregional Initiative for the WANA Region entitled "Natural Resource Conservation and Management for Sustainable Improvements in Productivity in the Northern Margins of the Sahara", where the northern margins encompass the arid and semi-arid areas of the countries of Algeria, Libya, Morocco, and Tunisia.

At the same time the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), which was identified by TAC as the convening center for an ecoregional program for the semi-arid tropics in sub-Saharan Africa, submitted a proposal for an Ecoregional Initiative entitled "Sustainable Natural Resource Options to Arrest Land Degradation in the Desert Margins of Sub-Saharan Africa", commonly referred to as their Desert Margins Initiative. Although ICARDA and ICRISAT exchanged documents, both of which referred to mutual cooperation in the respective ecoregional programs, time did not permit a thorough inter-center dialogue on the proposed programs for desert margins in Africa.

Having now had more time to consider both documents and other discussions on these proposals, ICARDA considers that, although the prevailing climatic conditions and farming systems may differ considerably between the two regions, the two proposals address many of the same issues and that there are considerable merits in dealing with the desert margins of Africa as "one". In this instance, ICARDA sees no benefit in maintaining the north/south Sahara divide.

ICARDA is, therefore, proposing that a modified version of ICARDA's original proposal be incorporated into ICRISAT's Desert Margins Initiative which would thus become an ecoregional proposal for the desert margins of Africa as a whole. The attached proposal represents this modified version.

SUMMARY

The countries of North Africa - Algeria, Libya, Morocco and Tunisia - cover a total area of about 0.5 billion ha, of which 93% is classified as arid or semi-arid, supporting an estimated population in 1995 of 71.5 millions. One of the major problems faced by the region is the accelerating degradation of its resource base (soils, water and natural vegetation). Nowhere is the problem more acute than in the drier margins of the region, where the resource base is inherently limited and fragile.

ICARDA recognizes that many of the problems faced by the region are being tackled by other centers, in other regions, notably in the semi-arid areas of sub-Saharan Africa. ICARDA is therefore proposing an inter-center initiative in natural resource management addressing common problems in the southern and northern margins of the Sahara. The southern margins encompass the Sahelian zone of west Africa; the northern margins encompass the arid and semi-arid (in terms of winter rainfall) areas of the countries of Algeria, Libya, Morocco, and Tunisia.

Relatively more international R & D investment in resource management has been allocated to the South. ICARDA proposes that lessons learned from this investment could be transferable to other agro-ecosystems, specifically the desert margins of North Africa. Considerable opportunities exist for inter-center cooperation in comparing and contrasting the systems, resources and needs of the northern and southern margins of the Sahara, and to collectively bring to bear the experiences of both centers to improving resource management for improved crop/range/livestock production in the desert margins of Africa.

ICARDA recognizes that development of improved technologies and/or resource management strategies will, necessarily, differ between the two zones, but also considers that there is much scope for collaboration in the development and transfer of relevant experiences and approaches (philosophies, strategies, and methodologies) in the development of improved technologies and management options.

The proposed initiative envisages collaboration with the ICRISAT Sahelian Center (ISC) and the other research organizations participating in the Desert Margins Initiative, with a view to achieving an overall objective of:

> Improved productivity of small ruminants based on sustainable increases in domestic feed supplies attained through the promotion of improved resource conservation and management options that are ecologically sustainable, economically viable and socially acceptable to the farmers and livestock owners in the desert margins of North Africa.

NATURAL RESOURCE MANAGEMENT FOR SUSTAINABLE IMPROVEMENTS IN PRODUCTIVITY IN THE DESERT MARGINS OF NORTH AFRICA

1. BACKGROUND AND JUSTIFICATION

1.1 NATURAL RESOURCE DEGRADATION IN NORTH AFRICA

In Africa some 1.3 billion ha, comprising arid, semi-arid and dry sub-humid areas, support a population of about 400 millions or two thirds of the African continent. The countries of North Africa - Algeria, Libya, Morocco and Tunisia - cover a total area of about 0.5 billion ha, of which 93% is classified as arid or semi-arid, supporting an estimated population in 1995 of 71.5 millions. One of the major problems faced by the region is the accelerating degradation of its resource base (soils, water and natural vegetation). Nowhere is the problem more acute than in the drier margins of the region, where the resource base is inherently limited and fragile.

