



**211**



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# Revitalizing Agricultural Research in the Sahel

A Proposed Framework for Action

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Jan Weijenberg  
Josué Dioné  
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Jan Weijenberg  
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Michael Fuchs-Carsch  
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Washington, D.C.

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## ***Abstract***

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The problem which this Framework for Action (FFA) seeks to address is the slow rate of technology generation of the agricultural research system in the Sahel. To overcome this problem, the FFA proposes to strengthen the national agricultural research systems in the region through a three-pronged effort:

- (a) Institutional reforms of the national agricultural research systems to evolve an "enabling" environment for creativity, innovation and improved performance.
- (b) New modes of regional cooperation based on the principles of comparative advantage and the relative strengths of national agricultural research systems.
- (c) A series of cross-cutting actions to support the revitalized national and regional efforts.

It is expected that a more demand-driven national/regional research agenda and more vibrant linkages between scientists and clients will lead to faster rates of technology generation, as was demonstrated by the success of cotton research in the Sahel.

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## Foreword

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Africa is facing an economic crisis of formidable proportions - one that has been exacerbated by the nexus of rapidly increasing population, degradation of the natural resource base and the environment, and persistent low agricultural productivity. The continent urgently needs to develop and adopt improved and new farming technologies if it is to begin to reverse this worsening crisis. Such a breakthrough will depend on dynamic, creative, and strong national agricultural research systems that work closely with farmers and extension workers. Such systems are, unfortunately, rare in Sub-Saharan Africa.

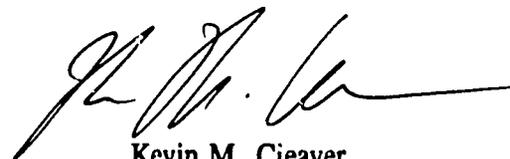
The Special Program for African Agricultural Research was established in 1985 by a group of donors as a forum for collaborating on programs to strengthen African agricultural research systems. SPAAR's initial efforts did not have the desired impact on agricultural research systems. Therefore, in May 1990, the SPAAR membership decided to adopt a new approach, based on regional frameworks for action. These are related to the major ecological groupings of Sub-Saharan Africa (SSA) and are prepared jointly with the managers and scientists of the national agricultural research systems.

This paper details the Framework for Action to Revitalize Agricultural Research in the nine countries collaborating in the Inter-State Committee for Drought Control in the Sahel (CILSS). The new strategic agenda was elaborated to promote stronger regional collaboration coordinated by the Sahel Institute (Institut du Sahel-INSAH). The elements for the Framework were developed

through an iterative process of workshops and in-country consultations by a task force appointed by INSAH and the SPAAR Secretariat.

The Framework has been accepted by both the CILSS Council of Ministers and the SPAAR membership and is being piloted by Mali for the CILSS region. Mali has initiated under its leadership the constitution of a regional collaborative research program on sorghum, the first of a series of such programs. In partnership with its donor community, Mali is introducing substantial institutional reforms of its public sector agricultural research system and its National Agricultural Research Institute will be given full management autonomy. Mali will also be spearheading innovative new approaches to participative research with farmers and extension services. The focus of its research effort will be on carefully prioritized programs in line with its National Strategic Plan for Agricultural Research adopted in 1992.

INSAH and SPAAR are actively promoting the implementation of the Framework recommendations in Burkina Faso, The Gambia and Senegal, the last of which is close to launching a collaborative research program on small ruminant productivity improvement and pathology. Cape Verde, Chad, Guinea-Bissau, Mauritania and Niger are expected to follow soon in this long-term program of revitalizing their agricultural research systems. The strength of the Framework's recommendations is that they are firmly anchored in the national systems which gives hope for their sustainability.



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Any errors of omission or commission remain the responsibility of the authors.

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## *Abbreviations and Acronyms*

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<b>AGIR</b>	Project d'Amélioration de la Gestion dans les Instituts de Recherche au Sahel
<b>ACBI</b>	African Capacity Building Initiative
<b>CGIAR</b>	Consultative Group on International Agricultural Research
<b>CIDA</b>	Canadian International Development Agency
<b>CILSS</b>	Comité Inter-Etat pour la Lutte contre la Sècheresse au Sahel
<b>CNRADA</b>	Centre national de recherche agronomique et de développement agricole, Mauritanie
<b>CORAF</b>	Conférence des responsables de la recherche agronomique africaine
<b>CRRA</b>	Comité Régional de Recherche Agricole
<b>CTFT</b>	Centre Technique Forestier Tropical
<b>DEPA</b>	Departamento de Estudos e Pesquisas Agricolas
<b>EPA</b>	Etablissement Publique à Caractère Administratif
<b>EPIC</b>	Etablissement Publique à Caractère Industriel et Commercial
<b>IARC</b>	International Agricultural Research Center
<b>IBPGR</b>	International Board for Plant Genetic Resource
<b>ICRISAT</b>	International Crops Research Institute for Semi-Arid Tropics
<b>IDRC</b>	International Development Research Centre
<b>IER</b>	Institut d'Economie Rurale, Mali
<b>IFPRI</b>	International Food Policy Research Institute
<b>IITA</b>	International Institute of Tropical Agriculture
<b>ILCA</b>	International Livestock Centre for Africa
<b>ILRAD</b>	International Laboratory for Research on Animal Diseases
<b>INERA</b>	Institut national d'études et de recherches agricoles, Burkina Faso
<b>INIA</b>	Instituto Nacional De Investigacao Agraria
<b>INRAN</b>	Institut national de recherches agronomiques du Niger, Niger
<b>INSAH</b>	Institut du Sahel
<b>IRCT</b>	Institut de Recherches du Coton et des Textiles exotiques
<b>IRHO</b>	Institut de Recherche pour les Huiles et Oleagineux
<b>IRRI</b>	International Rice Research Institute
<b>ISC</b>	ICRISAT Sahelian Centre

<b>ISNAR</b>	<b>International Service for National Agricultural Research</b>
<b>ISRA</b>	<b>Institut Senegalais de Recherches Agricoles</b>
<b>NARS</b>	<b>National Agricultural Research System</b>
<b>SAFGRAD</b>	<b>Semi-Arid Food Grains African Department</b>
<b>SPA</b>	<b>Special Program for Africa</b>
<b>SPAAR</b>	<b>Special Program for African Agricultural Research</b>
<b>WARDA</b>	<b>West Africa Rice Development Association</b>

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## *Executive Summary*

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### Organization of the Discussion Paper

The initial three chapters present a synthesis of the problems, the challenges and the concrete proposals to address the issues facing agricultural research in the Sahel. Chapters 4 and 5 detail the physical and socio-economic setting of the agricultural sector and agricultural research potential. Chapters 6, 7 and 8 provide detailed proposals for a Framework for Action. Chapter 9 provides an update (end-1992) regarding implementation of the Framework for Action in the respective countries.

### The Problem

Economic growth in the Sahel depends on the sustainable performance of its agricultural sector. The problem which this Framework for Action (FFA) seeks to address is the slow rate of technology generation within the Sahelian agricultural research system. Science-based technology generation should spearhead agricultural development in four priority areas concern:

- Maintaining and improving *food security* making research responsive to market conditions and consumption trends.
- Orienting research towards new markets for cash and export crops and animal products and fisheries (*diversification*) for which the region has a comparative advantage (climate, distance to market outlets, and labor costs).
- Broadening research to include upstream (production costs) and downstream (alternative product uses) considerations in a *sub-sector (filière) approach* to cash-in on market opportunities.
- Leading research towards the goal of making Sahelian agrarian systems *sustainable* in a rapidly changing ecological and economic environment.

### The Challenge

Taking agricultural research out of its relative isolation by making it more accountable to its clientele (farmers and herders and their associations, extension services, the processing industry, seed production companies, manufacturers and distributors of agricultural inputs, etc.) and more responsive to national and regional economic development challenges.

### The Proposed Framework for Action

To meet this challenge, the FFA seeks to address the present slow rate of technology generation through a three-pronged effort:

- Institutional reforms of the National Agricultural Research Systems (NARSs) to evolve an "enabling" environment for creativity, innovation and improved performance.
- New modes of regional cooperation based on the principles of comparative advantage and the relative strengths of NARSs.
- A series of cross-cutting actions to support re-italized national and regional efforts.

The reality of the Sahel is that of the countries and their national agricultural research systems (NARSs). These countries comprise Burkina Faso, Cape Verde, Chad, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and The Gambia. New in this approach is that the NARSs are the basic building blocks of an emerging eco-regional research agenda. They should be empowered to become the leaders of that agenda, based on past lessons learned, such as, for example, that networking, International Agricultural Research Centers (IARCs) and "enclave" projects have not had the expected impact, while acknowledging that successful research (e.g. cotton) has been client/ market-driven. In

this manner, the proposed FFA builds on the ongoing momentum and direction of change of the NARSs, in terms of its institutional and research focus.

### Principal Features

To generate an "enabling" institutional environment, the FFA proposes the following areas for immediate action:

- Removing concerned institutions from the stranglehold of the public sector and opening them to the outside world, by making them client/market-driven, through (amongst others) the introduction of "Consolidated Funding Mechanisms" to ensure: (a) the sustainable funding of recurrent research operating expenditures, and (b) the desired coordination between all the actors involved in the regional research agenda.
- Establishing regional research poles with a common priority research thrust and building on the relative strength of all the NARSs in the region by consolidating existing national scientific capacity.
- Creating an economic analytical capability to ensure the continuous adjustment of national and regional research strategies to the dynamics of a changing economic environment;
- Building human capacity to serve the agricultural sector of the region in general and agricultural research in particular.
- "Dove-tailing" the evolving CGIAR-IARC strategy by making it responsive to the "needs" of the regional research agenda.

### Implementation

Implementing the FFA will need the full endorsement of all its stakeholders, especially in obtaining the political commitment from the CILSS member states. To this end, the FFA formally adopted by the CILSS Council of Ministers. To further flesh out the FFA, the donor community, the IARCs and the "networks", each has to play its role in the evolving regional research agenda. All this culminated in the formal adoption of the proposed FFA by the Special Program for

African Agricultural Research (SPAAR) membership during its December 1991 session.

Adoption of the FFA has signalled the preparation of a series of parallel activities, coordinated by the Institut du Sahel (INSAH) (a) the NARSs reforms, (b) the first regional research poles for priority research programs, and (c) a "blue print" for a regional agricultural education system. To accomplish its expanded task under the FFA, INSAH will strengthen its policy analysis and research development capability as well as its scientific oversight and research coordination function. INSAH will also seek a special program arrangement with the International Service for National Agricultural Research (ISNAR) for methodological assistance in preparing the NARS reforms and a regional human resources development strategy. It is important to underline, once more, that the responsibility for FFA implementation lies entirely with the "empowered" NARSs, INSAH's mandate providing for the necessary coordination.

An important element to secure continued commitment of all the stakeholders (governments, donors, IARCs, etc.) will be the reaching of an agreement on the establishment of an independent mechanism to monitor and evaluate FFA implementation.

### Expectations

Successful implementation of the proposed FFA is expected to be indicated by the following:

- Increased number of technological innovations well adapted to local situations and higher rates of technology diffusion and adoption.
- The organization of vibrant interchanges between scientists and their clients so that the research agenda is more demand-driven.
- Gradual broadening of the research agenda and its client base to incorporate issues important to a market-driven agriculture, including emphasis on trade, utilization, agro-processing and market/product development.
- Stability in the institutional environment of

NARSSs, including areas of funding, programming and staffing.

- Increased participation of faculties of agronomy, private sector institutions, farmers and herders and their associations, NGOs and extension-oriented bodies in human capacity-building and technology generation.

- Gradual decrease in exogenous technical assistance and greater use of indigenous human resources.

- More substantial interaction with relevant IARCs as equal partners and for mutual benefit.

- Rationalization of the regional agricultural research system, perhaps through a reduction in the number of networks not focusing on national and regional priorities and in the multiplicity of uncoordinated regional efforts.

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# *1: Agricultural Research and the Sahelian Development Challenge*

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## **Objectives**

Agricultural research must be bold if it is to contribute significantly to the evolution of a fragile ecosystem whose development requires many integrated actions. A creative approach, tempered by a basic - if yet imperfect - understanding of Sahelian agrarian and economic systems, helps to target the major objectives for agriculture so that it can contribute significantly to economic growth. These objectives present the challenge which research must confront if it is to have a role in the economic future of the Sahel. This economic future cannot be isolated from West Africa's as a whole. If the Sahel is ecologically unique, its economy is, however, tied to its cities and its neighboring countries towards which its product and labor markets are already directed.

## **Food Security**

Maintaining and improving food security is an essential objective which must be based on the improved performance of traditional plant and animal food systems of the region. The rigidity of the northern Sahelian production systems, dominated by herding and/or millet-sorghum, is a basic factor which cannot be ignored. Market conditions and consumption trends should guide in the identification of specific actions to address both components of this production system. Research must also face the potential challenge of rising urban demands for the "preferred foods": rice and wheat.

## **Diversification**

Cash and export crops are a second, though equally important, objective. The southern Sahel, and the irrigated zones, have potential for agricultural diversification which can be exploited by moving towards new markets in

which the Sahel enjoys some comparative advantage: irrigated off-season crops for relatively nearby markets (animal traction and relatively low labor costs permitting), off-season fruits and vegetables, meat (especially small ruminants), dairy, fish - all have potential. In addition to gaining new markets, it is necessary to reinforce the existing comparative advantage (cotton) and to regain that which has been lost (vegetable oils, livestock). It is necessary to attach as much importance to the considerable growth of urban markets in the region (especially those in neighboring countries) as to the more traditional export market outlets. It should be noted that the evolution towards a more competitive and market-oriented agriculture depends on improved food crop performance to reduce the opportunity cost of labor, thus stimulating the production of cash and export crops.

## **The Sub-Sector (Filière) Approach**

A third objective is the development of the sub-sector or filière approach. For a range of commodities as diverse as cereals, legumes, tubers, fruits and vegetables, meat, fish, dairy etc. market research and food processing technologies may be as important as upstream research on breeding (plant and animal) and agronomy and/or husbandry. The sub-sector approach, in directing attention to markets and alternative product uses, particularly those in close proximity, is especially important for adding value and employment in rural areas. Off-farm employment, risk aversion and income security of various economic actors (farmers, agribusiness, traders, processors and others in the sub-sector) are also appropriate and important targets for agricultural research.

## **Sustainability**

Interventions which "sustain" the agrarian system, notably its natural resources, are most essential considering the ecological conditions of the Sahel. At different levels (villages, watersheds, agro-ecological zones), the fragility of the ecosystem requires improved environmental management, especially of the natural production factors, particularly in their relation to labor.

In sum, two *strategic objectives* emerge:

1. Increase agricultural production as much for improving food security as for generating surpluses for local and export markets.
2. Improve capacity to sustain the natural resource base as much for safeguarding the environment as for effectively managing the factors of rural production.

To achieve these objectives, bold measures are needed to raise the efficiency and productivity of the agricultural research system by:

1. Focusing research efforts on the sub-sectors and systems which promote these objectives and on the factors and processes which constrain them.
2. Harnessing all possible actors and resources in the region to unify the scientific base to meet the development challenge.

3. Reforming the organizations, management and research methods of national and regional systems so that they can mobilize and effectively use these actors and resources.

With respect to research methods, several actions should be undertaken which:

1. Develop capacity for analyses and proposals on the economic future of the Sahel: for example, land tenure, migration, urban markets, producer behavior, sub-sectors etc.
2. Enable a better understanding of local ecosystems and the biological processes best adapted to these systems so that natural production factors can be better managed and used.
3. Promote "sub-optimal" research which takes into account the actual conditions faced by farmers whose requirements for economic stability weigh more importantly in their decisions than yield increases and their associated risks.
4. Develop procedures for multi-disciplinary research which takes into account the diversity in the region's agrarian and farming systems.
5. Develop procedures for participatory research involving different economic actors in research design, trials, technology testing and evaluation of results. This iterative and constructive approach is particularly essential because there are no simple technical and economic solutions to the evolution of complex systems.

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## 2: A Necessary and Possible Regional Research Effort

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### The Role and Capacity of the Agricultural Research System

The contributions of agricultural research are essential for economic growth and the needs of communities inextricably tied to the region's fragile environment. However, research can do little without being consistent with macro-economic policy and, perhaps, even shaping it. And, very little of significance will happen without appropriate technologies and innovations. This explains the special role of research in the Sahel. The research system is composed of many actors: public and private, national and regional, international and overseas experts, working together in the region. It is this total capacity which must be harnessed, consolidated and reinforced to meet the development challenge.

### National Agricultural Research Systems

Many national systems are facing a crisis for several reasons.

- Neither the national economies nor their budgets have the capacity to support research at levels sufficient to face the diversity of problems and the development challenges.
- The public statutes favor a bureaucratic system rather than an enabling environment which promotes creativity and assures the flexibility needed for undertaking a multiplicity of tasks; these statutes also do not reward good management and innovative research operations. In particular, the vicious cycle of weak public administration and accounting procedures has led governments to impose overly strict *priori* controls on research expenditures. This has also prevented donors from entrusting spending responsibility for research operating costs to national research institutions. This, in turn, has resulted in donor funded research programs being designed as 'enclave' projects, thereby

further weakening research management systems.

- Other actors, such as farmers and herders and/or their associations, the faculties of agronomy, the extension services, NGOs, the private sector etc. have not been fully integrated in the technology generation and diffusion process. These actors harbor considerable, yet underutilized, research potential.
- The limited scientific and research capacity resulting from the above has not generated the technologies at rates sufficient for policy-makers, donors and development organizations to have confidence in the research system. Thus, without drastic reforms, donor "fatigue" and "decompression" under structural adjustment will continue to take their toll.
- The limited means of communication between scientists within and among countries in the region.

### Lessons Learned

While the performance of NARSs has been weak, the efforts of IARCs and regional activities (networks) have also not generated technologies at rates to demonstrate significant impact. The reality of the Sahel is that of the countries and their national systems which compose it. It is through the national systems, once reformed, that the *effective* research capacity of the region can be revealed and harnessed. Several efforts are demonstrating the necessity of reform and the ways of accomplishing it. Most importantly, past research successes in the Sahel, notably work on cotton, early maturing varieties and food grain policy, have demonstrated the directions which reforms should steer towards -- a demand-driven research agenda brought about through close working relations between researchers and clients and the sub-sector/filière approach to solving upstream and downstream problems.

## Past Regional Efforts

Concern regarding research efficiency, capacity and productivity have motivated several attempts to rationalize resource allocations on a regional basis. The weaknesses of such efforts were as follows:

1. Not taking into account the importance of NARSs as the basic building blocks for any sustainable regional initiative and the need to institute drastic reforms in their organizations, management and operations.
2. The inability to harness sufficient political support for research that would enable policymakers to understand that this support is an essential precondition for research success.
3. Weak attempts at linking research priorities to market opportunities and development challenges. Essentially, except for cotton, priority setting was an exercise in dialogue among researchers.
4. Lack of a framework which drew together in a coordinated and synergistic way a multiplicity of initiatives at various levels.
5. Lack of commitment from donors to assure funding and programming stability.

## A Convergence of Events

There is an evolving consensus on the priority problems that agricultural research should address in the region: the high production costs of the major rainfed cereals, their lack of alternative market outlets and the need for research on plant/soil/water relations. This substantive mandate makes a new initiative now opportune, especially in view of a possible convergence of key developments on several fronts. These are:

1. The policy breakthroughs as a result of CILSS-Club du Sahel activities on issues such as regional trade and natural resource management. Policy dialogue in cereals policy reform have highlighted the importance of the coastal states of West Africa to Sahelian agriculture. A recent meeting among West African Ministers of Agriculture recommended the evolution of an incentive environment to

promote a more commercial and market oriented agriculture. This has led to the proposed establishment at the African Development Bank of a special 'cell' to promote regional trade. With respect to national resource management, the Segou, Mali regional meetings in March 1989, was a first time dialogue among donors, states and autonomous rural organizations to define specific measures required to overcome current institutional bottlenecks (tenure, local participation, etc.) in addressing natural resource management issues at local levels.

2. The new role of INSAH, partially articulated in its new Five Year Plan, which casts its regional coordination functions in more discrete terms and in ways that do not compete with or draw resources from national efforts.

3. The reforms of NARSs already initiated in the region. With the exception of Cape Verde, Chad and Mauritania, the rest of the CILSS countries have all benefited or continue to benefit from the technical support of ISNAR in priority setting and programming, institutional reforms, and in the development of more efficient administrative and financial management systems. The AGIR program of INSAH has also been quite active in the field. The initiation of these reforms in many of the NARSs point to a certain degree of progress. However, donor "fatigue" with research, the institutional crises many NARSs now face, the almost total absence of genuine political support at national levels indicate the fragility of the gains and the need for deeper and more far reaching reforms.

4. The strategic planning and priority setting exercise of CGIAR. One of CGIAR's major objectives, as part of this effort, is to strengthen the human resources and the capacity of NARSs and it is devoting about 19 percent of its total resources to this objective. Of this amount, CGIAR is directing most of its efforts to African NARSs which are especially fragile and require urgent and intensified support. There is a global tendency towards experimentation with formal mechanisms of cooperation with NARSs directors and national scientists, such as the 'working groups' of IITA and WARDA. The idea to develop within several IARCs an eco-

regional approach and link it to NARSs should be strongly encouraged. Collaboration could vary from the simple backstopping of regional programs, to outposting IARC scientists, to an IARC being invited to take the lead in setting up and/or managing a program. The important underlying principles are that: (a) research objectives respond to specific research needs of the region; and, (b) regional programs (research poles) are executed by selected NARSs on existing research installations.

5. The African Capacity Building Initiative (ACBI). To strengthen the human and institutional capacity of Sub-Saharan countries, several donors (UNDP, the African Development Bank and the World Bank) have sponsored the ACBI with the financial support of other donors. The ACBI is not meant to

offer a detailed blueprint for capacity building in Africa over the next several decades. Rather, it seeks to establish a framework, such as the initiative proposed herein, which can help African governments and donors focus on priorities, respond to changing circumstances, and optimally coordinate their actions.

6. The Global Coalition for Africa, incorporating ACBI, SPAAR and SPA directs attention to the need for a new partnership amongst African leaders, international donors, the private sector and NGOs in addressing the fundamental challenges facing Africa beyond the medium term. The coalition encourages Africans to take greater initiative in designing and implementing credible reforms and sector programs.

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### ***3: A Regional Research System which Responds to the Challenge***

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#### **The Regional Framework for Action (FFA)**

In view of these converging trends, a fresh initiative is especially opportune to evolve a regional research system poised to meet the development challenges of the Sahel. This FFA provides the scope, orientation and guidelines for the design of interventions at national and regional levels. The FFA provides a framework for a "rolling design", actively involving all concerned actors at all stages in its evolution. The objective of these interventions is to increase the productivity and efficiency of the national agricultural research systems in the Sahel. This will be accomplished by actions which will: (a) focus research on the priority agricultural production constraints that limit economic growth; (b) rationalize ongoing and new research activities in a regional context; (c) improve research quality and relevance; and, (d) ensure the sustainability of these systems. It is anticipated that the specific actions to be proposed under this framework will be organized around three major thrusts. These are:

1. *Institutional Reforms of NARSs*: It is important that both the meaning and spirit of the word 'reform' are understood in an institutional sense rather than in the more commonly-used macroeconomic context. In this institutional sense, the objective of reform is to create an 'enabling' environment which promotes creativity and innovation and rewards performance. The reforms will contribute concretely to reinforcing NARSs as the basic building blocks for a sustainable regional research system. Solutions to the fundamental institutional, size, capacity and stability issues confronting NARSs will be proposed. Reforms will help NARSs set priorities in a regional context and define new mechanisms for greater financial stability and management autonomy.

2. *New Mechanisms of Regional Collaboration*: Since the priorities for research are clear, it is proposed to consolidate resources on key issues, processes and institutions in the region. To this end, the concept of regional research poles (lead national centers) is advanced. The poles will constitute the main foci for rapid advances in technology generation by representing the concentration of a critical mass of well trained and motivated scientists, adequate resources and efficient and flexible management systems.

3. *Cross-Cutting Actions*: Constraints common to national and regional efforts will be addressed. A human resource development strategy for the region will be initiated. INSAH will define and put into place the instruments for improved regional collaboration. NARSs will be helped to continuously inform the priority setting process. Additional institutional changes needed for the evolution of a client oriented and demand driven research agenda will be identified.

#### **Reforming NARSs**

In addition to the new research methods suggested above and the reforms already undertaken, the institutional reform of NARSs requires several complementary actions. These are:

1. Mechanisms to 'debureaucratize' the NARSs and to move them out of the public management system. Public statutes must be reshaped to give NARSs the flexibility needed to do research efficiently and to complete the research task. This will also allow for the mobilization of various research actors (universities, the private sector, farmer groups, NGOs, extension, development agencies) in the research agenda.

2. The evolution of an 'enabling' environment for scientists to promote innovation and

creativity and foster stronger linkage/liaison with research clients in ways that give scientists a greater stake in research results.

3. The reinforcement of economic analytical capacity to ensure the continuous adjustment of the research agenda to changing economic conditions. This does not mean that each NARSs should create its own analytical unit. In some cases, capacity already exists (ministries, faculties of agriculture, foundations) and only more structured arrangements for collaboration would be needed.

4. New research management techniques to promote autonomy, responsibility (accountability) and transparency as key indicators that will enable CILSS member states and donors to have greater confidence in research. In tripartite agreements among NARSs, the CILSS member states and donors, arrangements for scientific oversight, financial and management audits should be specified.

5. Consolidation of the political and scientific identity of NARSs through a strategy of human resource development, evaluation, information exchange and research processes which reinforce the linkage/liaison between researchers and clients.

#### **Guidelines for New Collaborative Regional Programs**

The strengthening of NARSs in a regional context should be done within a framework of regional collaboration that is responsive to the following guidelines:

1. Being mindful of the priority objectives for the development of the region considering:

(a) the various channels through which products flow from producers to final consumers including, therefore, technologies for processing and transformation;

(b) the major cross-cutting constraints limiting production in such areas as *Striga* and land tenure;

(c) the rural systems which must manage the natural resource base and use it productively.

2. Improving the functional-operational linkages with the research clientele (individual farmers and herders and/or their associations,

extension services, seed companies, processors, input suppliers and manufacturers) to make research more demand-driven and to ensure continued research focus on priority constraints.

3. Realigning the scientific capacity in line with the comparative advantage of existing scientific resources or incentive actions needed to develop such capacity in priority sectors where it does not now exist.

4. Mobilizing existing regional collaborative networks, notably those of IARCs or those of others such as CORAF and SAFGRAD.

5. Ensuring a coherence between actions in the areas of agricultural, economic and environmental policy.

6. Respecting a time frame over which specific objectives are to be achieved according to their nature, complexity and importance.

#### **Regional Research Poles**

A new approach in regional collaboration is proposed consistent with these guidelines. The approach, an outgrowth of networking, seeks to strengthen NARSs in research areas that they are best positioned for relative to others in the region. This approach calls for the evolution of *regional research poles* (lead and associated national centers). The unfolding division of labor should position NARSs, those which will host poles and those which cooperate with them, in ways that will enable IARCs, donors and others to better target their interventions and support for the greatest possible research success and impact. Strengthened programs in specialized areas should enable NARSs to share their knowledge, resources and research results with others in the region. NARSs should be able to mobilize scientific resources around these poles from various sources - regional, IARCs and overseas, universities, the private sector - to meet priority objectives. Management of the poles should be based on accountability and research efficiency. A major requirement of NARSs to host poles are new institutional arrangements which enable flexibility and transparency in their management. Poles can take many forms, depending on the comparative advantage of the scientific partners concerned.

## Regional Research Programs

Based on the agricultural research strategies of each NARSs, the NARSs directors of the CILSS countries identified<sup>1</sup> the following priority research domains as to coincide with national priorities, which should become subjects for regional collaboration over time:

- *National Resource Management and Conservation*, including:

- (a) soil and water conservation (including soil fertility regeneration);
- (b) management, regeneration and conservation of natural landscapes (including natural forests); and
- (c) methodology development for communal management of natural resources;

- *Food Production Improvement and Stabilization*, including:

- (a) integrated pest management,
- (b) post-harvest technology and processing,
- (c) crop diversification,
- (d) animal nutrition,
- (e) small ruminants, and
- (f) processing of animal products;

- *Strategic research*, including:

- (a) collection, evaluation, characterization and conservation of genetic resources, and
- (b) biotechnology development;

- *Research Support Themes or Activities*, including:

- (a) agricultural policy research, both at the national and regional level, to guide, justify and adapt research objectives to a continuously changing economic environment, and
- (b) scientific and technical documentation and information development.

Within these broad domains, a number of specific research themes were identified for immediate regional collaboration, including a distribution between countries, as follows:

1. Burkina Faso, Mali, and Senegal would each be responsible for components of a regional natural resources conservation and management research program, including:

- (a) developing indicators to characterize soil fertility;
- (b) optimizing plant water-use and run-off management;
- (c) biological nitrogen fixation;
- (d) developing degraded soil regeneration technologies, and
- (e) developing methodologies for communal land management;

2. The following countries would be responsible for genetic resources conservation and development, and host regional commodity research poles:

- (a) Burkina Faso for maize;
- (b) Mali for sorghum;
- (c) Niger for millet and cowpeas; and
- (d) Senegal for groundnuts.

3. Senegal's national livestock research laboratory was selected as the lead laboratory to host a regional small ruminant production and health research program, with components to be executed by the laboratories of Chad, Mali, and Niger.

## Human Resource Development

A critical ancillary thrust under the FFA is the development of capacity so that the research system can "sustain" itself. This new component in regional collaboration calls for:

- The regional consolidation of national human resource development strategies for agricultural research. The regional research poles will inevitably lead to research staff requirements - in terms of quantity, quality and skills mix - that are different from the simple summing-up of current individual NARSs requirements. If the poles are to be successful, the national human resource development plans will need to be consolidated and adjusted to redefine requirements in a regional context.

- The development of a long term strategy for the improvement of the agricultural education and training capacity in the region. Bringing the underutilized research potential of the education and extension system into use as an integral part of the national agricultural research system would be one of the objectives for the preparation of a long term 'blue print' for regional agricultural education and training. A second, no less important, objective would be to increase their relevance by making them more responsive to agricultural sector requirements, and by improving coordination and exchange within the region.

- The creation of capacity for research station management and training in the region. The sound management of financially sustainable station operations is a prerequisite for the implementation of regional research poles. Along with other proposed NARSs reforms, this should include financial management and accounting procedures as well as controls allowing for the earmarking of funds if and when needed.

### **The Role of Donors**

The FFA implies a special commitment from donors. New mechanisms will be needed to assure stability in funding. The idea of creating *Consolidated Funding Mechanisms* (CFMs) to assure the necessary stability and flexibility in the management of research operations (i.e. as a process to *pool* efforts on an agreed and consolidated priority program, while ensuring the sustainability of a coordinated regional research system and its funding) will need to be further developed on a case by case basis as an essential activity under the FFA. CILSS member states and donors could fund a research program or theme of one or several NARSs. The new modes of operations of regional poles and reformed NARSs, as described previously, could constitute the guarantees necessary for a climate of confidence.

### **The Role of CILSS Member States**

The commitment of governments and their political will to assume responsibility for

agricultural research is indispensable. Their support for agricultural research should be the highest priority. The proposals contained herein are consistent with, indeed supportive of, the moves toward regional integration and economic liberalization proposed by CILSS. At minimum, member states should sustain and consolidate their levels of existing financial support over the medium term. This support is expected to gradually increase as improved performance and impact are demonstrated. In the short run, political support for the institutional reforms and the new modes of regional collaboration called for under the FFA is essential.

### **The Role of INSAH**

CILSS, through its scientific instrument - INSAH - will have the major responsibility for orchestrating the various actors and actions called for under the FFA. INSAH's facilitation, coordination and data management functions will be reinforced so that it can effectively play its role. Specifically, INSAH will be supported to do the following:

1. Macroeconomic and environmental analyses to develop proposals for regional/national research priorities to be validated by NARSs directors and scientists.
2. Prospective studies and surveys to indicate new market opportunities for Sahelian agriculture and draw implications for research, e.g. new products, processes, technology development and transfer.
3. Maintain and update a data bank on Sahelian research capacity and national and regional programs; these data banks will be complemented by efficient modern communication links, both within and among countries in the region, such as facsimile services, modems and possibly satellite hookups.
4. Undertake limited socioeconomic research on issues related to agricultural research; marketing of research; diffusion of results; broadening the client base; and models for private sector participation.
5. Programming, monitoring and evaluation of regional research poles in terms of: economic

impact of technology generation and transfer; identifying institutional bottlenecks and policy constraints; resolving NARSs organizational, management and operational issues.

### **Implementation**

The proposed FFA was approved in substance by the May 1991 SPAAR Plenary in Abidjan, Cote d'Ivoire. The proposal was subsequently discussed and endorsed by the NARSs directors during a meeting which took place in Ouagadougou from 22-26 July, 1991. Between May and December 1991, a process of technical and political validation took place at ministry (agriculture, finance and plan) levels and, ultimately, by the CILSS Council of Ministers. Formal endorsement by the SPAAR membership was sought during the December, 1991 Plenary. In April, 1992, the CILSS Council of Ministers formally endorsed the FFA recommendations. The recently established (mid 1992) Council of Ministers of Agriculture of Western and Central Africa also endorsed the recommendations. A detailed design phase followed. The major actors are NARSs working groups organized by INSAH. Their major tasks are the identification of specific reform measures in the areas of research program and resource management, and human resource development. Similar working groups, involving also donor and IARC representatives, identified regional poles, their sequencing and methods of operation. Tripartite agreements and research 'contracts' specify funding arrangements and research programs for each research pole. Through an agreement between SPAAR and CILSS, the incremental resources which INSAH needs to orchestrate the start-up of various actions and actors under this FFA are provided. USAID has designed a long-term support program that would provide INSAH with the resources necessary to co-ordinate the start-up of the regional collaborative research programs and to set up mechanisms to monitor, evaluate and disseminate research results. The three broad subject areas are agricultural research, food security and natural resources management. Discussions are also ongoing between INSAH and ISNAR regarding colla-

borative support to the NARSs of the CILSS countries. Responsibility for donor coordination must rest with the individual countries concerned through the proposed CFM process. It is proposed that the SPAAR Secretariat, like that of CGIAR, promote and focus the interests of all concerned parties in the advancement of agricultural research and science in Africa in a balanced way.

### **Expectations**

A market-oriented agriculture requires that the Sahel regain its competitiveness in national, regional and international markets. This imperative helps to shape the research agenda and the research system has started reform to effectively respond to the challenge. The FFA outlined here builds on these changes. The priorities - substantive and institutional - are clear. Mechanisms are proposed for NARSs in the region to respond to these priorities. However, while a more productive research system can contribute significantly to agricultural growth, it cannot do it alone. A deepening of reforms at broader macroeconomic, institutional and political levels is needed so that agricultural research can perform and its impact be clearly demonstrated. The vision of a more productive and efficient research system is one in which government would assume a different role, focusing more on the needs of resource poor farmers and natural resource management. In the Sahel, this evolution will take time. Key events in this evolution may be the creation of independent research organizations (foundations for key commodities such as cotton) over the medium term. Beyond the medium term, key private sector actors - seed, fertilizer and chemical companies - may enter the research field and have a significant role. Successful implementation of the proposed FFA is expected to be indicated by the following:

1. Stability in the institutional environment of NARSs, including funding, programming and staffing.
2. Gradual broadening of the research agenda and its client base to incorporate issues important to a market-driven agriculture,

including emphasis on trade, utilization, transformation and market/product development.

3. Increased participation of faculties of agronomy, private sector institutions, farmer and herders, NGOs and extension agencies in human capacity-building and technology generation.

4. The organization of vibrant interchanges between researchers and their clients so that the research agenda is more demand driven.

5. Gradual decrease in outside technical assistance and the greater use of indigenous human resources.

6. Rationalization of the regional agricultural research system, perhaps through a reduction in the number of networks not driven by national and regional priorities and in the multiplicity of uncoordinated regional efforts.

7. Increased number of technological innovations well adapted to local situations and higher rates of technology diffusion and adoption.

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## 4: *Physical and Socio-Economic Setting of Agriculture*

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The first decades of independence in Sub-Saharan Africa have been marked by a multiplicity of crises: political, institutional, economic, financial, ecological, and agricultural. With these crises, the great optimism of the early years of African independence has given way to a substantial erosion of confidence. Using the most conventional economic and welfare indicators, Sub-Saharan Africa appears as the second poorest region in the world and the Sahel as the poorest sub-region. Per capita incomes have been extremely low and relatively stagnating to a large extent in the nine CILSS-member countries (Cape Verde, Chad, Burkina Faso, The Gambia, Guinea-Bissau, Mali, Mauritania, Niger and Senegal). In 1988, only two of these countries ranked in the middle-income category, while the remaining seven countries were part of the twenty-one poorest countries of the world. At an average of US\$ 270 in 1987, the per capita income in the Sahelian sub-region was 7 percent below that of South Asia and 18 percent less than that of Sub-Saharan Africa as a whole. Although an unfavorable climate is commonly blamed for the poor performance of the agriculture-based economies and societies of the Sahel, the facts point to other major causes for the situation in the sub-region. This chapter aims at putting into perspective the essential elements of the natural and socioeconomic context that explain the development and the performance of the agricultural sector of the Sahelian countries. A synthesis is first developed of the dominant features, dynamics and constraints pertaining to the natural environment, population, and the economic, socio-political, institutional, policy, and international environments in which Sahelian agriculture operates. A limited number of economic and social development challenges are then identified and discussed. Finally, the implications for agriculture and agricultural research as part of a larger sustainable

development strategy aimed at meeting these challenges is considered in the context of commodity-demand outlooks and alternative strategy scenarios.

### **Features and Dynamics of the Physical and Socio-Economic Setting**

#### *Natural Environment*

*Climate.* The Sahel draws its very name from the climatic features of the sub-region which constitutes the southern parts of the Sahara desert. Climate fluctuations characterized by wide and frequent swings in rainfall levels and spatial distribution are the most permanent and determining variable in the daily life of the 40 million inhabitants of the nine semi-arid to arid member-countries of the CILSS. Because of extreme scarcity of water, two-thirds of the total 530 million hectares of the region are simply unsuitable for agriculture. The remaining 178 million hectares are sub-divided into four major rainfall zones: the Sahelian zone from 350 mm to the northern limit of rainfed cultivation; the Sahelo-Sudanian zone with 350-600 mm; the Sudanian zone from 600 mm to 800 mm; and the Sudano-Guinean zone with more than 800 mm of average annual rainfall. In these vital zones, the main economic activity of the bulk of Sahelian populations, agriculture (crop and livestock), is highly vulnerable to variations in drought and non-drought years. The last two decades have been particularly marked by an increasing aridity, a shortening of the rainy, cultivation season and a significant southward displacement of all isohyets, resulting in fears of irreversible trends toward a "saharanization" of the Sahel under the presumed effects of global warming. The evidence is not yet conclusive about the cyclical or the irreversible nature of the phenomenon of drought. There is an on-going debate regarding the significance and the

comparative magnitude of the causal relationships between desertification and drought and increasing aridity on the one hand, or resource abuse by the resident populations on the other hand. Nevertheless, climate and weather vagaries will be a major structural variable that cannot be overlooked in planning realistic strategies for the sustainable development of Sahelian countries. For the decades ahead, success in improving the livelihood of the majority of Sahelians through substantial growth in agro-sylvo-pastoral production will primarily depend on the successful management of the scarce water resources available.