The amount of arable land available in these countries is limited, totalling only some 22 million ha. With average annual change in population in these countries averaging almost 3%, the population will rapidly increase, putting even greater pressure on the countries' limited resources. There is little potential for increasing the cropped area; between 1990 and 2025 the cropland available per capita is expected to fall from 0.36 ha to 0.18 ha.

Climatic features, especially the low and variable rainfall, limit the options available to farmers. Small ruminants (sheep and goats) represent the principal economic output in these areas and contribute a large proportion of the income of small farmers and nomadic or semi-nomadic herders through the sale of live animals, dairy products and wool, as well as providing a valuable dietary contribution to the household. In the low rainfall arable areas, receiving between 200-350 mm of winter precipitation, barley is the major crop, the grain, straw, and residues being used primarily, on-farm, for feeding livestock. Between this barley zone and the Sahara desert are the vast areas of seasonal pasture land, or rangelands, an important grazing resource for the small ruminant flocks based in the barley zone, as well as the nomadic herding populations based in the rangelands.

The region has experienced a substantial increase in animal numbers over the last two decades. Livestock producers have been encouraged to increase flock sizes by the increased demand for animal products combined with government policies aimed at national self sufficiency. Expansion in flock size and flock numbers has been particularly noticeable at the drier end of the arable farming spectrum, where more native pasture lands are open to free grazing. As livestock numbers have increased, so has the area planted to barley. This has been achieved primarily through cultivating previously uncultivated marginal land and by replacing the annual fallow in barley areas with continuous barley cropping.

Crop and livestock production traditionally have been closely interrelated in ways that maintained the producing population while conserving the resource base. However, recent economic growth, increasing urbanization and associated rising consumer demand are forcing changes in production practices that threaten the natural resource base of the region.

Intensified land use on poor soils in dry areas, the extension of cultivation into agriculturally marginal areas, and overgrazing of natural pastures by an expanding livestock population all threaten the future productive capacity of these resources.

The problems are exacerbated by the prevailing and persistent poverty that exists, particularly in the low rainfall zones of the region. The rural inhabitants in these areas are socially disadvantaged and politically uninfluential, are scattered and disfavoured in terms of infrastructural and institutional support, and are under severe stress with limited options to diversify their production systems.

Inappropriate policies regarding land use have also exacerbated the problem. In most countries in the Near East, the traditional tribal rights to grazing lands have been abolished, resulting in a system of "open access", but with no corresponding regulatory mechanism to control the extent and intensity of grazing. Such a system of open access, and the increasing mechanization of cultivation, has encouraged, in the rangeland margins, and increasingly within the rangelands proper, a dramatic increase in the area sown to barley. By reducing the costs of cultivation, and increasing the area that can be covered, mechanization has led to removal of the natural ground cover in a way even more destructive of soil and vegetation as overgrazing.

The present situation has dire consequences for the natural resource base. Continuous barley monocropping is rapidly depleting soil fertility and stimulates build up of pests and diseases. There are indications that barley yields in these systems are declining. Not only are rangeland resources insufficient to meet current demand, the absolute level of feed resources available is falling sharply due to overgrazing, permanent removal of vegetation, and soil erosion. ACSAD has classified 70% of rangelands in the Arab World as overgrazed and denuded. Continued degradation is reported in many areas of North Africa and the Middle East.

1.2 Potential for Collaboration in Research between the Northern and Southern Margins of the Sahara

ICARDA recognizes that many of the problems discussed above are encountered, and are being tackled by other centers, in other regions, notably in the semi-arid areas of sub-Saharan Africa. ICARDA is therefore proposing an inter-center initiative in natural resource management addressing common problems in the southern and northern margins of the Sahara. The southern margins encompass the Sahelian zone of west Africa; the northern margins encompass the arid and semi-arid (in terms of winter rainfall) areas of the countries of Algeria, Libya, Morocco, and Tunisia. The agro-ecological characteristics of this latter zone (the transition zone from the desert to the drier margins of rainfed cropping) continue through West Asia to the cool sub-tropics of Pakistan.