*Land, soils and natural vegetation.* The Sahelian countries (excluding Cape Verde and Guinea-Bissau) cover a total area of some 530 million hectares. Of this total area, 60 percent is just plain desert, 150 million hectares (28 percent) are classified as rangeland, and the remaining 62 million hectares (12 percent) are suitable for cultivation (Table 4.1). The potential for irrigated cultivation amounts to 13.9 million hectares (22 percent of land suitable for crop production), and is essentially concentrated in Chad (40 percent), Mali (29 percent) and Niger (12 percent). As far as rainfed agriculture is concerned, only 50 percent (31 million hectares) of the total land suited for crop production receives annual rainfalls of 600 mm or more with a 0.9 probability. Moreover, this potential is considerably reduced by the poor quality and the structural fragility of soils: low fertility (especially in phosphates and nitrogen), low humus content, low water-retention capacity, high propensity to laterization and exposure to wind and water erosion. Consequently, even in the highest rainfall zones, no more than 40 percent of the soils are fair to good for permanent cropland. The bulk of the best soils receiving annual rainfalls of 800 mm or more are almost entirely distributed among four countries: Chad (31 percent), Mali (31 percent), Burkina Faso (23 percent) and Senegal (13 percent).

An estimated 25 percent (15.6 million hectares) of total land suitable for cultivation in the Sahel was farmed in 1989. This estimate should not lead to the conclusion that the

Sahelian countries are oversupplied with farm land and can, therefore, raise agricultural production by expanding the area under cultivation. Indeed, what is most important is not so much how much of the available land is actually used in pastures and fields. Rather, it is the extent to which actual population densities are in balance with the sustainable carrying capacity of land in the different agro-climatic zones under the prevailing production systems. In this context, Table 4.2 clearly indicates that, with respect to the triple-demand for crops (food, feed and fuelwood) there is more room for additional population only in the southernmost (Sudano-Guinean) zone of the Sahel. Without a major transformation in traditional production systems, actual population density in the Sudanian zone has already reached the sustainable level for fuelwood and was actually very close to that level for crops and livestock in 1980. The Sahelian zone already carries seven times more people than it can sustain for fuelwood. The worst situation is found in the Sahelo-Sudanian zone. There, actual population densities exceed the sustainable levels by one-third for crops and livestock and by 103 percent for fuelwood. This evidence strongly suggests that, more than the amount of unused land, it is the low productivity resulting from the poor land quality and traditional production techniques that limits the carrying capacity of the Sahelian agro-sylvo-pastoral space. Worse, the natural forest cover is both the most vulnerable and over-exploited part of the Sahelian ecosystem.

#### *Population*

With a total population of 40.2 million and an average density of 7.5 persons/km<sup>2</sup> in 1988, the Sahel as a whole could still be considered as largely underpopulated. This global picture however hides great spatial disparities in population distribution, with densities (number of persons/km<sup>2</sup>) rising from 1.9 in Mauritania, to 4.7 in Chad, Mali and Niger, 26-36 in Burkina Faso, Guinea-Bissau and Senegal, 75 in The Gambia and 90 in Cape Verde. Within the countries, the population is also unevenly distributed among the different climatic zones:

*Table 4.1: Sahel: Land Distribution and Suitability of Soils by Rainfall Zones (millions of hectares)*

<i>Countries</i>	<i>Total Area</i>	<i>Area suitable for pasture</i>	<i>Area suitable for farming</i>	<i>Area suitable for irrigation</i>	<i>Area suitable for rainfed cultivation</i>					
					<i>Sahelian zone (NLC-350mm)</i>		<i>Sahelo-Sudanian and Sudanian zones (350-800mm)</i>		<i>Sudano-Guinean zone (above 800mm)</i>	
					<i>Good and fair soils</i>	<i>Marginal soils</i>	<i>Good and fair soils</i>	<i>Marginal soils</i>	<i>Good and fair soils</i>	<i>Marginal soils</i>
Burkina Faso	27.4	16.2	8.9	0.65	0.38	-	4.13	0.52	3.00	0.22
Chad	128.4	36.0	19.8	5.64	2.30	0.18	7.03	0.52	4.02	0.09
Gambia, The	1.1	0.4	0.6	0.37	-	-	0.05	0.03	0.16	-
Mali	124.0	37.0	14.2	4.04	0.47	0.25	2.87	1.43	3.99	1.24
Mauritania	103.1	20.2	2.1	0.65	0.74	0.13	0.61	-	-	-
Niger	126.7	29.1	10.8	1.75	4.23	-	4.69	0.11	-	-
Senegal	19.6	12.0	6.3	0.82	0.51	0.02	2.23	0.69	1.71	0.35
<i>Total</i>	<i>530.3</i>	<i>150.9</i>	<i>62.7</i>	<i>13.92</i>	<i>8.63</i>	<i>0.58</i>	<i>21.61</i>	<i>3.30</i>	<i>12.88</i>	<i>1.90</i>

*Source:* World Bank Technical Paper No. 61, 1987, pp. 40-41.

*Table 4.2 : Sahel: Sustainable and Actual 1980 Population Densities by Rainfall Zone*

<i>Zones</i>	<i>Sustainable Population (pers./km<sup>2</sup>)</i>			<i>Actual Rural Population density (pers./km<sup>2</sup>)</i>	<i>Sustainable Population for fuelwood (pers./km<sup>2</sup>)</i>	<i>Actual Total Population (pers./km<sup>2</sup>)</i>
	<i>Crops</i>	<i>Livestock</i>	<i>Total</i>			
Saharan	-	0.3	0.3	0.3	-	0.5
Sahelo-Saharan	-	0.3	0.3	2	-	2
Sahelian	5	2	7	7	1	7
Sahelo-Sudanian	10	5	15	20	10	23
Sudanian	15	7	22	17	20	21
Sudano-Guinean	25	10	35	9	20	10

*Source:* World Bank Technical Paper No. 61, 1987, p. 13.

Table 4.3: Sahel: Population Levels and Growth Rates

Countries	1988 Total Population		Population Growth Rates (percent per annum)			
	In Millions	Density (pers./km <sup>2</sup> )	1965-73	1973-80	1980-87	1987-2000
Burkina Faso	8.5	31.0	1.9	2.3	2.6	2.9
Cape Verde	0.4	90.0	2.0	1.2	2.2	2.7
Chad	5.4	4.2	1.9	2.1	2.3	2.6
Gambia, The	0.8	74.7	2.8	3.4	3.3	3.0
Guinea-Bissau	0.9	26.1	1.1	5.2	1.7	2.1
Mali	8.0	6.5	2.1	2.2	2.4	3.0
Mauritania	1.9	1.9	2.2	2.5	2.7	2.7
Niger	7.3	5.8	2.3	2.9	3.0	3.2
Senegal	7.0	35.5	2.3	2.8	2.9	3.1
<i>Total</i>	40.2	30.6	2.1	2.7	2.6	2.8

Source: World Bank (1989). *Sub-Saharan Africa: From Crisis to Sustainable Growth, A Long-Term Perspective Study*, p. 269, World Bank. *World Development Report 1990*, pp. 178, 243.

from almost zero in the most desert areas, the density increases in the south, reaches its maximum level in the Sahelo-Sudanian and Sudanian (350-800 mm) zones, and decreases in the highest rainfall (Sudanian) zone, mainly because of water-related health problems. At least 80 percent of the people live in 25 percent of the total area south of the Sahelian zone, with human concentration reaching 60 or even 100 persons/km<sup>2</sup> in some areas (e.g. the Senegalese Groundnut Basin, The Gambia, and the Mossi Plateau in Burkina Faso), thereby creating a virtually desperate demand for arable land and fuelwood under traditional production systems. Regardless of the impact of climate on desertification, it is now widely admitted that natural resource abuse, which is induced by the negative synergies between low-productivity techniques on the one hand and human and livestock population pressure on the other, remains the most significant determinant of the degradation of soils and vegetation. Exacerbated by the repeated droughts of the last twenty years, southward rural-rural migrations of people and livestock have visibly increased the rate of soil and vegetation depletion to meet the fast-growing demands for food and cash crops, pastures, forage and fuelwood.

Two other demographic features -- population growth and urbanization -- add to the complexity of managing the Sahel's vital space. First, as for Sub-Saharan Africa as a whole, population growth rates in the Sahelian countries are among the highest in the world. Worse, the annual growth rate of population for the whole sub-region has been steadily sloping upward from 2.1 percent in 1965-73, to 2.6 percent in 1980-87, and a projected 3.0 percent for 1987-2000 (Table 4.3). The projected growth rates for the 1987-2000 period range from 2.6 percent to 3.2 percent per annum in all CILSS member countries except Cape Verde (2.1 percent). At this pace, the 40 million population of the Sahel in 1988 will increase by 50 percent by the turn of this century and reach 80 million by 2010. This rapid growth of population stems from a decline in mortality rates, thanks to improved vaccination and primary health care over the past forty years, combined with high and stable fertility (six-

seven children per woman). Because 45 percent of the total population of the Sahel is presently under fifteen years of age, the growth rates will increase even more rapidly. In the absence of effective birth-control policies, it is expected that such a population boom will seriously hinder Sahelian development prospects.

Second, rapid and unplanned urbanization reinforces the likelihood of prospective negative effects of population growth on development. From 1.3 million in 1960, the size of the urban population in the Sahel rose almost sevenfold (by nearly 7 percent per annum) in twenty-seven years to reach about 9 million (28 percent of total population) in 1987. This strong trend toward urbanization is essentially explained by rural-urban migration flows, which in turn are mainly caused by the perception of widening socio-economic disparities between rural and urban areas. The stagnation of production and the decline of real incomes in rural areas under the combined effects of droughts and ineffective development projects, and the overconcentration of socio-economic infrastructure, health, sanitation and education facilities, etc. in the major urban centers make Sahelian life much more attractive in the cities and the towns, especially in the capital cities which account alone for 40 percent of the total urban population of the sub-region. Rapid urbanization constitutes a major driving force, which not only deprives rural households of a significant proportion of their adult-male labor force, but also exerts an upward pressure on the demand for critical commodities that tends to deplete the available reserves of either natural resources (e.g., fuelwood) or foreign exchange (imported rice and wheat). Moreover, the capacity of urban areas to meet the expectations of most city-dwellers has been stretched, particularly under the short to medium-term impact of structural adjustment programs undertaken by most Sahelian countries during the 1980s. Without significant growth in the main productive (industrial, manufacturing, informal, services) activities in urban areas, rapid urbanization has resulted in rampant unemployment and severe deterioration of living conditions and social climate in peri-urban areas.

## *Agricultural Economy*

*Overall importance.* An overwhelming reliance on agriculture (crop and livestock production, forestry, hunting and fishing) is the most common feature of the national economies of CILSS-member countries. The agricultural sector accounted for 34 percent of total GDP for the Sahel in 1987. This share declined by 26 percent from its 1965 level, as shown in Table 4.4. Agriculture in 1987 contributed 35 percent to 60 percent of total GDP in all Sahelian countries except in agro-ecologically harsh Cape Verde (19 percent) and relatively more urbanized and industrialized Senegal (22 percent). Agriculture is in fact the largest domestic producer across the Sahel and employs between 80 percent and 90 percent of the total labor force in each Sahelian country, except Mauritania (69 percent) and Senegal (52 percent). Agriculture supplies -- mainly in cereals -- the bulk of the food consumed by Sahelian populations and is the largest foreign-exchange earner in the Sahel. Its share in total 1987 export revenues averaged 57 percent for the whole Sahel and ranged from 60 percent to 98 percent in all Sahelian countries, except Niger (13 percent) and Cape Verde (insufficient precise data). The agricultural sector is the largest consumer of natural resources. Taken together, these indicators point to the inescapable conclusion that overall economic growth and development in the Sahel depend primarily on the performance of agriculture in driving incomes and employment.

*Production systems, output and productivity.* Past trends of growth and diversification of agricultural production have been rather disappointing in CILSS-member countries. Farming in the sub-region is dominated by two rainfed food crops (millet and sorghum), a minor one (maize), one irrigated food crop (rice), and two rainfed cash/export crops (cotton and groundnuts). Table 4.5 shows that throughout the 1965-73 drought period outputs fell for all these crops (annually, by 2.8 percent for cereals and 4.6 percent for groundnuts), except cotton (7.3 percent annual growth). Cereals and cotton production grew slightly (by 3.5 percent and

3.3 percent per annum respectively) during the 1973-80 post-drought period, while groundnut output continued to decrease by 4.8 percent per year. The 1980s showed more encouraging signs, as suggested by the quite impressive 1980-89 annual growth rates of all major crops, admittedly from a low base. This emerging optimism needs to be tempered, however. The remarkable recent upward shift in crop production, rather than translating into productivity gains in land and/or labor use, is mostly associated with the combined effects of a significant increase in annual rainfall and the extension of cultivated land in the more humid southern zones. This is a precarious situation since there will certainly be bad rainfall years again, and the land base is finite and threatened.

The situation is not easily changed, as long as Sahelian crop and livestock production systems remain very extensive in nature, using little processed/purchased inputs and relatively large quantities of natural resources (particularly land) per unit of output. It is estimated that in 1986, for instance, the average fertilizer consumption in the Sahel (4.7 kg/ha) amounted to only 55 percent of the average for Sub-Saharan Africa, 8 percent of that of South Asia, and 7 percent of the average for the whole group of low-income countries in the world. Growth in crop production, therefore, feeds mostly on the extension of cultivated land in the southern zones. There is an increasing demand for pasture by extensive livestock production systems, which continue to feed essentially on grazing and tree forage. Increasing population pressure, the clearing of extended areas of arable land and the reduction of fallow, and the absence of appropriate conservation actions have resulted in an annual decrease of 3 percent in the overall fertility of soils under traditional cultivation. Consequently, livestock productivity is weak, and rainfed foodgrain yields are very low, stagnating or even declining around averages of 0.3 ton/ha in the Sahelian zone, 0.5 ton/ha in the Sahelo/Sudanian zone, 0.7 ton/ha in the Sudanian zone and 0.9 ton/ha in the Sudano-Guinean zone.

A few intensification efforts have taken place, but their focus and scope remain very

*Table 4.4: Sahel: Basic Indicators of the Agricultural Sector*

<i>Countries</i>	<i>Percentage of Labor Force in Agriculture 1980</i>	<i>Share of Agriculture in GPD (percent)</i>		<i>Share of Agriculture in Exports (percent)</i>	
		<i>1965</i>	<i>1987</i>	<i>1965</i>	<i>1987</i>
Burkina Faso	87	53	38	94	98
Cape Verde	52	-	19	-	-
Chad	83	42	43	93	-
Gambia, The	84	35	35	100	92
Guinea-Bissau	82	-	61	-	-
Mali	86	65	56	86	71
Mauritania	69	32	37	5	66
Niger	91	68	34	95	13
Senegal	81	25	22	88	60
Sahel 1980-89	79	36	38	62	44

*Source:* World Bank (1989). *Sub-Saharan Africa: From Crisis to Sustainable Growth, A Long-Term Perspective Study*, pp. 224, 227.

Table 4.5: Sahel: Annual Growth of Agricultural Output (percent)

Countries	1980-1989 Output Growth Rates				Fertilizer Consumption (kg/ha) 1986
	Cereals	Groundnuts	Cotton	Total	
Burkina Faso	10.2	13.7	18.6	11.8	6.1
Cape Verde	27.8	-	-	27.8	1.3
Chad	9.0	3.1	4.0	6.6	-
Gambia, The	6.8	2.3	-	4.4	16.6
Mali	10.3	8.7	7.6	9.6	5.0
Mauritania	20.8	-	-	20.8	0.7
Niger	3.6	1.9	19.4	3.2	4.0
Senegal	7.1	6.5	0.3	6.6	4.7
Sahel 1980-89	7.9	5.4	8.8	7.4	
1973-80	3.5	-4.8	3.3	-	
1965-73	-2.8	-4.6	7.3	-	

Source: World Bank Estimates, 1990; World Bank (1989). *Sub-Saharan Africa: From Crisis to Sustainable Growth, A Long-Term Perspective Study*, pp. 229, 235.

limited. Under rainfed agriculture, cotton is the single most intensified crop, and also the only crop for which positive output growth was sustained (at the incredible rate of 7.3 percent) throughout the sub-region even during the most severe drought period of 1965-73. The cotton success story, partly attributable to area expansion, is in fact deeply rooted in the synergistic effects of successful and integrated efforts in agricultural research, extension, and input and output marketing. Between 1961 and 1979, average cotton yields have been multiplied by a factor of five with the widespread adoption of new varieties, fertilizers, pesticides and animal traction. The sustainability of such high growth in production is being increasingly questioned. Cotton yields remained relatively stagnant throughout the 1980s, around 1.3 tons/ha in Mali, 1.0 ton/ha in Burkina Faso and 0.8 ton/ha in Chad -- three countries accounting for more than 90 percent of total cotton output in the Sahel -- demonstrating that output growth relied essentially on an extension of the cultivated area by 7.4 percent per annum. Among the rainfed food crops, maize shows the best prospect for intensification, as witnessed by the doubling of its average yield from 0.8 to 1.6 ton/ha in southern Mali, using only selected local varieties and modest doses of fertilizer. These promising prospects, however, apply to only 3 percent of total cropped land, since the demand for maize seems severely constrained by the lack of appropriate development of food and feed processing. Likewise, the development of the considerable potential for intensified rice production in the valleys and deltas of the Niger and Senegal rivers has also been flawed: high investment/recurrent-cost irrigation technologies, policies of marginal participation of farmers in managing irrigated perimeters, and awkward single annual crop production systems. Irrigated farming covers no more than 5 percent of total cultivated land and 10 percent of the total 13.9 million hectares suited for irrigated cultivation. Rice yields barely exceed 1 ton/ha in major irrigated areas such as those administrated by the Office du Niger in Mali.

The overly extensive nature of traditional farming and pastoral systems underlies the

persistence of conflicting relations and weak integration between crop and livestock production in the Sahel. Other than the residues of crops grown primarily for direct human consumption and for exports, Sahelian agriculture specializes very little in producing forage and high-energy feeds for the multimillion herds of cattle, small ruminants and camels. Not surprisingly, given the remarkable progress achieved in the field of livestock health, the size of these herds increased. However, they were significantly reduced because of severe feeding problems during the droughts of the early 1970s and 1980s. Substantial investments of labor and other complementary inputs required for maintaining draught animals and for producing good quality manure have limited livestock's contribution to draught energy and soil fertility for crop production. Rather than being mutually reinforcing, livestock and crop activities tend to compete for land and, in so doing, generate more conflict among herders and farmers.

*Infrastructure and domestic markets.* Poor communication and market infrastructure add to the hardship imposed on Sahelian agriculture by unfavorable climate, a weak natural resource base and high population pressure. Other than through the radio, communication means are virtually non-existent for the largely illiterate rural populations. Most of the population has no ready access to an all-weather road, be it paved or laterite. Moreover, wrong priorities and the bad performance of public infrastructure agencies, as well as the cost-ineffectiveness of most private services, have resulted in a lack of maintenance which erodes the meager infrastructure base in an alarming fashion. The magnitude of the problem can be appreciated by the fact that Sahelian countries are among the poorest in road infrastructure in Sub-Saharan Africa. It is estimated that the neglect of road maintenance increases the cost of repair by 200-300 percent. Costs to vehicle owners and shippers are almost 50 percent higher for paved roads and much higher for gravel and earth roads. Population concentration in urban areas and a few rural areas is

also related to the geographic concentration of the little infrastructure available in these areas. Taken together, the insufficiency and the backlog of maintenance of the infrastructure base constitute the main constraint to developing the productive potential of some of the best agricultural zones of the sub-region.

The negative impact of a poor communication infrastructure is further compounded by major weaknesses in upstream (inputs) and downstream (processing) supporting industries and markets for major crop and livestock sub-sectors. There is evidence that adoption of promising agricultural technologies has been jeopardized by the lack of efficient manufacturing of farm equipment and spare parts (e.g. for animal traction). There are few industrial units to process agricultural commodities despite a growing demand for traditional food grains (especially maize), feeds and livestock products. Past efforts in these fields have mostly failed, mainly because of their excessive, large-scale import-substitution orientation and bad management of the majority of the public sector plants (e.g. the over-scaled mills for rice and imported wheat). Most Sahelian countries are faced with a costly, industrial base too idle to sustain even a modest growth in basic traditional foods.

Agricultural input markets are characterized by two additional drawbacks. First, all marketing stages and channels for all major purchased inputs and implements (equipment, fertilizers, pesticides, seeds, etc.) have been and still remain under heavy public sector control, either directly through specialized parastatals or indirectly within the multiple mandates of official rural development agencies. Because of their distortive effects on agricultural incentives, the poor policies, practices and management of these agencies have recently come under severe criticism with regard to their roles in input procurement, pricing and distribution. Financial and technical constraints prevent private traders from assuming a greater role in agricultural input marketing. Thus, current trends toward economic liberalization and greater private sector participation in these markets will likely have a long gestation period

before yielding the full effect. Second, poor performance is caused by inefficiencies in agricultural credit markets which are characterized by the dual burdens of a bureaucratic and inflexible formal (public bank or agency) component and a weak or poorly-known informal component. Financial scarcity in the official networks results in tight credit rationing with restrictive and politically-biased access. On the private side, there is no conclusive evidence to indicate that the assumed sizeable savings circulating through informal channels can be easily directed toward investments in agriculture.

Downstream of the farm and pastoral production stages, there are major drawbacks in the output markets, which have been dominated by monopolistic public marketing boards throughout the last three decades. Increased pressures on Sahelian states have caused restructuring of these domestic agricultural markets. The inhibiting effects of the public sector (pan-territorial pricing and marketing policies) on farmers' incentives and consumers' access to agricultural commodities (especially food grains), have made market liberalization the single most important feature of the agricultural development strategies of the 1980s and 1990s. As parastatal grain boards gradually withdraw from direct commercial functions (administered-price formation, purchases, storage and sales) their role is being restricted to the supply of market facilitating public goods, such as market information, food aid and national food security stock management, credit-access mediation for private traders, etc. Besides the severe restrictions imposed by a generalized financial crisis on the entire spectrum of economic activities in the Sahel, the overall efficiency and cost-effectiveness of the private marketing sector has yet to overcome an unstable environment. This environment is still characterized by persistent distortions primarily reflected in ambiguities, inappropriateness and frequent changes in the formulation and the enforcement of the legal foundations (laws, rules and regulations) of the emerging market economies of CILSS member countries.

*Foreign Trade.* The economic fate of Sahelian countries in world markets is essentially based on a very few agricultural export commodities: two cash crops (cotton and groundnuts), livestock products (mostly live cattle), seafood in the two instances of Senegal and Mauritania, and the exceptional mineral products of Mauritania and Niger. Export earnings from all these commodities have suffered from substantial falls in their world market prices in the 1980s. The largest cotton exporters (Burkina Faso and Mali) as well as Mauritania (the main Sahelian iron-ore exporter) have seen their terms of trade reduced by 27-31 percent between 1980 and 1986, while the remaining countries of the sub-region were experiencing 6-13 percent deterioration in their terms of trade (Table 4.6). However, beyond the obviously negative effects of this deterioration of the terms of trade, the degradation of the foreign trade position of Sahelian countries is strongly rooted in the continuous erosion of their world market shares, as witnessed by the drastic rates of decrease in the volume of groundnut products exported following the 1968-73 drought and throughout the 1980s. Notwithstanding the crowding-out effect of unfair international trade practices aimed at protecting the foreign substitutes to some of these export commodities, evidence points increasingly to bad economic policies (taxation and local currency overvaluation), stagnating or declining productivity and, therefore, high unit production costs, as the main causes of the growing loss of competitiveness of Sahelian agriculture in world markets.

The productivity argument is further supported by evidence that the decreasing competitiveness of Sahelian agriculture also applies to regional and even domestic food markets. Imported rice and wheat products progressively displace domestic cereals in food grain markets throughout West Africa, while the growing demand for meat and edible oil (especially in the West African coastal countries) is being met from sources outside the region. The low productivity problem of the Sahel is compounded by the region's increasing dependence on food imports, which currently account for about 20 percent of the total

consumption of food grains and for half of the current trade balance deficit of the sub-region. The poor and declining performance of agriculture for the Sahel is well illustrated here. The agricultural trade balance, which was 51 percent in surplus in 1965, fell to a 10 percent deficit in 1980, and a 31 percent deficit in 1987 despite the beneficial effects of two good rainfall years and the significant recovery of cotton prices in world markets. The resulting decline in foreign exchange reserves, combined with an unsustainable growth in consumption by the public sector, explain in large part the emergence of striking levels of indebtedness and financial and food aid dependencies which now characterize the Sahelian economies. For the whole sub-region, the total amount of public debt rose twelvefold from its 1975 level to reach US\$ 12.5 billion (US\$320 or 118 percent of the GNP per capita) in 1987. Moreover, the servicing of this debt alone represented 8 percent of the GNP and 44 percent of the total export revenues in 1987. Sahelian countries are thus trapped in a situation of considerable dependence on foreign assistance. This assistance rose by nearly 50 percent between 1980 and 1987, to reach an average of US\$59 per capita (22 percent of the GNP) in 1987, with peaks of 57 percent to 73 percent of the GNP in countries with small populations such as Cape Verde, The Gambia and Guinea-Bissau.

#### *Socio-political, Institutional and Policy Environment*

*Rural Society.* Community cohesion and solidarity used to be the distinguishing quality of rural societies throughout the Sahel. The emotional security thus achieved in traditional societies is rapidly disappearing in the face of a profound collapse of these values through the remorseless drive of a cash economy, the exposure of rural people to the "outside" world through migration and the decline of rural real incomes caused by drought, degradation of the natural resource base and falling commodity prices. The resulting gradual disruption in the functioning of traditional rural societies underlies a widening generation gap, which stems from an increasing feeling of alienation among

Table 4.6: Sahel: Evolution of Terms of Trade Indices (base 1980 = 100)

Countries	1980	1982	1985	1986	1987	Annual Growth Rates	
						1980-85	1986
Burkina Faso	100.0	83.0	81.0	76.0	88.0	-2.0	-6.7
Chad	100.0	-	-	87.0	-	-	-
Gambia, The	100.0	86.0	110.0	109.0	98.0	-0.5	-0.4
Mali	100.0	83.0	82.0	74.0	85.0	-2.6	-10.0
Mauritania	100.0	103.0	96.0	87.0	85.0	-0.2	-9.4
Niger	100.0	104.0	99.0	94.0	83.0	-0.1	-5.0
Senegal	100.0	98.0	97.0	86.0	90.0	-0.5	-11.2

Source: UNDP and World Bank (1990). *Données Economiques et Financières sur l'Afrique*, p.51;  
World Bank. *World Development Report 1990*, pp. 178, 243.

rural communities in a society that is being transformed in favor of rising urban minorities. These social dynamics help to understand the growing passivity and introversion of the Sahelian rural world, where incentives to increase surplus production for the market have almost completely disappeared. In their search for an escape, the most dynamic young elements of the rural labor force are faced with uncertain future in urban areas, leading to the unfortunate consequences of rising unemployment and juvenile delinquency.

If it can be argued that profound social transformation rarely occurs smoothly, the basic cause of the current hardships resulting from social disruption in the Sahel is related to a prolonged political marginalization of the rural population. This marginalization is first felt through a rigid political control and denial of autonomy to socio-professional rural organizations such as farmer associations and cooperatives during the colonial era and during the past three decades of independence. This reality is also reflected in the very top-down, public sector managed, vision and approach adopted in rural development planning. The inescapable consequences of low or inadequate prioritization, inefficient allocation and poor management of public resources intended for agricultural development are everywhere evident. In the absence of true democratic participation, the policies underlying this vision have largely been over-extractive and biased in favor of urban populations in general. They have been guided by governmental concerns about safeguarding standards and levels of living of an elite minority of politically influential urban consumers.

The chances of reversing these drawbacks are increasing with recent moves towards structural adjustment and economic policy reform programs, the gradual redefinition of the economic roles of the public sector and the private sector, and a slow but perceptible evolution toward a working democracy. At the same time, the most neglected segments of the Sahelian population in past development planning exercises and practice, women, may take on more important and visible roles, especially in urban areas, through increasing parti-

cipation in outside professions, trade, and informal activities and services. As efforts become more directed toward promoting private and grassroots-level initiatives and participation, strategies need to evolve so as to develop and maintain a political momentum strong enough to raise these concepts above and beyond the status of "simple new fashions" in development planning in the Sahel.

### *International Environment*

Notwithstanding internal efforts to meet these challenges on the domestic front, the Sahel's policies, institutions and development efforts must also be supported by the international environment. Despite the impressive amounts of money involved, official international development assistance in the Sahel has been severely criticized for its weak impact on growth in the main productive sectors such as crops, livestock, forestry, industry as well as in the areas of education, health, and indigenous human and institutional capacity-building. Estimates show that of a total of US\$15 billion \* of development aid received by CILSS member countries from 1975 to 1987, only one fourth was allocated to productive investment, while negligible shares trickled down to agriculture (4 percent) and natural resources (1.5 percent). To sustain their domestic development efforts over the next two to three decades, Sahelian countries will need the support of the international community to stimulate regional integration and cooperation, promote a growth-oriented and liberal trade environment, and ensure long-term financial assistance. In addition, Sahelian governments must be encouraged towards less centralized economic and political structures by a corresponding donor willingness for greater flexibility regarding the increasingly restrictive conditions and modalities of their assistance. This is necessary to help the recipient countries develop their own capabilities and, in the long term, reduce and eventually eliminate their dependency on foreign aid.

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\* 1 billion = 1000 million

## Development Challenges

### *Achieving Self-Reliant Food Security*

Achieving food security implies facing up to and resolving problems of food availability and access. Adequate food availability may be achieved through a combination of domestic production and foreign supplies, heavy reliance on commercial imports and food aid. However, this is not a viable food security option for Sahelian countries for several reasons. First, severe foreign currency constraints set clear limits to the commercial import capacity of individual countries. Second, fears of domestic market distortions and political dependency will prevent food aid from becoming a major structural component of any sustainable food-security strategy. Third and above all, despite rapid urban growth, as much as two-thirds of the Sahelian population lives in rural areas, where agriculture (particularly rainfed cereals production) employs about 80 percent of the total labor force. This overwhelming employment dependence on food means that any realistic and sustainable food-security strategy must significantly increase domestic food production. This is because food production constitutes the most critical determinant of food availability and income for the majority of rural households to purchase food.

Two additional challenges compound the food issue. First, rapid urbanization is inducing significant changes in food consumption patterns and food demand structure. The demand for rice and wheat products increases by 7-8 percent per annum (twice as fast as domestic production for rice), while per capita consumption of local rainfed cereals (millet, sorghum and maize) shows a declining trend. The gap between domestic production and consumption of cereals, therefore, tends to widen steadily, under the combined effects of poor irrigated farming strategies and the lack of adequate processing of traditional rainfed food-grains. This aggravates the agricultural trade balance deficit. Second, nutritional considerations of food security have yet to be seriously faced, given the low quality of Sahelian diets reflected by an overwhelming dependence on

cereals. The food security challenge, therefore, encompasses also a gradual diversification in the sources of nutrients. This has significant implications for strategies aimed at developing the production of non-grain food commodities such as livestock products, fruits and vegetables.

### *Reducing Poverty, Indebtedness and Financial Dependency*

Even from a basic food security standpoint, the overarching problem faced by Sahelian countries is persistent poverty, as depicted by the low level and the stagnation or decline of per capita incomes and increasing unemployment and underemployment. In 1988, six of the nine Sahelian countries had a per capita GNP of \$300 or less; only two of these countries (Cape Verde and Senegal) ranked among middle-income countries. Moreover, from 1965 to 1988, the annual growth rate of per capita income was positive but low (1.1 percent to 1.6 percent) in four Sahelian countries (Burkina Faso, Cape Verde, Gambia and Mali) and negative in the five other countries. Besides the lingering effects of climatic vagaries (repeated and prolonged droughts), several economic causes explain poverty in the Sahel. First, investment is characterized by its low rate (15 percent of GDP in 1987), a declining trend (-3.4 percent per year in 1980-87), and dramatically low returns (0.1 to 0.2 ratios of the growth rate of output to the rate of investment). Second, the poor investment performance translates into slow growth in production, especially of the main productive sectors such as agriculture (3 percent per year) and industry (3.3 percent per year) between 1980 and 1987. Third, sharp falls in the terms of trade (13 percent for Chad and Senegal, 27 percent for Mali and 31 percent for Burkina Faso and Mauritania between 1980 and 1986) eroded Sahelian reserves of foreign currency in the 1980s. Fourth, high population growth rates (2.6 percent per annum on average for the subregion, and between 2.2 percent and 3.3 percent in all countries except Cape Verde) have compounded the depressive effect of the low growth in domestic production

and per capita income levels. Finally, generalized policy-induced distortions of factor and product prices and poor public sector management contributed to inhibit to a large extent private economic agents' incentive to increase production for the market. Together, these factors have caused Sahelian economies to experience losses of competitiveness and shares in export markets, mounting indebtedness (\$320 per capita debt in 1987, up twelvefold from 1975 in terms of total amount), deteriorating socio economic conditions, institutional decay and a crisis of confidence. In this context, stimulating economic growth requires restoring confidence in order to induce investment, savings and capital formation by the private sector. A climate of confidence is a prerequisite to initiating and sustaining growth of real income through both domestic and international markets.

The challenge of reversing the negative trends in economic and social welfare requires that Sahelian countries adopt wise investment and incentive strategies, which are capable of inducing a substantial and sustained growth in key productive sectors. Agriculture (crop and livestock) ranks first among these sectors for all Sahelian countries. The agricultural sector employs more than two-thirds of the total labor in all Sahelian countries, except Cape Verde and Mauritania (50-65 percent). These simple statistics strongly suggest that neither food security, nor general levels of per capita income can improve without significant growth in agricultural production. Within agriculture, food sub-sectors deserve, in turn, special attention. Indeed, for the Sahel as a whole, cereals account for two-thirds of total crop value and almost half (46 percent) of total crop and livestock output value. The share of cereals in total crop value ranges from 40-45 percent in Senegal and The Gambia to 70-75 percent in Burkina Faso, Chad, Mali and Niger. Moreover, foodgrains are grown (mainly for home consumption and domestic markets) on about 75 percent of the total crop area, with the share of rainfed farming amounting to roughly 90 percent of both the cultivated area and the total value of cereals. The declining trend of per capita food production until the early 1980s

has been reversed with the remarkable growth rates (from a small base) of cereal output during the last decade. Nonetheless, there is *no* strong evidence that, beside positive rainfall effects, this improved performance can be attributed to sustainable productivity gains through the development and the wide diffusion and adoption of improved foodgrain production technologies.

The incapacity of Sahelian countries to increase productivity and reduce unit costs of production in key agricultural sub-sectors has resulted in the loss of export market shares for all agricultural commodities except cotton. The challenge raised by the stagnation-decline of per capita incomes, foreign-currency constraints and mounting debt calls for Sahelian economies not only to regain competitiveness in their traditional export markets, but also to strategically expand and diversify their export base. This could be done by identifying and carefully developing promising new export commodities (e.g. dairy and horticultural products), based on thorough market analysis of commodity outlooks in regional and international markets. In addition to crops and livestock, fisheries constitute an important source of income and a potential source of economic growth for countries such as Mauritania and Senegal, where seafood sub-sectors provide sizeable employment and income (respectively 28.6 and 75.4 billion CFAF in Mauritania and Senegal in 1980) and foreign exchange earnings. Strategies for developing selected product lines should be comprehensive enough to ensure significant employment and multiplier effects through vertical synergies between sub-sector stages and complementary linkages between key sectors. Careful development of critical support activities of the informal sector should receive greater priority in this respect. Informal financial markets, which handle up to two-third of total domestic savings in countries such as Mali and Senegal, can play significant roles in investment as public sector credit lines shrink. Likewise, successful promotion of small scale industries (e.g. manufacturing of spare parts for animal traction equipment) has often proved to be an essential condition to sustainable technological change in key productive sectors.

## *Enhancing the Quality of Human Resources*

Health and education indicators reveal more strikingly than economic indicators the depth of underdevelopment of the people in the Sahel. Compared with other major low-income regions of the world, the Sahelian sub-region showed in 1987 the lowest life expectancy at birth (46 years) and among the highest infant mortality rates, ranging from 129 to 171 per thousand in all countries except in Cape Verde (71 per thousand). The proportion of the total population with no access to health care ranges from a minimum of 50 percent in Burkina Faso to 60 percent in Niger and Senegal, 70 percent in Chad, and an alarming 85 percent in Mali. The insufficient numbers of health professionals is demonstrated by the ratio of 32,600 persons per physician and nearly 1,700 inhabitants per nursing person in 1984. The low priority given to health also emerges from official expenditures profiles. Central governments allocate a markedly negligible share of their expenditures to health: 1-2 percent in Mali and Mauritania, 5-8 percent in Burkina Faso, Cape Verde, Gambia, Guinea Bissau and Senegal, with more than 80 percent of these already small amounts being spent on personnel and recurrent costs. As a result, investment in health care is left almost entirely to external financing, while no more than 2 percent of total public development assistance is directed toward health. The resulting poor health status contributes to depressing the quality of life and the productivity of human resources in the Sahel.

Education and literacy rates, also among the poorest in the world, constitute the second dimension of the underdevelopment of human resources in the Sahel. Excluding countries with small populations (Cape Verde and Guinea-Bissau) and Mauritania all Sahelian countries rank among the twelve countries with the highest adult illiteracy rates of the world. Global illiteracy rates in 1985 exceeded 50 percent in all countries, 70 percent in Chad, Gambia and Senegal, and 80 percent in Burkina Faso, Mali and Niger. A bias in the sex distribution makes this picture even worse for women: 80 to 90 percent of females are

illiterate in all Sahelian countries, except Cape Verde (61 percent). The rate of enrolment of Sahelian school-age children generally stand at 50 percent or less of the rates prevailing in other developing regions of the world, including Sub-Saharan Africa as a whole. If secondary and college education (with respectively 8 percent and 1 percent enrollment rates) are outright luxuries for the common Sahelian, primary school remains out of the reach of 71 percent of Sahelian children (51 percent for males and 72 percent for females) in 1986. The problem of low primary school enrollment is particularly severe in two countries: Niger, with an enrolment rate of 29 percent in 1987 and Mali where the enrolment rate, already below 25 percent shows a further declining trend over the 1980s. Like health care, education suffers from a low and declining priority in government spending. During 1980-87, its share in total government expenditure fell from 16 percent to 9 percent in Mali, from 18 percent to 11 percent in Niger and from 23 percent to 17 percent in Senegal. As a consequence, education resources (manpower, infrastructure, equipment and material) are extremely scarce in quantity and poor in quality, heavily concentrated in major urban centers and mostly reserved for children of a few privileged social, political and economic classes. The challenge here is considerable because any significant improvement in the economic and social welfare of Sahelians is most unlikely to occur in the absence of basic primary education and literacy of the bulk of the population living outside the confined and privileged circles of the formal or public sector.