Although there are significant differences in climate, and hence in natural vegetation and farming systems, between the two agro-ecological zones, the inherent problems facing the two zones are similar. Livestock production is important in both zones, and is dependent on the primary plant production: natural vegetation, cultivated feed crops and crop by-products. The quantity and quality of plant production determines the secondary livestock production;

likewise the management of livestock influences the quantity and quality of feed production, particularly in the natural grazing lands of both zones.

The agriculturalists of the Sahel and the desert margins of North Africa face similar resource management and production problems: soil erosion by wind and water; declining soil fertility; overgrazing; shortages of domestically produced fodder; declining quantity and quality of natural grazing for livestock; lack of fuelwood; and inappropriate policies regarding land use and the lack of regulatory mechanisms to control the extent and intensity of grazing often as a result of the breakdown of traditional tribal rights.

In North Africa, national agricultural research programs have concentrated on the higher potential cropped areas, with the aim of increasing national production and food security. Relatively more international R & D investment in resource management has been allocated to the South. ICARDA proposes that lessons learned from this investment could be transferable to other agro-ecosystems, specifically the desert margins of North Africa and, more generally, to similar agro-ecological zones throughout the Near East. Likewise, lessons learned from ICARDA's on-station and off-station research in West Asia, which in some respects is more advanced given its proximity to ICARDA headquarters, could prove to be transferable to North Africa.

The proposed initiative envisages collaboration with the ICRISAT Sahelian Center (ISC) and the other research organizations associated with ICRISAT's Desert Margins Initiative. ICARDA considers that considerable opportunities exist for inter-center cooperation in comparing and contrasting the systems, resources and needs of the northern and southern margins of the Sahara, and to collectively bring to bear the experiences of both centers in developing approaches to tackle the problem of improving resource management and crop/range/livestock production in the desert margins of Africa.

ICARDA recognizes that development of improved technologies and/or resource management strategies will, necessarily, differ between the two zones and will, therefore, not be transferable, but it also considers that there is much scope for collaboration in the development and transfer of relevant experiences and approaches (philosophies, strategies, and methodologies) in the development of improved technologies and management options.

In 1995, ICARDA will also be initiating the implementation of a "Regional Adaptive Research Programme for the Development of Integrated Crop/Livestock Production in West Asia and North Africa" co-financed by IFAD (International Fund for Agricultural Development) and AFESD (Arab Fund for Economic and Social Development). This project includes collaborative technology transfer components with the NARS of both the Mashreq (West Asia) and Maghreb (North Africa) regions, including a community-based livestock management component and research and technology development to improve feed and fodder production throughout the arable sector as well as from natural pastures. A third component, to be implemented jointly with IFPRI, involves research on policy and institutional issues, including analysis of the role of government policies and particularly their effect on economic incentives for the sustainable use of land and range resources, and analysis of property rights issues and

the role and effectiveness of local institutions in regulating rangeland use. The proposed initiative for the desert margins of North Africa would take advantage of the complementary research activities of this project.

IFPRI is also collaborating with ICRISAT in research on Sahelian household decision-making and crop and livestock management practices. Thus, IFPRI provides a linkage between ICARDA and ICRISAT in research related to the socio-economic determinants and policy and institutional issues related to resource management in both the northern and southern margins of the Sahara.

1.3 Ecoregional Initiative for the Desert Margins of North Africa: Institutional Linkages

The strength of this initiative lies in exploiting the comparative advantage of each of the research partners. ICRISAT is the convening center for the Desert Margins Initiative, and details of the research organizations participating in the initiative for sub-Saharan Africa - other CG centers (ICRAF, ILCA, IFPRI and IPGRI), other international and regional cooperators, and national research systems - are given in ICRISAT's document. The linkages detailed below refer specifically to ICARDA's proposed initiative for the desert margins of North Africa.