## *Preserving and Improving the Productive Capacity of the Environment*

The degradation of the natural environment compounds the inhibiting effect of underinvestment in human resources. Improving and preserving the productive capacity of the natural resource base raises the challenge of facing up to the crucial and interactive problems of rapid population growth and technological lag. Technological improvement may significantly increase productivity and,

therefore, reduce the extent of depletive use of natural resources. However, population growth will lead to spreading the resulting gains so thin that no meaningful improvement will be achieved in the livelihood of the population. The battle for re-establishing an environmental equilibrium must, therefore, be fought on the dual fronts of strategic planning to slow population growth and transform the extensive production systems of crops, livestock and forest-related goods (especially fuelwood).

Another challenge facing Sahelian countries in relation to environmental protection pertains to the political, institutional and legal changes needed to induce socially feasible forms of natural resource management. Genuine participatory management of these resources by local populations requires true political and economic democracy and decentralization. This is necessary to ensure an effective delegation or transfer of responsibility and authority from central government to local decision-making bodies. Changes in institutions, laws, regulations and policies must take place to generate a new system of incentives (prices, user-fees, compensation for investments aiming at long-term improvement of the resource base). These changes must reward positive initiatives and penalize socially undesirable behavior of individuals and other private entities in the use of strategic natural resources (land, water and trees). Among these changes, reforms in land tenure deserve special attention. Tenure issues result from the competing allocations of land to crops, pastures and forests in different ecological, demographic and socio-cultural zones. In the northern (Sahelian and Sahelo-Sudanian) zones where pastoralism dominates, climatic risks and natural resource scarcity call for a legal recognition of the collective management of user rights by the pastoral communities in a way that secures major investment in pastures and water points. In the Sudanian and the Sudano-Guinean zones where crops dominate, the challenge consists in solving conflicts in allocating cultivated land between individuals and clarifying access-user rights for the unused reserves of arable land. In densely-populated areas (especially in the vicinity of major urban centers), the emergence of a *de facto* land

market needs to be recognized by law and private ownership of land should be dealt with as such.

#### *Adjusting to Rapidly Changing National, Regional and International Contexts*

Perhaps the greatest challenges that Sahelian countries will face in the decades ahead are the political and institutional adjustments required to stimulate private sector initiatives for sustainable growth with equity. At the national level, ongoing structural adjustment programs call for an inescapable debate on the clearer division of responsibilities between the state and the private sector, and among the central authorities, local governments and local communities, with the ultimate goal of reducing the number of tasks performed by the central government and decentralizing the provision of public services such as water supply, health care and primary education. The momentum set for market liberalization cannot survive and meet expectations unless it is accompanied by a parallel move toward true political liberalization, democracy, freedom of expression and of the press, and respect for human rights. Less and better government will enable the emergence of effective countervailing structures that are capable of voicing the concerns and priorities of grassroots institutions, empowering minority socio-political groups such as women, curbing the endemic corruption entertained by political centralism, and emphasizing the strong accountability of government officials and civil servants for the management of public funds.

Beyond their national boundaries, Sahelian countries must renew efforts to promote regional integration and cooperation. Regional integration is needed to stimulate the evolution of effective domestic markets in the Sahel and to exploit the economic complementarities between the Sahelian countries and their neighboring coastal countries of West Africa. Integration is necessary to strengthen the Sahel as a regional block in world markets, especially for agricultural tradeables. Notwithstanding the continuous efforts for trade liberalization set forth through negotiations under the General

Agreement on Tariffs and Trade (GATT) and the Lomé Convention, Sub-Saharan African economies in general must be prepared to face significant obstacles to free trade. Doing this will promote a liberalized growth-oriented trade environment, reduce excessive dependency on foreign aid and donor dirigism.

### **Implications for Agriculture and Agricultural Research**

#### *Food-crop Sub-sectors*

*Increasing foodgrain production by 4 percent per year to meet direct consumption-demand for cereals.* Commercial imports and food aid account for about 20 percent of total cereal consumption in the Sahel. With population growing at an annual rate of nearly 3 percent, domestic production would have to increase at the sustained rate of 4 percent over the next fifteen years to reach self-sufficiency in foodgrain, assuming no change in the present composition and level of per capita consumption. This represents a major challenge given the reality that, over the last three decades, the growth rate of domestic cereals production barely matched the annual pace of rural population growth which was between 1.8 and 2.0 percent. This moderate growth has been achieved mostly through the extension of cultivated area. Considering that the extension of cultivated land is not likely to proceed at a greater rate over the next two decades, average yields of domestic cereals would have to increase by 45 percent to 50 percent (or 2.5-2.8 percent per annum) to meet the challenge of global self-sufficiency in foodgrain by the year 2005. In spite of the paucity of reliable data on income elasticities in the demand for cereals, it may be inferred from the evidence of widespread chronic undernutrition in the Sahel, that any increase in per capita real income will exert an upward pressure on foodgrain consumption. This further raises the target growth rate of domestic production required to meet the cereals self-sufficiency challenge.

*Increasing significantly, through productivity gains, the production of rainfed food crops.* Millet, sorghum and maize are, and will continue to be, the dominant cereals consumed by rural households in the Sahel. For these households, which still account for the bulk of the population of Sahelian countries, increasing self-reliance in food security is almost synonymous to significantly increasing rainfed food-grain production. Moreover, the distribution and use of land and water resources throughout the Sahel makes rainfed food production growth an unavoidable priority choice for sustainable agricultural development strategies. The threat of natural resource base degradation (deforestation, shortening or disappearance of fallow, soil erosion and declining land fertility) under heavy population pressure, however, precludes sustaining more than 1.5-2.0 percent annual extension of land brought under rainfed cultivation. This constraint is particularly severe in the Sahelian and the Sahelo-Sudanian zones where, in the 1990s, the actual crop-livestock population had already exceeded the estimated sustainable carrying capacity. The major implication of these trends is that rainfed-foodgrain production increase should be sought primarily through productivity gains, i.e. higher and more stable yields, especially in the Sahelo-Sudanian and the Sudanian zones, where two-thirds of the population is concentrated and where demographic pressure continues to build with southward migration. Although there is a certain margin for the further extension of rainfed cultivation in the Sudanian and the Sudano-Guinean zones, reversing the declining productivity of rainfed food crops in the Sahelo-Sudanian zone requires raising millet-sorghum yields by 25-30 percent over the next two decades.

Emphasis on breeding research for higher-yield, drought-tolerant and disease-resistant varieties of rainfed food crops is a top priority. This is because of the strong correlation between the high opportunity cost of farm resources (especially labor) and the low productivity of rainfed cereals. These crops are

non-tradeable wage goods exerting considerable influence in determining the competitiveness of Sahelian countries in all major economic activities producing tradable commodities. Because traditional rainfed foodgrains account for up to three-quarters of the implicit income of farm households, the productivity, or alternatively, the unit cost of production of millet and sorghum significantly determines the internal cost of agricultural labor. Hence, reducing the unit costs of rainfed foodgrains through efficiency gains in production (increasing yields especially) remains vital for raising the competitiveness of major economic sectors and sub-sectors.

*More rational and efficient development of irrigated farming.* Even a significant increase in rainfed cereals production will not be enough to face Sahelian food problems in the decades ahead. Food security concerns must incorporate risk-management strategies for coping with agro-climatic vulnerability. The unabated growth of rice and wheat consumption-demand (7-8 percent per year) due to rapid urbanization implies a widening gap between domestic food-grain supply and demand and, therefore, an increasing dependency on imports in the face of severe foreign exchange constraints. These two factors clearly call for a serious re-examination of the priority to assign to developing the potential for irrigated farming. Given the factors underlying the disappointing performance of irrigated agricultural development, research should focus on cost-effective irrigation technologies, double-cropping, better redefinition of private (farmers, agro-industrial firms, traders) and public sector roles in irrigated perimeter management, input marketing, credit management, output processing and marketing.

*Diversification of production into selected non-cereal food crops.* Sahelian dietary standards are low in terms of quantity and quality. Deficiencies in proteins and vitamins, which are common features of malnutrition in virtually all segments of the population, require diversification in food production. Cowpeas, fruits and vegetables (which are increasingly

demanding in urban areas) are strong candidates for diversification. Research in this field should bear not only on biotechnological matters (varieties, fertilizers, pesticides, etc.), but also on market development, processing, conservation, transport.

*Strengthening upstream (factor markets) and downstream (output markets) synergetic linkages in major food sub-sectors.* Unlike the major export crops such as cotton and groundnuts, traditional food sub-sectors in Sahelian countries are characterized by weak, if not missing, linkages leading unsatisfactory vertical coordination between upstream and downstream stages of activities. The lack of adequate processing facilities is among the most significant factors explaining the gradual decline of the share of traditional foodgrains (millet, sorghum and maize) in consumption, relative to rice and wheat. Traditional Sahelian rainfed food crops suffer from the lack of organized upstream supporting services such as seed multiplication and distribution, provision of credit and other inputs. Transport costs alone account for more than 50 percent of the total unit cost of Sahelian foodgrain delivered to consumers. Thus, research must tackle crop development issues within a more comprehensive sub-sector approach. This is necessary to reduce, through overall efficiency gains, the unit cost of the end product to the consumer.

#### *Cash-Export Crops*

*Demand outlooks and preservation of competitiveness in world cotton markets.* Cotton is the agricultural commodity in which the export competitiveness of Sahelian producers is presently the strongest in world markets. Optimistic international demand outlooks for cotton over the next fifteen years are supported by income growth prospects in industrialized countries, the need to rebuild international stocks of fibers and the rapid development of underutilized capacity of textile industries in cotton-producing developing countries. To take advantage of such export opportunities, the major cotton-producing and exporting countries of the Sahel (Burkina Faso, Mali and Chad)

would have to pay closer attention to improving and maintaining the quality of the product, and to push for additional productivity gains so as to reduce and keep the costs of labor and imported inputs (especially fertilizers) under control. Opportunities also exist for reducing marketing and processing costs. In addition to research on these technical matters, macro-economic factors such as real exchange rate management policies should be faced up to in order to maintain the Sahelian comparative advantage in cotton.

*Demand outlooks and regaining competitiveness in regional markets of edible oil and oilseed cake.* Tough competition from various oilseeds such as soybeans, sunflower and rapeseed in most markets of developed countries result in rather poor outlooks for groundnut oil and meal. In constant 1990 dollar terms, world prices are projected to fall between 1990 and 2000 by 41 percent for groundnut oil and 14 percent for groundnut meal. These pessimistic figures may however be reversed by a regional-African perspective, especially for the neighboring coastal countries of the Sahel, where the demand for vegetable oils is expanding much faster than in world markets as a whole, and where groundnut oil still enjoys a strong consumer preference. Higher production and exports of small ruminants and poultry to urban and coastal markets increases the demand for groundnut hay and cake. Because of their bulky nature, these two by-products, which represent up to 50 percent of the c.i.f. value of groundnut production, are costly to transport and, therefore, enjoy a high degree of natural protection. These prospective market opportunities call for a careful examination of the major factors underlying changes in the comparative advantage of Sahelian groundnut producing countries (particularly in Senegal, The Gambia and Chad) to enable them to compete with Asian palm oil producers who recently filled the vacuum created by the loss of Sahelian shares in regional vegetable oil markets. Research should focus here on restoring or maintaining the quality and the productivity of land under groundnut cultivation, reducing unit costs (especially labor

costs) across key stages of the groundnut sub-sector (production, processing and transportation), and differentiating the quality of Sahelian products to meet the growing preference of consumers for non-saturated fats.

*International demand outlook and selective development of new export crops.* One of the major problems faced by Sahelian economies is their heavy dependence on one or two agricultural commodities for foreign exchange earnings. To break the vicious cycle that feeds on this dependency, agricultural development strategies need to incorporate feasible options for enlarging and diversifying the cash-export crop base. Non-traditional crops such as selected off-season horticultural products (fruits, vegetables, ornamental plants, etc.), which are presently overlooked by agricultural research and development programs may reveal opportunities worth exploring for that purpose. Such new agricultural sub-sectors, however, require research not only on varieties, but also on modern techniques of production, processing, and marketing of the products. After all, the Mediterranean Basin and the Middle East have short periods of the year when open air vegetable production is impossible. These periods represent market niches for the Sahel, which then has a comparative advantage in terms of distance to markets.

*Developing potential comparative advantage in regional markets of livestock products.* Urbanization and income growth exert a significant upward pressure on the demand for livestock products (meat, dairy, poultry) in West Africa, especially in coastal countries such as Nigeria, Côte d'Ivoire and Ghana. In excess of US\$400 million per annum, Nigerian imports of livestock products amounted to nearly the total agricultural GDP of neighboring Niger. Per capita consumption of meat doubled in Côte d'Ivoire between 1973-76 and 1984-87. While these coastal markets of West Africa may continue to represent catchment areas for EEC's excess stocks, it still holds that clear opportunities exist for Sahelian livestock producers to recapture regional market shares in Sub-Saharan Africa for preferred meat and dairy products.

Taking advantage of such regional opportunities poses three major challenges to research: facing up to the problems of feed, high transport costs, and overvalued real exchange rates. Alleviating the feed constraint implies developing synergetic linkages between livestock product sub-sectors and crop sub-sectors by offering, through an increasing demand for high-energy forage and meals, additional outlets for by-products of such crops as groundnuts, sorghum and maize.

### **Environmental Protection**

#### *Need for a strategic choice of an optimal mix of intensive and extensive production systems*

Beside the long-term and general decline in rainfall, the major factor blamed for environmental degradation in the Sahel is the abusive use of natural resources through extensive farming and increasing population pressure. Past attempts to intensify crop and livestock production have been tentative with rather disappointing outcomes, and require greater and more systematic research attention. Research for productivity improvement should proceed neither with a single-input bias, nor a single-sector (crop, livestock, forestry) approach, which pays little attention to the global (socio-cultural, political and institutional) contexts in which Sahelian production systems operate. The critical issue is not one of "either-or." Rather, it is one of rational choice and promotion of an optimal mix of intensive and extensive production (of crops, livestock and forestry) based on the relative abundance or scarcity of available production factors (labor, land and water). The end objective of maximizing while sustaining, from a social point of view, the productivity of scarce resources must be kept in view. This obviously calls for significant improvements in knowledge, information and monitoring the availability, productivity and carrying capacity of natural resources at the zonal, national and regional levels.

#### *Strategy for extracting the "sleeping agricultural surplus" of the marginal drier zones*

To properly cope with their natural resource management problems, Sahelian countries must address the important issue of finding alternative uses for the underutilized productive capacity present in the sub-optimal use of the human resource stock of the most northern and driest agro-pastoral areas (the Sahelo-Saharan zone and the northern fringe of the Sahelo-Sudanian zone) of the sub-region. Spontaneous population out-migration from these zones tends to increasingly compound threats of rapid disruption of the precarious ecological equilibrium in the more humid southern areas of Sahelian countries. Research should focus on finding the best options for facilitating the process of transfer of rural households from the north to the south, alternative opportunity sets of rural activities and employment for the remaining populations of the drier areas, and efficient investments in infrastructure and institutions to improve the livelihood and welfare of these populations.

### **Limits on the Scope of Agricultural Research Development**

Agricultural research does not, and cannot, develop and perform efficiently in a vacuum. At a time where much is being said about the productivity-profitability of investment in alternative activities, it is of the utmost importance to keep in mind that agricultural research is but a single activity among several others, which determine the final outcome. The scope of the performance of agricultural research is consequently constrained not only by deficiencies that are internal to the research systems, but also and to a significant extent, by the limits imposed by exogenous factors pertaining to the political, institutional and policy environments.

*Constraints pertaining to the political environment.*

First and above all, development priorities for agriculture and agricultural research result primarily from political considerations. Over the past three decades, Sahelian countries have been characterized by monolithic, highly centralized and urban-biased political systems, with the inescapable consequence of residual and superficial treatment of virtually all major agricultural development issues in the "real" world. This is demonstrated by the adoption of numerous cheap food strategies and policies, which were conceptually flawed at the outset, by improper priorities, the rather disruptive-extractive nature of their implementation, and the negligible impact of the apparently considerable levels of investment involved. However, seemingly irreversible developments toward greater political democracy and administrative and economic decentralization are emerging, and are expected to gain firmer ground throughout Sub-Saharan Africa during this last decade of the twentieth century. In this new political scenario, the agricultural world in the Sahel should be prepared to raise itself from a position of passive recipient of mandates and credits to being an aggressive proponent of both its own priorities and for a genuine development of the food and agriculture sector and the agricultural community.

*Constraints pertaining to the policy environment.*

The efficiency and the competitiveness of agriculture depend significantly on the incentive system set forth by economic policies pertaining to prices, taxes, subsidies, tariff barriers, quota limitations, interest rates, exchange rates, etc. It is now widely acknowledged that, at the national level, Sahelian farmers have been severely penalized by policies of depressed farm-gate prices, over-taxation of rural populations and overvaluation of exchange rates. The removal of these impediments and improving the distribution of complementary economic roles between private entities (farmers, agro-industrial firms, traders) and the public sector, thus restoring an appropriate set

of agricultural incentives for the effective adoption of successful research results, will have a relatively long gestation period. Moreover, many of the economic and environmental problems (specialization based on comparative advantage in regional trade, natural resource management planning by cross-national ecological zones, etc.) in the Sahel have regional dimensions, which cannot be dealt with effectively solely within national boundaries. The contribution of agricultural research to solving these problems will necessarily be constrained by insufficient coherence between relevant national policies and by weak political willingness-commitment for true transnational integration of major economic and environmental concerns of regional interest. At a more global level, other factors will likely contribute to determining the scope of agricultural research development in the Sahel. Chief among these are the evolving food and agricultural sector policies of leading economic blocs in world trade and markets of agricultural commodities, and the increasing propensity of major donors to refrain from granting developing countries too easy and inexpensive aid.

*Constraints pertaining to the institutional environment*

Institutions shape to a large extent the structure, conduct and performance of economic activities. Structural deficiencies in agricultural credit, factor and product markets have thus played a central role in distorting agricultural incentives under the political economy regimes characterized by the central planning of vital economic activities over the last three decades in the Sahel. These distortions have been compounded by the absence of genuine rural grassroots organizations, free of central political control and interference and capable of voicing the perceptions of rural populations about their own problems and the proposed or required solutions. From the outset, the overall productivity and possible effective impact of agricultural research have been curtailed by the one-way, top-down process imposed on research by an institutional logic deriving from monolithic political centralism. As reforms for

greater economic liberalization and private initiative proceed, basic institutions as well as the legal foundations that sustain them must be rethought to mitigate the likelihood of

exogenous distortions from unreformed sectors impeding expected benefits from investment in the reformed economic sectors and sub-sectors.

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## ***5: Current Agricultural Research Potential And Capacity in the CILSS Region and Recent Trends***

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### **Historic Overview**

Agricultural research in the Sahel was launched in the early 1920s by the colonial governments and organized into federal and secondary research centers. These centers were managed and operated by various metropolitan institutes, such as: IRCT, IRHO, CTFT, etc. Between the 1920s and independence, research programs focused primarily on the improvement of cash crops, tree crops and animal health. In the wake of independence, the newly sovereign states continued to rely on the metropolitan institutes through bilateral agreements. Operating funds were generally provided by the former colonial power. This period (1960-1970) saw a shift in the programs towards food crops. Being aware of the need for them to manage their own agricultural research, the Sahelian countries proceeded in the second half of the 1970s to establish national research institutes. These institutes were established in a context of economic change characterized by the emergence of large public sector development corporations. With the exception of Mali whose IER has been in existence since 1960; INRAN (Niger), ISRA (Sénégal), and CNRADA (Mauritania) all came into being in 1974; the Agricultural Research Division in The Gambia was founded in 1977; INERA (Burkina Faso) in 1981; and INIA (Cape Verde) and DEPA (Guinea Bissau) following their independence in 1975. Chad is the only exception with a pluralistic system of three separate research institutions for cotton, food crop agronomy and livestock (animal health) research.

Faced with food security problems caused by the successive droughts of the 1970s and given the importance of food crops for the Sahelian countries, the newly-established national institutes focused on shifting their programs to this area. For the livestock sub-sector, animal health

research continued to be important, although the success of improved prophylactic measures has led to reorienting research more towards increasing animal productivity through genetic improvement. During this period, the close links with the metropolitan institutes continued in various forms depending on the individual countries concerned. For the first ten to fifteen years of their existence, the national institutes had to face serious challenges, exacerbated by natural calamities and an increasingly difficult international economic situation. Today (1992), the earlier economic development policies are being questioned, thus suggesting a new vision for agricultural research policies and strategies.

### **Analysis of Past and Present National Research Efforts**

#### *Research Programs (focus and results)*

*Food Crops.* The most important rainfed food crops grown in the Sahel are: millet, sorghum, cowpeas and maize. Research on these commodities has focused mainly on varietal improvement, i.e. high yielding, stable varieties, resistant to diseases and insects. New varieties are generally released with an agronomic package, including cultural practices and fertilization. The successive droughts of the early 1970s prompted the NARSs to place increasing importance on developing early and drought-resistant varieties for the Sahelian and Sahelo-Soudanian zones (low to medium rainfall). The task consisted specifically of identifying varieties (mainly populations) that are resistant to abiotic (drought, sand storms, etc.) and biotic (mildew, leaf diseases, mites and flies, ergot, smut, etc.) constraints. Rice and groundnuts occupy a special place in the farming systems. Formerly considered only as a cash crop, groundnuts play a significant

role in the Sahelian diet. Much research has been done on this crop both during and since colonial rule. The research topics dealt with are similar to those in the case of foodgrains. Rice, an important foodstuff (particularly in the urban areas), is produced in small amounts despite the potential that exists. Most of the work on rice has been undertaken in a regional context (WARDA, see pages 36 and 37). Certain food crop varieties are widely distributed and adopted, the following in particular: for millet, HKP and SOUNA3; for sorghum, CE-151-262; for maize, MAKA and JEKA; and for cowpeas, KN-1 and TN-8867. Simple selection methods among local populations using farmer knowledge and focussing on early maturing varieties to reduce the risks of irregular rainfall patterns have contributed to this success. In the area of plant protection, research has so far mainly contributed to a better understanding of the biology of the various crop pests.

*Cash Crops* (essentially cotton and groundnuts). The nutritional value of groundnuts aside (page 29), they still present an important foreign exchange earner, and a market to regain. Over the years, many early maturing and disease (Rosette) resistant varieties have been released. It is fair to state that all groundnut varieties presently grown in the region are the result of this research. Certain varieties, in particular those that are Rosette resistant, have become famous and are widely distributed outside the region. Cotton research has concentrated on developing production models, incorporating ecological, economic and human considerations, with technical research on plant architecture, the *in vitro* creation of haploids and fiber strength. Varietal research has focused on insect and pest resistance (jassidaes, fusarium wilt, etc.), while agronomic research concentrated on harvesting losses, integrated pest management and fertilization. Research results have been impressive in terms of universally adopted higher-yielding varieties with improved lint quality in response to market demands. Important progress has been made with integrated pest management, reducing the number of preventive treatments with pesticides (and the costs). The introduction of new maize varieties in rotation with cotton,

using the residual effect of cotton fertilization, has given rise to important production increases in the cotton-growing areas. Most of this very successful research is conducted under the auspices of IRCT.

*Livestock and Fisheries.* Meat, poultry and fish are important elements of the diet of Sahelian populations. Moreover, for herders, cattle is an important form of capital accumulation and savings. Small ruminants, poultry and dairy products are rapidly growing in importance with rising demand in urban areas. Research so far has focused mainly on animal health and productivity increases through genetic improvement. Some research has been done on range management, animal feed, small ruminants, and intensive production of pigs and poultry, but this has not been a central focus of livestock research. Research on dairying and fisheries (both inland and marine) has remained limited. The most important research results of the past have been in the area of animal health and the development of vaccines (rinderpest, contagious bovine pleuro-pneumonia, small ruminant pest, etc.). The impressive development of artisanal marine fisheries in the region's coastal countries can to a large extent be attributed to research on the assessment and management of marine resources.

*Forestry and Environment.* Forestry research in the Sahel was first started in the 1950s. CTFT started its activities in 1963 by setting up a common center for Niger and Burkina Faso. Research was oriented towards the introduction of eucalyptus in the Sahelo-Sudanian zone, the regeneration of natural forest populations, and the introduction of exotic woody species (other than eucalyptus) for reforestation. Over time, with a growing awareness of the importance of restoring and preserving Sahelian ecosystems, the research focus has moved towards the management of natural forests. The following research topics have recently assumed importance: the development of natural tree populations, genetic improvement, plantation silviculture (utilization of local species for reforestation), soil and water conservation, wood technology (charcoal and fuelwood), and the socioeconomic context of forestry development. However, forestry and

natural resources management is at present the research sub-sector that is most plagued by the general constraints of inadequate human resources (both in terms of skills and numbers) and infrastructure. Ongoing activities are characterized by an *ad hoc* approach. Despite this rather bleak picture, important progress has been made in terms of soil and water conservation: for example, improvements in water harvesting and soil conservation techniques in Burkina Faso are widely adopted and well documented.

*R & D, Farming Systems Research.* Farming systems research (terminology used here includes a variety of approaches) has increased in Sub-Saharan Africa over the 1980s. One of the first attempts was the "Unités Expérimentales" in the Sine Saloum region of Sénégal. R&D research is also an important activity in Mali and Burkina Faso. This new tendency towards agricultural research was developed to try a bottom-up approach in tandem with adaptive on-farm research and to provide feedback to experiment stations. Thus, addressing farmers' needs was a primary objective of on-farm research. However, a recent study by ISNAR has shown that although much of the adaptive research was successful, it did little in changing the objectives of on-station research. Farming systems research has proven its value in diagnosing specific problems and in identifying on-farm constraints which prevent farmers from adopting new technology. However, there is usually not one straight forward universally applicable solution to these constraints, nor has it proven to be easy to change the research focus of on-station researchers to accommodate on-farm research findings. Sometimes this has been caused by institutional barriers; more often, however, there are no incentives for on-station researchers to directly liaise with their clientele - the farmers. In this context, good farm economics research, i.e. "how can farmers increase their income?", has been particularly weak. Up until recently, social research has been practically absent, leaving totally unattended important areas influencing farmer behavior and thus production, such as land tenure and the suppression or promotion of

indigenous producer and credit organizations. Weaknesses in farm economics and social research, combined with institutional squabbling between commodity and systems researchers have done much harm to the "standing" of the various forms of participatory research.

*Economic Analysis.* Generally speaking, micro and in particular macroeconomic analysis capability has been one of the weakest areas of research for the NARSs in the region. This has often prevented the national systems adjusting their research strategies to the continuously changing economic environment and providing needed evidence of the utility of proposed research to policy (decision) makers. The systems have often done themselves a disservice in this respect. There is, however a growing awareness of this weakness.

*Limitations.* Agriculture is invariably presented as the priority sub-sector in national economic development strategies. However, national policy frameworks are not always conducive to stated sector objectives, such as: augmenting agricultural productivity and food security. If agricultural research strategies should respond to national economic policy considerations, flaws in such policies (prices, subsidies, tariffs, etc.) will affect research efficiency. On the other hand, if the technology generation focus of research is too narrow, its results may not have the desired impact on the entire production process, from producer to consumer. Enlarging present agricultural research in this manner to both upstream (natural resource management considerations) and downstream (processing, transport, marketing) domains can only be envisaged in a larger (regional) context, each NARSs being individually too small to cover the entire spectrum.

#### *National Research Potential and Capacity (institutional, human and financial)*

*National Research Institutions.* Despite the relatively short history of the NARSs in the Sahel (see page 29), several have already gone through a series of internal reorganizations. With the exception of Chad and The Gambia, all the other systems respond to one ministry.

Three systems consist of several independent sectoral institutions: Burkina Faso, Chad and Mauritania, whereas multisectoral unified institutions are the prevailing model in the other countries. Two countries have opted for a semi-autonomous parastatal model, Senegal (EPIC) and Niger (EPA) whereas the other systems are either completely integrated in the public administration (Cape Verde, The Gambia, Guinea Bissau and Mali) or partially (Chad and Burkina Faso). The degree of management autonomy for personnel and finance is generally limited, even in the parastatal institutions. As a result, most institutions share similar efficiency constraints.

(a) Researchers, particularly in the smaller systems, are entrusted with a multiplicity of ill-defined responsibilities, ranging from administrative-managerial to representational, detracting from their research duties; and

(b) Because of large administrative overheads, fluctuating and unreliable government funding, available research operating funds are low to the point that research systems have become simple government bureaucracies with little congruence between stated goals and objectives and daily tasks and duties.

*Human Resources.* Presently (1992), close to 700 scientists are working within the NARSs in the CILSS Region, 27 percent of them expatriates, including 49 outposted IARC scientists (page 36). Of the national scientists, 30 percent have an equivalent of a B.Sc. degree, 35 percent have a M.Sc. level degree (of which 50 percent in Mali), and 130 are Ph.Ds (60 percent in Mali).<sup>2</sup> Table 5.1 presents the distribution of scientists over the main research sub-sectors. Approximately 50 percent of all scientists are working on crop improvement, agricultural practices and crop husbandry. Of these, roughly 45 percent may be general agronomists, 35 percent plant breeders, and 20 percent phytopathologists, entomologists and plant physiologists. The majority of the animal production scientists are veterinarians (exact numbers are not available), reflecting past emphasis on animal health at the expense of animal production, including range management, animal nutrition and the processing of animal products. Nevertheless, there are more animal nutrition scientists in the regional

research system than human nutrition and food technology scientists. The soil scientists are mainly specialized in soil chemistry and pedology and scientific capacity in soil physics is practically non-existent in the region. Forestry and the ecological sciences are also severely underrepresented. Together with the limited capacity in soil science, this illustrates the low priority assigned in the past to research on natural resource management. Finally, the small number of agricultural engineers in the overall regional research system should be noted, which puts into perspective the very limited capacity available for the development and improvement of tools, farm equipment, machinery and post-harvest technology.

The preceding figures and comments illustrate some important points:

(a) As each country in the region has more or less the same skills-mix distribution and research priorities with respect to crop production, duplication of effort is easily exacerbated in a regional context.

(b) On the other hand, if one assumes that for carrying out effective multi-disciplinary research through single commodity research programs a minimum of about eight to ten scientists are necessary, there are very few national programs in the Sahel that reach such a critical mass - one to five scientist programs are generally the rule.

(c) In the absence of long-term strategic human resource planning and development, the apparent bias towards crop improvement and animal health disciplines would tend to keep research supply-driven, making a shift in orientation towards more client and market-driven research difficult, as evidenced by the severely limited research capacity in agricultural mechanization, on-farm and off-farm post-harvest technology, and the processing of crop and animal products.

(d) More or less the same bias amongst expatriate scientists may illustrate that their recruitment is supply-driven, i.e. reflecting available capacity in the donor country, rather than responding to priority research needs in the receiving country.

Table 5.1 Distribution of Scientists by Sub-Sector and Disciplines

	National	Expatriate	Total	Percentage
Agronomy/Crops	243	87	330	48
Animal Production	108	18	126	18
Forestry/Ecology	19	1	20 <sup>a/</sup>	3
Fisheries	19	10	29 <sup>b/</sup>	4
Social Sciences	45	15	60 <sup>c/</sup>	9
Soil Science/Geography	23	6	29	4
Agricultural Engineering	8	1	9	1
Water Resources Mgmt. <sup>d/</sup>	11	9	20	3
Food Technology <sup>e/</sup>	3	-	3	0
Other	26	44 <sup>f/</sup>	70	10
<i>Total</i>	<i>505</i>	<i>191</i>	<i>696</i>	<i>100</i>

- a. Concentrated in Mali and Senegal (15).
- b. Concentrated in Senegal/The Gambia (21) for marine fisheries/oceanography and 8 in Mali for inland fisheries.
- c. Concentrated in Mali (30).
- d. Including irrigation, hydrology, rural engineering and land development.
- e. Does not include Food Technology Research Institute in Dakar.
- f. Mainly unknown disciplines.

Sources: Annexes

(e) The shortage of scientists in the ecological sciences, forestry and soil science severely limits the region's capacity to undertake research on natural resource management, which is rapidly becoming one of the highest priorities.

(f) There is a relatively high percentage of B.Sc. level scientists who in general do not have the required scientific training in experimental design and biometry; moreover, many researchers are young (average age estimated at 30 - 35), with few having more than ten years of experience to act as mentors to those with limited or no experience.

(g) To remain up-to-date, scientists need to stay in close contact with universities and other training institutions; the lack of relevant educational institutions in nearly all Sahelian countries, particularly at post-graduate level thus represents a severe handicap.

Other issues, related to the institutional environment of most of the NARSs in the Sahel, may have a potentially serious effect on research focus, output and efficiency.

(a) Most scientists in the region are civil servants or quasi-civil servants (parastatal employees); civil service career path patterns and staff evaluation systems (if they exist) are seldom adapted to the needs of research organizations that often lack autonomy in personnel management and in some cases even staff postings (Chad); only one country in the region has so far accorded its agricultural scientists a special status (Burkina Faso).

(b) A lack of institutional autonomy not only affects scientific independence but also the establishment of appropriate personnel management policies (hiring-firing-advancement) and thus the implementation of human resources development strategies adapted

to the needs of research institutions (recruitment policies as a function of desired research priorities, staff retraining to meet changing skills-mix requirements, etc.); higher-level staff in the institutions have in general little experience and or training in personnel management skills to implement such strategies.

(c) Limited research operating funds and non-incentive eroding salary levels have in a number of countries seriously affected scientist motivation, and in certain cases (Senegal) led to high turnover rates (the best go) or a high incidence of outside employment "on-the-side" (consultancies, etc.).

(d) The prevailing institutional environment is not conducive to instill a client and market orientation in its scientists who are not accountable for the relevance of their research proposals.

A decade ago there was a serious shortage of national scientists -- this is much less the case now. The problems of the NARSs have become much more of an institutional nature, pointing to the need for fundamental reform, which will require a large dose of political willpower for it to be successful.

*Financial Resources.* The order of magnitude of annual agricultural research expenditures by the NARSs in the CILSS region is estimated at roughly US\$ 35 million. The available data presented in Table 5.2 indicate that approximately 40 percent is funded by domestic resources and 60 percent by external donors. Research expenditures per scientist in the Sahel are relatively high, ranging from US\$ 75,000 to US\$ 90,00 (available data for Mali may indicate that not all research operating expenditures and investments are recorded in the accounts of the national system). Research operating expenditures per scientist, excluding investments, salaries and training, range from US\$ 33,000 in Senegal to US\$ 46,000 in Burkina Faso.

An analysis of agricultural research funding in the CILSS countries leads to the following comments and issues:

(a) Insufficiencies in government funding in some countries in relation to the size and diversity of their agricultural economy, but

even more important inter-annual irregularity in public funding.

(b) Overall, approximately 75-80 percent of public funds cover staff costs, leaving 20-25 percent for recurrent fixed operating expenditures; this has led in many countries to serious under-budgeting of fixed operation and maintenance requirements of research installations.

(c) Reluctance of donors to fund a reasonable share of recurrent fixed operating expenditures and overheads, even though directly related to donor funded research, has in many cases distorted the system.

(d) Responsibility for commitments and payments of most of the bilateral donor funds and some of the multilateral funds remains with the donor agency, i.e. excluding the national institutions from the management of often the largest part of their operating budgets.

(e) Weak public administration accounting systems not adapted to research needs (often the reason that donors are reluctant to part with the management of their funds) and salary scales not attractive to recruit capable accounting staff becomes a vicious circle inherent to most public or parastatal institutions.

(f) Centralized public administration and para-public accounting procedures do not provide for budgeting, internal budget control and accounting procedures adapted to a decentralized management structure which is typically the case in NARSs with research installations spread throughout a country with weak communication links.

(g) Another drawbacks of over-centralized management systems is the lack of a clear definition of who is to be held accountable for what expenditure - timeliness of the availability of funds is essential for agricultural research to avoid losing out on research quality and thus efficiency (once an experiment has started, everything is timed to avoid introducing involuntary variables). Only the person on the spot can judge the justification of an expense.

(h) A serious limitation is the lack of transparency in existing accounting and management systems, making the tracing of earmarked funds difficult if not impossible, which in turn has prevented donors from trusting their funds to

*Table 5.2 Annual NARSs Expenditures and Funding*

	<i>Total Costs</i>	<i>Local Staff Costs (million US\$)</i>	<i>Domestic Resources</i>	<i>Donor Funds</i>	<i>Total Costs per Scientist (thousand US\$)<sup>a/</sup></i>
Burkina Faso	7.6	1.3	1.9	5.7	83
Cape Verde	2.3	n.a	0.7	1.6	95
Chad	4.8	0.8	0.9	3.9	83
Gambia, The	n.a	n.a	n.a	n.a	n.a
Guinea-Bissau	n.a	n.a	n.a	1.0	n.a
Mali	6.0	n.a	2.4	3.6	29
Mauritania	0.5	n.a	0.2	0.3	80
Niger	n.a	1.7	2.3	n.a	n.a
Senegal	7.1	3.8	4.8	2.3	77

*Note:* Total costs include investments but exclude the costs of expatriate staff. Available data are from 1989 or 1990.

a. Including expatriate scientists.

national institutions, often creating autonomously managed "enclave projects" within the national systems.

*Recent Institutional Changes and Their Dynamics.* The issues summarized in the previous paragraphs are symptomatic of the weak institutional capacity of many NARSs. However, much has been done in recent years to improve this capacity through the establishment of long-term national research master plans (completed or close to completion in Chad, Burkina Faso, Mali, Niger and Senegal), improvements in research management, training, etc. Several NARSs are in the process of developing human resources development strategies based on their long-term research plans. In some countries with para-public institutions (Senegal and Niger), important changes have been made in the legal statutes of these institutions providing them greater management autonomy. ISNAR has often been instrumental in preparing these new avenues by providing methodological support. These are all steps in the right direction that overtime should

mitigate some of the problems enumerated in the preceding paragraphs. The question is if this is enough? Will these new avenues ensure focus, motivation and sustainability of the national systems concerned?