1.3.1 IARC to IARC Linkages

1. ICARDA - ICRISAT. The primary linkage will be between ICARDA and ICRISAT's Sahelian Center, as discussed above.

2. ICARDA - IFPRI. Resource management problems reflect the social and economic circumstances of land users, so technical research on resource management interacts closely with research on socio-economic, public policy and public management issues. IFPRI is already collaborating with ICARDA in the IFAD/AFESD programme, and can also draw on their experiences in research on Sahelian household decision-making and crop and livestock management practices.

3. ICARDA - IPGRI. ICARDA hosts IPGRI's regional office for WANA and the secretariat of the WANANET plant genetic resources network. IPGRI will support the proposed inter-center initiative through the WANANET Working Groups on Cereal Genetic Resources and Pasture and Forage Genetic Resources and through its participation in the UNDP supported regional project to establish a database on rangelands in Algeria, Morocco and Tunisia.

4. Further linkages are envisaged with the ICARDA/ILRI proposed inter-center initiative on "Improved Utilization of Small Ruminant Genetic Resources for sustainable Production in Livestock-Crop-Range Production Systems in Countries of the WANA Region", and with the systemwide water management initiative for which IIMI is the convening center.

1.3.2 IARC to NARS Linkages

The proposed initiative for North Africa will benefit from:

1. the existing linkages between ICARDA, and other international/regional centers in North Africa (ACSAD, CIHEAM), and linkages with partners in the NARS of North Africa, operating through ICARDA's North Africa Regional Program (NARP).

2. the existing linkages between ICARDA and our partners in the NARS with similar agro-ecologies in West Asian countries, operating through ICARDA's West Asia Regional Program (WARP).

3. the existing linkages between ICRISAT, and other international/regional centers in the Sahel, and their partners in NARS, operating through the ICRISAT Sahelian Center (ISC).

1.3.3 NARS to NARS Linkages

Linkages already exist between the NARS in North Africa through the Maghreb Union. Multinational, multi-institutional and multidisciplinary cooperation between NARS has also been encouraged by the research programs and networks operated by ICARDA through the North Africa Regional Program.

Strong linkages already exist between the NARS of the Sahelian countries. However, as far as we are aware, there are few if any linkages between the Sahelian and North African NARS. No forum exists for integrated regional cooperation between the NARS of the two regions. An important objective of the proposed initiative is to develop transnational mechanisms for collaboration between NARS in research and technology transfer.

2. DEVELOPMENT OBJECTIVE

The overall objective of the proposed program for the desert margins of North Africa is:

> **Improved productivity of small ruminants based on sustainable increases in domestic feed supplies attained through the promotion of improved resource conservation and management options that are ecologically sustainable, economically viable and socially acceptable to the farmers and livestock owners in the desert margins of North Africa.**

To achieve this overall objective, action is required on several fronts:

(i) Identification of the extent and impact of land degradation and the underlying causes, both physical and human, with a view to formulating an appropriate research program for the development of natural resource conservation and management options in the northern margins of the Sahara.

(ii) Evaluation, with the participation of local land users, of current indigenous and improved land and grazing management systems and crop and livestock production practices, with a view to identifying causes of misuse, designing effective options for improvement, and identifying constraints and incentives to their adoption.

(iii) Development of improved resource management options, land use practices and technologies that increase productivity while conserving and enhancing the resource base.

(iv) Development of improved conservation, management and utilization of the agricultural biodiversity of the desert margins of North Africa.

(v) Identification and analysis of policy distortions and, where considered appropriate, the investigation of property rights and communal control of access to rangeland resources, with a view to enhancing the adoption by land users of resource management options and technologies that increase local feed production and livestock productivity while at the same time conserving the resource base.

(vi) Enhancement of the institutional capacity of the participating countries to undertake resource management research and extension, with particular attention to multidisciplinary and participative socio-economic research, and the establishment of mechanisms for collaboration between NARS in participating countries to ensure that the initiative is self sustaining.

3. IMMEDIATE OBJECTIVES, OUTPUTS AND ACTIVITIES

3.1 PROBLEM IDENTIFICATION AND ANALYSIS

3.1.1 Immediate Objective

Identification of the extent and impact of land degradation and the underlying causes, both physical and human, with a view to formulating an appropriate research program for the development of natural resource conservation and management options in the northern margins of the Sahara.

3.1.2 Outputs

- assessments of the natural resources (land and vegetation), the extent and severity of degradation, and the resource management and production systems prevailing in the northern margins of the Sahara, that will be comparable to similar assessments for the southern margins proposed in ICRISAT's Desert Margins Initiative;

- priority research issues identified for the northern desert margins;

3.1.3 Activities and Institutional Input

- Characterization and analysis of land use systems in the northern margins of the Sahara v. the southern margins. [*ICARDA and ICRISAT*].

- Evaluation, with the participation of local land users, of current indigenous and improved land and grazing management systems and crop and livestock production practices, with a view to identifying causes of misuse, designing effective options for improvement, and identifying constraints and incentives to their adoption [*ICARDA and NARS*]

- Research problem diagnosis/priority setting and identification of research hypotheses and approaches to achieving potential solutions. [*ICARDA and associated NARS; ICRISAT*]

3.2 TECHNOLOGICAL RESEARCH AND TRANSFER

3.2.1 Immediate Objective

Improved land use practices and technologies that increase productivity while conserving and enhancing the resource base, accepted and implemented by land users in the northern margins.

3.2.2 Outputs

- rehabilitation, conservation, and management of rangelands including recommendations, based on field tested methods, for soil, water and vegetation management and guidelines for stocking and grazing management.

- local production of high quality feed and the establishment of sustainable cropping systems, through the adoption of forage and pasture legumes in farmers' crop rotations.

- improved feed availability through the higher yields of barley grain and straw from the widespread adoption of improved production practices and varieties.

3.2.3 Activities and Institutional Input

- field testing of appropriate methods of soil, water and vegetation management for rangelands, including surface water management for water harvesting and/or erosion control; use of shrubs for soil surface protection and wind erosion control, fodder and fuelwood. [*ICARDA and associated centers/NARS; ICRISAT and associated centers/NARS in the Sahel; linkages with IIMI initiative on water management*].

- evaluation of nutrient status of soils and investigation of nutrient cycling in crop/livestock systems, using on-farm methodologies developed in the Sahel. [*ICRISAT and associated IARCs; ICARDA and associated NARS*].

- evaluation of reduced cost tillage systems for crop production in marginal rainfed cropping areas. [*ICARDA, ICRISAT and associated NARS*].

- integration of pasture and forage legumes into cereal based rotations. [*ICARDA and associated NARS*].

- on-farm testing of identified promising cultivars of barley, both under farmers' own conditions and in combination with improved management practices, and follow-up monitoring and evaluation with farmers. Improvement of productivity in these areas requires selection and testing of cultivars for specific adaptation to these environments. ICARDA is already in the process of devolving its breeding program for North Africa by distributing specific nurseries of earlier (F2) material for selection for specific adaptation, *in situ*, by NARS. [*ICARDA and associated NARS*].

- farmer participatory trials in small ruminant management and nutrition, with particular reference to grazing management. [*linkages with ILRI/ICARDA intercenter initiative on small ruminants in WANA*].

Complementary activities within the IFAD/AFESD funded programme and other complementary projects include:

- evaluation of the role and economic value of weedy fallow, and alternative strategies for its management in crop production systems. [*ICARDA and associated NARS*].

- seed production of pasture legumes is widely reported to be a major constraint in their adoption. ICARDA has initiated and provides support to a farmer-based pasture seed production project in Morocco and Algeria, using low-cost mechanized techniques developed by ICARDA scientists and local manufacturers in Aleppo, which could serve as a prototype for other countries in the region. [*ICARDA and associated NARS*].

- further research is needed to establish best methods of harvesting, handling and utilizing forage legumes, including grazing management. Lack of experience and/or suitable equipment in forage harvesting and conservation may be a main reason for low rates of adoption by farmers. [*ICARDA and associated NARS*].