To answer this question, one should perhaps first analyze what is missing in these new approaches. Will they provide the enabling environment that guarantees that from now on research will be client market-driven, i.e. be responsive to the constraints of the client (first and foremost the farmer, but also the extension services, the seed companies, the processors, the producers and suppliers of agricultural inputs, etc.). The answer is perhaps that such a change in attitude and motivation of the researcher will not occur automatically. It may happen when the scientist can be held accountable for the work-related results. This would certainly be in the interest of the farmer, the government and the donor. Being held accountable implies a contractual arrangement. It would also introduce healthy competition: the scientist or group of scientists with the best research

proposal, i.e. most responsive to what the client, government or donor is willing to pay for, gets the contract. In conclusion, to change the national agricultural research systems around to make them client and market-driven and thus relevant, will require fundamental institutional reforms, responding to criteria of performance accountability through personnel and financial management autonomy. Institutional adaptations at the margin have been proven not to work.

## **Regional and International Research Efforts**

### *International Programs and Priorities (Results and trends)*

The mission of the CGIAR Centers (IARCs) in Sub-Saharan Africa is to generate technological innovations which address food production constraints and help strengthen NARSs. IARCs accomplish this goal through various activities: training, research and communications, collaborative networks, publication of scientific information, seminars, development and dissemination of new techniques and improved technologies. CGIAR has emphasized strengthening of human resources and institution building in NARSs as one of its goals and is presently devoting about 19 percent of its total resources to that goal. After concentrating on technology generation and building scientific capacity for a decade, the CGIAR recognized that it was addressing only addressing part of the problem. Consequently, it created ISNAR to deal with policy, organizational and institutional issues that were limiting the effectiveness of NARSs. CGIAR directs a large part of its resources to Africa where many NARSs remain fragile and require urgent and intensified support.

The CGIAR Task Force on Sub-Saharan Africa (1986-1989), set up to analyze and make recommendations on the NARSs/IARC interface, recognized that there have been no technological breakthroughs in Africa comparable to the Asian green revolution in wheat and rice, for which IARCs can be credited. The single most dramatic impact in farmers' fields has probably been in the

checking of the cassava mealybug through IITA'S biological control program. The CGIAR impact study of 1985 identified 244 CGIAR Center related varieties released by African national programs. The main commodity releases were reported as maize(61), bread wheat (40), potato (31), and cassava(26). By the end of 1984, more than 6,000 African professionals, of which 1,257 were from the nine CILSS countries, had received some kind of training from the IARCs.

Since the creation of the first IARC in Africa (IITA, 1967), CGIAR has invested increasingly in Sub-Saharan Africa. Three more IARCs (ILCA,ILRAD,WARDA) and a Sahelian Center depending on ICRISAT have been located in Africa. Total CGIAR expenditures in Africa reached more than US\$ 100 million per year in 1990, 211 scientists were outposted from IARCs in African Center sub-locations or NARSs in 1990, of which 49 were in the Sahel. Allocations of funds to Africa by commodity and type of activity were as follows in 1986: livestock - 22 percent (ILCA, ILRAD), rice - 19 percent (inputs provided by four Centers: WARDA, IITA, CIAT, and IRRI); maize - 15 percent (inputs from CIMMYT and IITA); cassava - 6 percent, cowpea and millet - 5 percent each, and sorghum and potato - 3 percent each. These ratios have been drastically modified in favor of sorghum and millet with the creation of the ICRISAT Sahelian Center in Sadore, Niger (operational in 1989) and the recent establishment of the ICRISAT Regional Sorghum Center in Samanko, Mali. For the CILSS countries, ICRISAT, ILCA/ILRAD and WARDA activities are more important. But, as mentioned above, IARCs not located in Africa have also significant activities in the sub-region e.g. ISNAR in Burkina Faso, Mali, Niger and Senegal; IBPGR in Niger; IFPRI in Niger and Senegal.

The crucial question is: "To what extent has this rather massive effort effected farmer incomes in the region?" Since there have not been any "green revolution" type breakthroughs, the answer is not easy. IARC research results feed into the national systems which are ultimately responsible for assessing their usefulness. Since work on farm economics

and impact evaluation is one of the weak areas in many NARSs (see page 31), there is no immediate answer. However, the lessons to be learned from this experience are: (a) that IARC programs in the region should become more responsive to the needs of the national systems for their mutual benefit; and (b) that the national systems should improve their impact evaluation and through that become more concerned with the client (farmer) constraints. The IARC Medium-Term Plans recognize these needs and are a step in the right direction, but more could be done to make IARC research and networks in the region an integral part of an evolving regional research agenda and more demand-driven.

*ICRISAT.* In its Medium-Term Plan (1989-1993) ICRISAT put increasing emphasis on its three Sub-Saharan research programs -- cereals, legumes and resource management. As a result, Africa accounted for 44.3 percent of ICRISAT's operations budget in 1989, 45.4 percent in 1990, and the projections are 46.3 percent for 1993. In the Sahel, ICRISAT aims to reverse the decline in smallholder production of sorghum for food by significantly increasing productivity through cooperative research with NARSs, sound ICRISAT teamwork, and continuity of support. It considers that a farming systems approach is needed to guide crop improvement. The strategy of the Center for pearl millet will be similar to that for sorghum, but more directed to increasing stability rather than yields. ICRISAT's work will concentrate on helping pearl millet producers cope with drought and make efficient use of available resources and inputs. ICRISAT intends to combine its efforts with those of other IARCs or international Institutions, particularly IITA, ILCA, IFPRI, IFDC, in incorporating other crops and livestock production into new and improved farming system options. For groundnut, ICRISAT will balance its program in long-term multi disciplinary research covering breeding, pathology, entomology, and agronomy. A recent workshop at the ICRISAT Sahelian Center (ISC) recommended the development of an initial research plan but discussions are still needed to determine how

the work could be divided between ISC and the NARSs.

*ILCA.* Among ILCA's more significant research results has been the testing of alley farming in the humid zone and fodder banks in the sub-humid zone. Simple milk processing technology has also been successfully tested in Ethiopia. ILCA has shown that trypano-tolerant animals can be productive under challenging conditions. It has confirmed that the use of chemotherapy to control trypanosomiasis can open new areas for intensive livestock production. ILCA has also assumed a leadership role in the collection and distribution of forage germplasm. Throughout its sixteen years of existence ILCA'S research priorities have been three species: cattle, sheep and goats. But after more than a decade of research on pastoralism in both East and West Africa, ILCA has been unable to identify technological innovations that bring more than a marginal benefit over the traditional practices. Therefore, the Center decided to concentrate on high potential semi-arid, sub-humid, humid and highland zones, where the chances to achieve substantial increases in food production are greater. The semi-arid zone is considered to have high potential because of recent evidence that moisture is less of a constraint than previously thought, and because it is free of some constraints, notably tse-tse fly, that severely curtail production in other zones. The Center's strategy is to focus its work on smallholders and, to a lesser extent, on agropastoralists.

*WARDA.* WARDA's Medium Term Implementation Plan (1990-1994) placed first priority on the upland/inland swamp continuum found in the forest-savanna transition zone. The Sahel, in which rice is grown exclusively under irrigation and mostly in large governmental development projects, constitutes WARDA's second priority due to human needs and potential impact. Individual holdings are generally small and, in the absence of suitable rice varieties for both the rainy season and the cold dry season, it is difficult to estimate if there is a possibility of influencing the small farmer's apparent choice to grow other profitable cash crops, like vegetables, even with appropriate

rice price or marketing policies. One of WARDA's objectives is to constantly evaluate the competitiveness of new rice technologies in both seasons and compare them with other crop options. WARDA believes that despite the considerable technical potential for expansion of the Sahel's irrigated area, cultivated area will remain limited in the near future due to the high costs of land development following dam construction (Diama and Manantali). But, WARDA considers that with good management in the Sahel (once important water management problems are solved) improved technology for irrigated areas and on-farm research could raise average yields from their current level of 2.8 t/ha to about 3.5 t/ha by the year 2000.

*IARC Strategic and Medium-term Plans.* The existing plans of the Centers located in Africa reveal an emphasis on greater interaction with the NARSs in planning and executing the IARC agendas. In their annual reports, almost all the Centers stressed closer linkages with NARSs through scientific relations with researchers, and collaborative programs. Concerning Africa, the ICRISAT Medium-Term Plan (1989-1993) mentions the establishment of a special fund under the control of the Deputy Director for Africa, aiming to stimulate associative projects involving national scientists in semi-arid Africa, while citing collaborative programs implemented in close cooperation with INRAN [Niger], INERA [Burkina Faso] and INSAH. The IITA Medium-Term Plan also makes collaboration with the NARSs an essential element of its strategy. Two new mechanisms under the responsibility of the Deputy Director for international cooperation are: (a) liaison scientists at the Center's headquarters will study the requirements of the NARSs, linking them with IITA and other sources of technology and ensure that the Center is moving towards a constructive partnership with the NARSs of the region; and (b) a small group of resident scientists will continue a "service" to NARSs which are at insufficient stages of development. WARDA identifies the NARSs as the principal clients of its research, training and communications activities. Its strategy stresses that WARDA has to closely involve the NARSs

from the outset in both the planning and implementation of all its program activities, employing interventions which are appropriate to the NARSs' current capacities.

*NARSs/IARC Interplay: The WARDA Example.* To institutionalize substantive input from the NARSs into WARDA planning, implementation and evaluation, a set of WARDA/NARSs Working Groups has been constituted around WARDA's main activities: varietal improvement research, resource management research, training and communications.<sup>3</sup> These Working Groups - consisting of eleven members each, of which a majority of six are NARSs representatives - are to become WARDA's "think tank", i.e. they advise on activities involving collaboration with and support to NARSs in each of these four thematic areas. Even though the groups do not have the authority to make WARDA policy or commit its resources, the summary reports and recommendations of their meetings will be made available to all WARDA member states and its Board of Trustees, so as to ensure that WARDA management takes them into account in the design, modification and implementation of collaborative program activities. Working Group meetings are co-chaired by the representative of a host country NARSs and the Director of the concerned WARDA Division. NARS representation is proposed to rotate every two years to ensure that over time each NARSs would be systematically represented on each Working Group. Each of the Working Groups has created Task Forces of WARDA and NARSs scientists as the basic units for planning and conducting collaborative work within the regional rice research system. They might be thought of as "mini-networks" that bring together regional scientists working on common research problems in similar rice-growing environments. These networks may evolve into truly regional collaborative research programs based on a distribution of tasks between NARSs. WARDA scientists act as Task Force Coordinators, responsible for coordinating the development of action plans for discussion, modification and consensus endorsement by Task Force participants. The

medium term and long term perspective of CGIAR could dramatically change IARC's mode of operation in Africa and especially in the Sahel if some existing IARCs in this region are reshaped as "Eco-Regional Centers" as endorsed by the CGIAR membership. WARDA's approach towards a true partnership with the NARSs may be the first step in this direction.

#### *Other Regional Research Efforts*

Besides the IARCs, regional collaboration in research involves numerous organizations and networks, of which SAFGRAD and CORAF are the most important. A detailed description of the activities of each one of them would go beyond the purpose of this document. The basic principle of networking, i.e. bringing together a critical mass of scientists around a common objective, is sound. In practice however, since not one of them has a true institutional base of their own, and since their very existence depends entirely on the flow of funding supporting them, a dispersion of efforts has often been the result. More important, however, is their lack of a client base, since it is the scientists amongst themselves who determine research objectives and priorities. Also, their often narrow commodity focus may lead to a disregard for other factors influencing agricultural production. This does not mean that there is no place for networking. On the contrary, networking is a necessary complement of a truly regional research agenda that is client-driven. In other words, there is a dire need to bring about a greater coherence in the large number of disparate research activities being undertaken in the region. Under the proposed Framework for Action (FFA, page 48), worthwhile existing networks would be given a new impetus if organized around lead centers and integrated into an evolving regional research agenda.

#### **Conclusion**

##### *Analysis of the Global Effort*

The national agricultural research system in the Sahel is composed of numerous NARSs,

each with its own mandate and statutes. The Sahelian governments took on - without modifications - the structures, infrastructure, policies and programs of the metropolises. The primary constraint to effective operation is that NARSs are not sufficiently integrated and directed. However, the problem is not only lack of coordination but also that the NARSs fall into the realm of public administration. While these institutions have considerable scientific talent, they lack material and financial support to do research and their relations with the faculties of agronomy are weak. Weak institutional capacity is, therefore, manifested by insufficient financial resources and an absence of a plan for harnessing and developing the human resources that are available in the region. The reforms ongoing and already achieved by several NARSs are not enough. Building on what has been done at national levels, reforms are also needed at levels of regional and international cooperation.

A critical examination of the institutional issues confronting NARSs should be tied to the choice of an agricultural development strategy which research should confront. This choice would determine the mandate, policies and strategies for research. The uncertainty surrounding the role of research in development is illustrated by inappropriate public statutes, their limited dimensions, a personnel management system not well adapted to the research function and by the erratic allocation of resources.

Research now done by the individual NARSs is extremely varied in its performance and relevance. Although the climatological characteristics vary from state to state, the individual research programs do not reflect this diversity. This situation leads to misallocations of resources and insufficient attention to specific challenges. The scepticism that politicians display regarding research can be partially explained by the fact that research policy and programming has not sufficiently taken into account the differing needs of a variety of producers, agro-ecologies and countries of the region. In this regard, the reorganization of the entire research effort in the Sahel - including all actors and activities - is an essential and urgent task.

## *Research Priorities*

The overarching research focus on food crops for resource poor farmers is undeniably the correct one. However, research in general should become more driven by market trends and be more responsive to producer constraints.

*Food crops.* The present focus on *traditional* food crops must continue to have top priority.

*For the Sahelian zone:* Research must focus on security and stability, not on highest yields. Varieties must be selected for their tolerance to drought from the perspective of soil-plant-water relations by adjusting water needs to availability. Since water is the principal factor of production in this zone, interventions must be designed to reduce risks due to insufficient rainfall whilst assuring the food needs of the rural population.

*For the Sudano-Sahelian zone:* Research must focus on varieties which relate water with a yield level compatible with soil conditions. These yield levels must take into account the financial risks faced by producers, their interests and stock of equipment. The objective of research would be to provide the plant material which assures sufficient food and which generates adequate monetary returns.

*For the Sudanian zone:* Research should focus on raising yields through disease resistance breeding and low-cost integrated pest management (experiment with the use of local materials). Socio-economic studies are needed for product and market development and to identify appropriate research interventions at all points and channels of the filière or subsector through which products flow from producers to consumers. These studies should also differentiate among different groups of producers to better target the specific needs of clients.

Agronomic work must be based more on concerns for soil and water conservation, and more generally on the management of the natural resource base. Interventions should be tailored to specific ecological zones. Particular attention should be given to germplasm conservation to prevent depleting the genetic resource

base. More attention needs also to be given to the development and adaptation of farm equipment and onfarm post-harvest technology to improve the efficiency and timeliness of farming operations.

Food processing research, work on utilization and alternative market outlets is needed to ensure that farm products meet changing and growing urban demands. This is of particular importance for the wetter part of the region that could produce surpluses to meet as yet unsatisfied demand.

*Diversification:* An important source of income for producers which should be encouraged in the more humid zones of the region. The objective of research is to develop technological packages for maximum gain. The traditional export crops (cotton and groundnuts) and sorghum could be directed to the Nigerian markets.

*Livestock:* Emphasis should be given to feed and forage crops, particularly for dairy; and to transforming food grains into animal products, thereby diversifying market outlets for potential surplus foodgrain production. Research should focus its attention on integrated livestock-farming systems. In animal health, special attention should be given to diseases affecting small ruminants. Improved husbandry practices should be identified, especially for local breeds.

*Forestry and the environment:* Three directions should be explored: soil and water conservation; management of natural forests; and management of communal forests. Particular attention should be given to the exponential growth in household energy demand (fuel wood). The objective is to restore the ecological equilibrium and define norms for natural resource management. In this context, a holistic approach to soil fertility management and agro-forestry to counter human induced soil degradation should be emphasized.

*Inland and marine fisheries:* Successful marine resources research (page 30) should continue, but more attention should be given to inland fisheries. If well managed, the Senegal,

Niger and Casamance rivers could remain an important source of fish products.

### *Cross-Cutting Constraints*

In the Sahel, a fundamental fact of the agricultural research system, including IARCs and regional networks, is the slow rate of technology generation and its limited impact on economic growth. Overall, the system probably has sufficient human resources (in terms of numbers but less so in terms of skills-mix), at least for now and the medium term. And, the system is correctly focused on food crop research. There is a multiplicity of research units and there is dispersion of effort. However, this is not a cause but a manifestation of the problem. To pinpoint the root causes of the system's problems, it is helpful to look into cases where research has performed well and had impact and to understand the reasons for success. One such case is cotton research; other cases are socioeconomic work on food grain policy and agronomic work on early maturing food grain varieties. A first feature common to these 'successes' is the way research tasks were identified and undertaken. There was a *close working relationship between researchers and users* of the research product and much participation by users in the design and implementation of the research effort. Significantly, in all cases, the user was able to argue for support - and, in the case of cotton, directly provide this support - to the research effort. Thus, a key cross-cutting constraint for most research in the Sahel is *the absence or weakness in researcher liaison functions in ensuring the participation of clients in research design and implementation*. This problem has been recognized for some time and several NARSs have established separate units (farming systems and/or extension liaison) to deal with it. However, effective liaison with research

users can only be assured when researchers themselves take an active part in it. The limited application of the *sub-sector/filiere approach* to other commodities is a second key cross-cutting constraint of the research system in the Sahel. The evolving emphasis on food processing technology, alternative market uses and trade of the more traditional food crops is, therefore, a welcome development. A third key cross-cutting constraint is the *recurrent cost problem*. The contributions of CILSS member states to the research budget are not insignificant. Nevertheless, these contributions barely cover 50 percent of total recurrent costs. Donors must accept the fact that they will have to continue to bear a significant portion of recurrent costs, even as new sources of finance are marshalled from other sources.

### *A Regional Research Strategy*

INSAH's Five Year Plan (1990-94) is an expression of the need to reform the entire agricultural research system in the region. INSAH's program proposes to focus and coordinate the efforts of all actors that should be engaged in research. The program covers priority activities in natural resource management, livestock, food crop, and socioeconomic research. The fundamental idea for implementing the program is for NARSs to become specialized lead and associate centers for priority commodities and research tasks in ways that promote a division of labor and a sharing of responsibilities. Such a new approach in collaboration, based on the relative strengths of all NARSs - large and small - in the region will have significant implications for the new approaches that CILSS, IARCs and donors should bring to bear so that they can become more effective partners and supporters of the research effort in the Sahel.

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## 6: Proposed Framework for Action (FFA)

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### Objectives

To meet the double challenge of agriculture-based sustainable economic growth and halting the rapid degradation of the natural resource base in the Sahel, agricultural research should spearhead the generation of technologies to achieve export growth and food security, provide jobs and facilitate an increase in living standards. To accelerate the current slow development and adoption of agricultural technologies, research would need to be better focused and more efficient in the context of a resource-constrained environment. The proposed FFA to strengthen the national agricultural research systems in the Sahel is designed to meet this double objective and to start lifting the constraints (analyzed in Chapter 5) that have plagued these systems in the past.