- barley straw is also an important livestock feed. Breeding programs need support from back-up research on improvement of total productivity (biomass). This work will be conducted in collaboration with livestock nutritionists (on straw quality and palatability traits) and with participation of farmers and livestock owners in identifying desirable traits and selection criteria. [*ICARDA*].

3.3 Conservation, Management and Utilization of Biodiversity

3.3.1 Immediate Objective

Improved conservation, management and utilization of the agricultural biodiversity of the desert margins of North Africa accepted and implemented by landusers.

3.3.2 Outputs

- a database, integrated with the agro-ecological characterization (under Objective 1) using GIS, documenting key sites of biodiversity and species.

- germplasm of major species conserved and characterized.

- where applicable, germplasm identified for rehabilitation of natural rangelands.

- where applicable, land races of barley and forage legumes included in breeding programs to exploit specific adaptation and maintain genetic diversity.

3.3.3 Activities and Institutional Input

- Identification and documentation of characteristic areas of high or unique genetic diversity, including local (indigenous) knowledge of characteristics and use of species. [*ICARDA, IPGRI*].

- Germplasm collection, evaluation and characterization. [*ICARDA, IPGRI and associated NARS*].

- Identification of species for incorporation in breeding programs - farmer involvement in selection and breeding. [*ICARDA and associated NARS*].

3.4 POLICY AND PUBLIC MANAGEMENT ANALYSIS

3.4.1 Immediate Objective

Amendment of policy distortions so as to improve incentives for farmers to invest in technologies that increase local feed production and livestock productivity, and where considered appropriate, the establishment of property rights and communal control of access to rangeland resources so as to improve incentives for land users to adopt improved technologies and rangeland management practices.

3.4.2 Outputs

- Assessment of the changes in land use, productivity and degradation and analysis of incentives and disincentives (constraints) to appropriate resource management, integrated with agroecological characterization (under Objective 1), in a manner to allow comparisons with the Sahel.

- Recommendations for government interventions (legislation, policy reforms) to support natural resource conservation and management.

3.4.3 Activities and Institutional Input

- Comparative descriptive analysis (in the northern and southern margins), utilizing available information, to track trends in land use, productivity and degradation. Information about changes in land laws, land tenure, and indigenous institutions that manage common property (rangelands) will also be compiled, together with details about government efforts to set up alternative regulatory mechanisms. [*ICARDA, ICRISAT, IFPRI*].

- In selected sites detailed field work will be undertaken to establish exactly what is happening to property rights on the rangelands, to communal control over grazing, and to the traditional rights of rangeland use by different groups of users (especially nomadic and semi-nomadic people). [*ICARDA, IFPRI*].

- The data will provide the basis for constructing models of resource management decisions on the rangelands. These models will be used to help identify changes in policy and grazing regulations needed to improve incentives for the adoption of more sustainable technologies and soil and range management practices. The models will also be used to evaluate the economic viability of the technologies and management practices to be developed and/or transferred as part of this research project. [*ICARDA, IFPRI*].

3.5 Regional Cooperation between NARS

3.5.1 Immediate Objective

Enhanced institutional capacity of the participating countries to undertake resource management research and extension, with particular attention to multidisciplinary and participative socio-economic research, and established mechanisms for collaboration between NARS in participating countries ensuring that the initiative is self sustaining.

3.5.2 Outputs

- A cadre of skilled scientists, supported by established mechanisms within NARS, that will undertake production systems and resource management research thus ensuring the sustainability of this initiative.
- A self-sustaining network for information and technology dissemination and exchange.

3.5.3 Activities and Institutional Input

- Provision of short term group training courses on specific topics and the provision of support to national scientists to undertake research towards their M.Sc and Ph.D degrees within the overall training component proposed for ICRISAT's Desert Margins Initiative.

- Exchange visits, seminars, workshops, etc. ICARDA has found from its experience in other regional programs that the networking concept has had considerable success in reducing the potential risks inherent in implementing a multi-country multi-institutional program. Network activities have included information exchange, training, regional study tours and workshops; the personal and professional relationships which have been established among scientists have enhanced the institutional linkages generated by the project activities. However, such networking requires national commitment by the governmental institutions in the countries particularly at the personnel level and in support of networking activities. [*ICARDA, ICRISAT, and associated NARS and other centers*].

4. COORDINATION ARRANGEMENTS

Institutional mechanisms and coordination arrangements for the overall initiative for Africa are expected to be formulated at the International Planning Workshop on the Desert Margins Initiative to be convened by ICRISAT in January 1995 in Nairobi, Kenya.

With respect to the proposed program for the North Africa Desert Margins, we propose that ICARDA function as the coordinating center through its North Africa Regional Office in Tunis. Selected ICARDA and NARS scientists would be responsible for research leadership, management and coordination of specific components of the research program (jointly with IFPRI in the case of the policy and institutional research component). Such coordination may be facilitated by regional working groups, networks, special committees, etc.

The project will benefit from cooperation with other activities in the region; where feasible, the project will seek collaboration with other regional and international research and development institutions (for instance ACSAD, AOAD, CIHEAM, ESCWA) and projects. In addition to collaborating with researchers from national agricultural research systems, close contacts will be maintained with appropriate personnel of government policy and planning departments, with the relevant faculties of national universities, and with other research institutions and non-government organizations working on similar problems.

5. BUDGET

The attached budget was developed for ICARDA's original proposal for an Ecoregional Initiative for West Asia and North Africa (WANA) submitted to TAC in August 1994. This provisional budget is included here as an indication only of ICARDA's estimations of the minimum support needed to initiate the proposed activities in the desert margins of North Africa.

ICARDA recognizes that if the proposed program for North Africa is incorporated into the overall Desert Margins Initiative for Africa, this budget will be adjusted following discussions with ICRISAT as the convening center.

5.1 PROVISIONAL BUDGET

($ US)	1995	1996	1997	1998	Total
ICARDA					
North Africa Program Coordination	84,000	84,000	84,000	84,000	336,000
Operational costs	20,000	20,000	20,000	20,000	80,000
Travel	15,000	15,000	10,000	10,000	50,000
Training Support	15,000	15,000	10,000		40,000
Workshops/Seminars	20,000	20,000	20,000	50,000	110,000
Sub-total	**154,000**	**154,000**	**144,000**	**164,000**	**616,000**
ICRISAT					0
Agro-ecological characterization	25,000	25,000			50,000
Technology transfer	15,000	15,000	30,000	30,000	90,000
Training Support	15,000	15,000	10,000		40,000
Workshops/seminars	20,000	20,000	20,000	20,000	80,000
Sub-total	**75,000**	**75,000**	**60,000**	**50,000**	**260,000**
IFPRI					
Personnel	19,600	19,600	19,600	9,800	68,600
Operational (field surveys)	10,000	10,000	10,000		30,000
Travel	11,000	11,000	11,000	5,500	38,500
Policy Workshop				30,000	30,000
Sub-total	**40,600**	**40,600**	**40,600**	**45,300**	**167,100**
IPGRI-WANA					
Germplasm Conservation and use	15,000	15,000	15,000	15,000	60,000
ILRI					
Linkage to Inter-Center Initiative on Small Ruminants	15,000	15,000	15,000	15,000	60,000
NARS					
National Professional Officers	60,000	60,000	60,000	60,000	240,000
Operational	35,000	35,000	35,000	35,000	140,000
Travel	10,000	10,000	10,000	10,000	40,000
Training	20,000	20,000	20,000	20,000	80,000
Sub-total	**125,000**	**125,000**	**125,000**	**125,000**	**500,000**
TOTAL	**424,600**	**424,600**	**399,600**	**414,300**	**1,663,100**

5.2 BUDGET NOTES

ICARDA

Programme Coordination: One senior scientist full-time, budgeted at ICARDA's average employment costs of $US 84,000 per year.

Operational costs for ICARDA's field operations.

Travel. Costs of ICARDA scientists travel to and from North Africa and ICRISAT Sahelian Center

Training Support. Costs of training materials, preparation, etc., and HQ support. Support for trainees is included under NARS component of the budget.

Workshops/Seminars. To support regional cooperation between NARS, ICARDA and ICRISAT Sahelian Center. Costs are shared in first three years with ICRISAT Sahelian Center. Final Workshop budgeted for in final year.

ICRISAT

Agro-ecological Characterization: personnel and operational costs for collaboration in Agro-ecological characterization.

Technology Transfer: personnel and operational costs involved in transfer of appropriate technology from southern Sahel to northern Sahel.

Training Support: see notes under ICARDA's component.

Workshops/seminars: see notes under ICARDA's component.

IFPRI

Budget for IFPRI is complementary to funding provided under IFAD/AFESD funded programme, and supports additional activities.

Personnel: Research Fellows, at IFPRI's standard employment costs (including benefits) of $US 9,800 per month. Two months in the first three years, one month in the fourth year. Note, the IFPRI component will also be supported by one National Professional Officer, budgeted under the NARS component.

Operational costs: Field surveys additional to those required under IFAD/AFESD programme. Activities under this component will also be supported by operational costs under NARS component.

Travel: Two trips from Washington to Damascus, in first three years; one trip in final year for Policy Workshop. Round trip airfare, plus *per diem*, budgeted at $5,500 per trip.

Workshop: Policy Workshop in North Africa in final year.

IPGRI

Germplasm Conservation and Use. Costs to support participation of IPGRI WANANET.

ILRI

Costs to support linkages with ILRI/ICARDA Inter-Center Initiative on Small Ruminants.

NARS

National Professional Officers: three NARS scientists will be seconded to the programme. Budgeted according to ICARDA's standard scale for NPO2, equivalent to professionals with a Masters degree or relevant training plus twelve years experience or a PhD with less than five years related experience.

Operational costs: for field activities in the northern Sahel and, where appropriate, technology transfer from other areas of WANA.

Travel: travel of NARs scientists within North Africa, and to ICRISAT Sahelian Center.

Training: support to trainees, including travel, stipend, per diem, etc.

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

L'ICRISAT

Les régions tropicales semi-arides couvrent entièrement ou partiellement 48 pays en développement: une majeure partie de l'Inde, des régions de l'Asie du sud-est, une bande au travers de l'Afrique au sud du Sahara, la plus grande partie de l'Afrique orientale et australe, ainsi que quelques régions d'Amérique latine. La plupart de ces pays sont parmi les plus pauvres dans le monde. Près d'un tiers de la population mondiale habite dans ces régions tropicales semi-arides qui sont caractérisées par un climat peu prévisible, une pluviosité faible et aléatoire et des sols pauvres en éléments nutritifs.

Les cultures faisant l'objet du mandat de l'Institut international de recherche sur les cultures des zones tropicales semi-arides (connu sous le sigle anglais d'ICRISAT) sont le sorgho, le mil, l'éleusine, le pois chiche, le pois d'Angole et l'arachide, cultures qui sont vitales pour la subsistence des populations sans cesse croissantes des régions tropicales semi-arides. Le mandat de l'ICRISAT est d'effectuer des travaux de recherche conduisant à une production améliorée et durable de ces cultures ainsi qu'à une meilleure gestion des ressources naturelles limitées de ces régions. L'ICRISAT communique des informations sur les technologies au fur et à mesure qu'elles sont mises au point au travers d'ateliers, de réseaux, de la formation, des services bibliothèque et de publications.

L'ICRISAT a entamé son action en 1972 et constitue l'un des 16 centres de recherche et de formation à but non-lucratif, financé au travers du Groupe consultatif de recherche agricole internationale (GCRAI). Le GCRAI est une association informelle d'environ 50 bailleurs de fonds relevant tant du secteur public que du secteur privé. Le Groupe est supporté conjointement par la Banque mondiale, l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO), le Programme des Nations Unies pour le développement (PNUD) et le Programme des Nations Unies pour l'environnement (PNUE).