Thus, in concrete terms the objectives of the proposed framework for action would be *to increase the productivity and efficiency of the national agricultural research systems in the Sahel through:*

- *A better focus on priority agricultural production constraints that are limiting economic growth.*
- *Harmonizing and rationalizing ongoing and new research activities in a regional context.*
- *Improving research quality and relevance.*
- *Ensuring the sustainability of these systems.*

Perhaps with the exception of cotton, national and international agricultural research in the Sahel has not come up with significant breakthroughs that have had a measurable impact on the agricultural economy of the region. Amongst the many reasons that can be advanced, three substantive ones may be cited:

1. The neglect of economically important or promising sub-sectors (filières), such as:

dairying, small ruminants, forestry (fuel-wood) and fruits and vegetables;

2. Within the various sub-sectors (filières), supply-driven over-concentration on crop and animal improvement and animal health, at the expense of other equally important elements of the total production system from producer to consumer such as the reduction of production costs (competitiveness), farming sustainability (production factors: water, land and labor), alternative uses of agricultural products, market opportunities, etc.; and

3. Insufficient attention to environmentally sustainable agricultural practices and considerations.

To make existing research more productive and efficient, the emphasis should be on concentrating and consolidating efforts in a regional context, as each NARSs in the region does not individually have the capacity to respond to all the agricultural development challenges and opportunities. Such concentration and consolidation of efforts can only be accomplished successfully in a stable and sustainable institutional environment, enabling client or market-driven quality research, i.e. in which scientists and research systems are held *accountable* for research goals and quality. Since they cannot be held accountable for "results of the unknown", their performance can only be measured by the relevance of research objectives and the quality and efficiency of program implementation.

Regional pooling of research capacity to improve research efficiency will remain merely a good idea if it cannot be implemented by well-managed and adequately-funded national agricultural research systems. Moreover, national systems (small and large alike) will not be in a position to reap the full benefits of regional and international research, if they cannot provide the enabling institutional

environment called for (page 34). The proposed FFA would therefore have a three-pronged approach:

1. The institutional reform of the national agricultural research systems, to make them *accountable* for being responsive to: (a) priority economic development constraints, and (b) significant production constraints of the agricultural research clientele (farmers); and *sustainable* to ensure the continued availability of necessary quality services for the implementation of national and regional collaborative research programs and networks;
2. The gradual establishment of regionally consolidated, multi-disciplinary, collaborative research programs (research poles): (a) with a sub-sector (filière) approach for food grains and export crops, fruits and vegetables, livestock, small ruminants, dairying, fisheries, genetic resources management, natural resources management (also including the study of soil-plant-water relations, fuel wood production, forestry and agro-forestry), and integrated pest management; (b) addressing identified pervasive common production constraints, such as *Striga*, requiring a concentrated effort to solve; or (c) investigating promising new research avenues, such as genetic manipulation (biotechnology), that are at present beyond the scope of individual NARSs; and
3. Improving the relevance and quality of agricultural research through the implementation of a number of cross-cutting actions in the areas of: human capacity-building, agricultural research policy analysis and development, and the strengthening of the regional institutional framework.

### **Institutional Reforms of NARSs**

#### *Creating the Institutional Enabling Environment Criteria for NARSs Reform*

The purpose of the FFA is *not* to provide a recipe for the reform of each national agricultural research system individually, but rather to propose and agree on the criteria for such a reform, and subsequently to set a process in motion through which each NARSs

could meet these criteria within a national context. In other words there is no single model. On the contrary, a *pluralistic approach* should leave room for institutional creativity, and include the tapping of underutilized research potential in agricultural education institutions, with NGOs and elsewhere.

The following criteria are proposed for the improvement of the institutional environment:

- Having a system in place that ensures: (a) adherence to research priorities meeting national requirements, coordinated in a regional context, and (b) holding individual researchers (or groups of scientists) and the system as a whole accountable for responding to significant client production constraints.
- Personnel management procedures aimed at retaining a motivated corps of national scientists.
- Inter-annual stability and timeliness of government and donor budgetary support.
- Management autonomy, transparency and accountability.

In several cases, these criteria may be difficult (if not impossible) to fulfill in a public administration or para-public environment. The drastic reforms called for under the FFA may ultimately lead to a "de-bureaucratization" of the national systems, i.e. transforming them into independently managed autonomous legal entities (foundations, associations, private institutions, or other legally admissible configurations).

*Setting National Priorities in a Regional Context.* To respond to the challenges spelled out in Chapter 5, i.e. the reorientations between sub-sectors and within sub-sectors, combined with the greater attention to be given to natural resource management (i.e. sustainability), the NARSs should strengthen their *economic analytical capability* to ensure the continuous adjustment of national research strategies to the dynamics of a changing economic environment. Thus, the function of such an economic analytical capability would be to:

- Ensure continued research focus on priority economic development challenges.

- Clarify the importance of priority research objectives for consideration by decision-makers.
- Put into perspective the dependence of the adoption of research results on the prevailing economic and monetary policy environment.

This does not mean that each NARSs would have to create its own analytical unit or section, if they do not have one yet. In some cases it may simply be a question of identifying where the capability exists (ministries, research institutes, faculties of agriculture, etc.) and assuring its collaboration in a structured manner. Only in a few instances may such a capability need to be created (recruited).

Simultaneously, long-term *national agricultural research plans and strategies* should be conceptualized and/or adjusted, not only to take account of the new regional dimension (taking into account the research activities of other NARSs in the region), but also to better reflect national agricultural development trends, opportunities and objectives (such as: improving competitiveness, regaining lost markets and capitalizing on new market opportunities). This in turn will have implications for the organizational structure, management, programming, budgeting and funding arrangements for the individual NARSs. To be credible for decision makers, national plans would not only have to show and justify how national priorities would be met in a regional context, but also how priorities that are not of a common regional interest would be adequately dealt with. It is important to underline here that National Agricultural Research Plans are elements of a research management process. These plans need to be flexible and regularly revisited. Their main purpose is to agree between the various actors on a set of priorities and to ascertain commitment for their execution. Such commitment can only be achieved when there is agreement on *key indicators* for impact assessment and measurement of implementation progress.

Improved management of the national systems and increased regional collaboration will require a strong national *research programming, monitoring and evaluation (PME)* capability to measure the progress and impact of implementation. For each NARSs to

play its respective role in the evolving regional research agenda, it is important that its PME system is harmonized across the region and guided by a strengthened INSAH PME capability (page 54). Reinforcing the existing national capabilities, and creating such a capability where it does not exist, should have a high priority under the proposed FFA. It is suggested that this be undertaken in close collaboration with ISNAR and the AGIR Project ("Projet d'Amélioration de la Gestion dans les Instituts de Recherche au Sahel", IDRC/CIDA-funded and implemented by INSAH).

*Generating a Demand (Client-Market)-Driven Research Agenda.* While ultimate users of research results are the farmers, the intermediary agents that are in direct contact with the farmer, the extension services in their various forms, the seed companies, the processors, the producers and suppliers of agricultural inputs, etc. are all stakeholders. The best feedback an agricultural scientist can receive comes from the user of research results. Formal institutional links between research and its users are important, but should not become a substitute for direct contact between the scientist and his or her clientele. Nor should such direct contacts (including on-farm experimentation) be the monopoly of R & D researchers alone. The setting of priorities and strategies is a matter of national research policy, which should be used as a yardstick to decide on the funding of research proposals. When it comes to defining the objectives for individual experiments and trials, it should be in response to identified constraints of the client. Each research proposal should therefore not only provide the traditional analysis of past research results but also *evidence* of its responsiveness to client constraints. In this manner it should be possible to generate a demand-driven research agenda, provided that the research system (and the individual scientist) is held *accountable* for the relevance of its research objectives and the efficiency of its implementation. This implies the introduction of *contractual arrangements* for the execution of research programs, similar to the ones proposed

for the execution of regional collaborative programs (page 52), and having a system in place to monitor such arrangements. Also, research scientists should be allowed sufficient time to interact with their clients, and may in certain cases be released to work as their consultants. Job descriptions for scientists should include necessary linkage and liaison functions. Evaluation and promotion criteria could be developed based on performance in working with clients as much as on the research that has been accomplished. Linkage and liaison functions should be integrated in research methodology training. In certain cases it may even be possible to enable clients to assess the effectiveness of linkage and liaison activities of research programs and researchers.

### *Human Capacity-building*

Regional pooling of research capacity should over time lead to a redistribution of research tasks (specialization) across the various NARSs, taking into account their individual comparative advantages. This should in turn free human and financial resources for priority programs that are presently understaffed, mainly in the areas of natural resources management, soil and water conservation and forestry research, but also for new orientations such as alternative markets (usages) for food crops, animal production systems (dairying and small ruminants), and agro-processing. Both, improvements in the research priority setting process and the pooling of research staff in a regional context, will have important implications for long term human resources development because of the changing skills-mix requirements.

Long-term human resources development objectives can only be established in the context of long-term research strategies (page 44). Therefore, the first step will have to be taken by the NARSs in developing their own plans. The preparation of such plans is a rather tedious process starting with detailed function descriptions in relation to the individual NARSs organizational structure, including a description of responsibilities and accountability (see also page 44). Profiles will need to be prepared,

describing education, training, experience and other specific skills, required to fulfill these functions. Staff will need to be evaluated, followed by a skills-gap analysis through the matching of profiles and evaluations. On the basis of this exercise, function descriptions and in some cases the organization itself or operational procedures will need to be changed so as to adapt these to available staff skills. The end of the exercise would be a training program for existing staff, possibly some dismissals, clear career paths, procedures for growth promotion, including annual evaluation procedures and criteria for all categories of staff, and clear recruitment criteria for new staff. Also, laboratory technicians, tractor drivers, equipment operators and workshop staff will need to be tested to determine on-the-job training needs. In some countries this whole process is already under way with ISNAR providing methodological support. In the light of the new research orientations and the proposed changes in the institutional environment, the process will need to be deepened and expanded to also include institutional reforms required to improve staff motivation and retention. In concrete terms, this implies providing for institutions to have their own statutory personnel policies (hiring, firing and advancement), independent of the civil service.

### *Sustainable Research Funding*

Even though present levels of budgetary support may in general be reasonable in terms of the share of total public expenditures for agriculture, the erosion of such support over the last decade has often led to serious underfunding of the fixed recurrent operating costs and maintenance of research installations, and the continuing devaluation of research staff salary levels in real terms. This in turn has been exacerbated by the lack of transparency and accountability in the budgeting, internal budget control and accounting systems, inherent in public and para-public administration procedures that are not geared towards the administration of multiple sources of funds. For national agricultural research systems to be viable, and to overcome the present *ad hoc*

approach to research funding arrangements will need to be developed that ensure:

- Timely availability of funds (essential to ensure quality agricultural research).
- Flexible management/transparency/accountability.
- Sustainability of the national agricultural research systems.

These goals cannot be achieved if donors and governments alike are unwilling to consider alternative modes of funding, combined with institutional adjustments to manage financial resources. For the majority of the NARSs in the Sahel it is not only a question of sustainability and regularity of funding from domestic resources, but also one of *sustainability of external funding*. Thus, the need to develop alternative funding mechanisms.

#### *Consolidated Funding Mechanisms (CFMs)*

The objective of a Consolidated Funding Mechanism is to provide for the adequate, stable and sustainable funding of priority agricultural research activities that are responsive to national and regional development challenges and the constraints of the users of research results. To reach this objective it is imperative that a CFM provides national authorities with an instrument to effectively coordinate donor-funded research activities. A CFM is an instrument to pool efforts on an agreed and consolidated priority program by making sure that such efforts are adequately funded in a timely fashion. This does not exclude the actual pooling of funds (an account of co-mingled donor and government funds), should this be desirable, but it is not a condition *sine qua non*. Rather, the introduction of CFMs can only be successful if governments and donors have confidence in the review and decision making process.

*Operational Considerations for CFM Management.* Governments would need to establish (and institutionalize) a council, board or committee of all funding agencies and users of research results that will decide annually on

which research programs are to be funded and how. The council, board or committee should be chaired by a high-level civil servant ("Secrétaire Général" or "Directeur de Cabinet" or Under-Secretary) of the line ministry responsible for agricultural research policy. The council, board or committee should also include a high-level (Director) representative of each of the ministries of finance and plan (or economic affairs). The council or committee should have powers of decision-making with respect to the funding of agricultural research clearly spelled out in its statutes and acceptable to all parties. The basis for the council or committee's functioning would be an endorsement of:

- The adequacy of the *independent* internal and external scientific and technical research program review process in place or to be proposed.
- The suitability of the management instruments available to individual research institutions to be funded through the CFM.

*Operational Implications for NARSs/ Institution Management.* Institutions that are to be funded through a CFM should have *in place* and acceptable to the council or committee, the following management instruments:

1. A consolidated<sup>4</sup> research programming, monitoring and evaluation system.
2. An autonomous personnel management system.
3. An "auditable" and consolidated budgeting, internal budget control and accounting system.

The statutes of the individual research institutions that are to receive funding through the CFM should provide for *independent* and timely annual accounting and management audits, and also spell out the review and decision making process.

*Budgeting and Accounting Procedures.* For a research institution to become eligible for funding through a CFM, it should have *in place* a budgeting and accounting system that allows for the tracing of expenditures by source of funds. The system should also allow for

budgeting and the recording of expenditures by research program (and/or contract) and by location. Distinctions should be made between direct-indirect and fixed-variable costs and the terms clearly defined (e.g. maintenance of buildings and grounds as a fixed indirect cost, general overhead as a variable indirect cost). Fundamental to the design and the successful introduction of such systems is a clear allocation of responsibilities (accountability) for spending within budgetary limits, and flexibility in budget execution (i.e. regular budget reviews throughout the year). This may require in certain institutions a decentralization of responsibilities and, as a consequence, adaptations in organizational structure and management (task descriptions and definition of responsibilities based on the principle of accountability). The requirements for such a process to function in a flexible manner will include a well-designed internal budget control system, combined with a management information system, which in turn is linked with a consolidated research programming, monitoring and evaluation system.

*Funding Mechanisms.* The terminology of 'restricted and unrestricted base program' and 'special program' funding is used here to define possible future funding mechanisms. The following distinctions are suggested:

1. The *base program* of a research institution consists of essential and consolidated priority research programs, consistent with an agreed long term-national agricultural research strategy (master plan), and includes all the fixed and variable, direct and indirect costs related to such programs.
2. *Unrestricted base program funding* relates to funds that are generally managed by the research institution and that are *not earmarked* for specific base programs or purposes. In general, all government funds are available for such purposes. Under certain conditions, a limited number of donors may make funds available for unrestricted base program funding, provided a transparent accounting system allows the funds to be traced, and management provisions include an independent annual audit

to certify that the funds were used for their intended (agreed base program) purpose.

3. *Restricted base program funding* relates to funds that are *earmarked* and *only* available for specific programs or purposes within the overall base program. In the future, the requirements for a research institution - rather than the funding agency - to manage such funds will include a transparent accounting system allowing the funds to be traced, backed-up by an independent audit to certify that the funds were used for their intended (restricted) purpose.

4. *Special program funding* relates to the funding of all *research contracts* both *inside and outside* the base program, that are *eligible* for government funding (whether the government actually supports such contracts or not) and thus CFM scrutiny. This would specifically exclude those research programs undertaken by non-governmental private institutions, NGOs and foundations that are *not eligible* for government support and thus CFM scrutiny.<sup>5</sup> As a matter of principle, research contracts should always include funding for a reasonable and 'auditable' share of the fixed and variable indirect overhead and operating costs (including maintenance) of a research institution. The management of funds provided for research contracts should meet the same criteria as those that are applied to base program funding.

5. A *balancing mechanism* is often required to meet the shortfall in the funding of the base program. In principle, governments should be responsible for the provision of balancing funds. The need for balancing funds can be minimized in several ways:

- (a) Expanding the practice of research contracting whereby the funding of indirect overhead and operating costs should not be negotiable.
- (b) Negotiating with funding agencies to increase their participation in non-restricted base program funding at the expense of restricted base program.
- (c) Including the funding of indirect overhead and operating costs as an integral part of the restricted base program funding.

(d) Where appropriate and in particular for export crops, the levying of cesses (not taxes) by the industry (e.g. cotton), to fund research contracts.

The proposed funding mechanisms are based on the principle that funds would flow *directly* from funding agencies and government to beneficiary institutions within the NARSs, subject only to reviews by the CFM process.

*Research Contracting* has a number of advantages. The most important one is that funding is assured for the duration (several years) of the contract. Also, once the contract is completed there are in principle no remaining recurrent expenditures that go unfunded. However, this is only true when staff is employed and funded for the duration of the contract. For an institution, employing a certain percentage of its staff under contract has the advantage that it avoids overstaffing during periods of budget constraints and allows for flexible personnel management. For contract staff it has the advantage of higher incentive pay. It is suggested here that permanent staff working under contract, be removed from the payroll for the duration of the contract, so that they can receive the same incentives. Such a system only works if new staff are in principle recruited only under contract—"tenuring" i.e. the passage from contractual to permanent is only possible after say six to eight years, and clear criteria are established for obtaining tenure.

So far only a system of '*contracting-in*' has been discussed, i.e. a national institution contracts for the implementation of a research program (e.g. cotton research or a regional research program). A CFM may also open the possibility for '*contracting-out*', i.e. for research to be undertaken by institutions elsewhere in the region or outside (e.g. IARCs), in cases where the capacity of the NARSs does not suffice and a high priority constraint needs to be addressed. Providing funding for a regional program undertaken in another country is another possible example of '*contracting-out*'.

*Possible Institutional Implications.* The introduction of a CFM should put into place the

necessary conditions for an enabling environment for creativity and innovation, based on transparency and accountability. There are two possible consequences. First, those *internal* to the organization of participating institutions, occasioned by the introduction of reliable, transparent and consolidated budgeting and accounting procedures (page 46). Second, those that relate to the formal statutes of the institutions concerned, which, if appropriately modified, would give the public sector elements of the NARSs the *autonomy* they need to become a productive research system, accountable to clients and results. Without these fundamental changes, it is unlikely that regional research programs can successfully be implemented by participating NARSs.

If well managed and independently audited, the proposed system should provide a sufficient guarantee for donors to discontinue the widespread practice of providing funds through independently managed 'enclave' projects within (or sometimes outside) existing institutions. Instead, donors would, through their bilateral and regional, project and non-project assistance, be requested by governments to channel funds through a CFM for research operating expenditures earmarked for programs they wish to support.

*Evolution of National/Regional Agricultural Research Institutions.* Successful and efficient institutions are like living organisms continuously adapting and responding to a changing environment. The frequency of successive institutional modifications is often greater in a growing than in a stagnating or declining economy. In the latter case, institutional modifications are often unexpected and abrupt, even disruptive in the face of severe budget cuts. If one foresees, however, an economic growth scenario for the Sahel, one could expect responsive agricultural research institutions to change almost naturally with a changing economic environment. In deciding on reforms, a vision of possible future developments may help in guiding the decision making process. What possible future institutional developments could be envisaged under an economic growth scenario? First, in the short run one could

expect governments to continue to strongly support agricultural research in recognition of its importance for agriculture based economic growth through increased budget outlays in line with the importance of the agricultural sector for the economy. Government funded research would continue to cater to the immediate needs of resource poor farmers. Second, over the medium term, one could expect certain research clients (common interest groups) to demand more from research than government could be reasonably expected to deliver. At that moment, one could anticipate the emergence of foundation type national or regional organizations with strong constituencies and only partly funded by government. Possible examples are cotton, poultry and dairy research. Third, over the long term and with continued economic growth, one could foresee the emergence of entirely private research undertaken by seed, fertilizer and chemical companies. Under such a scenario, sustained economic growth would almost automatically lead to more *institutional pluralism* and specialization. When deciding on NARSs reforms, it is important to take such possible future scenarios into account to avoid making the wrong decisions that could inhibit the future healthy development of agricultural research in the Sahel.

*Timetable.* Successful implementation of the institutional reforms contemplated in the preceding paragraphs is the most important challenge of the proposed FFA. Even though several NARSs have already made important advances in preparing and implementing reforms, others have yet to start. Following formal endorsement of the proposed FFA by policy-makers and the donor community, the whole process may still take up to five years to complete. INSAH (page 54) together with ISNAR is expected to provide methodological support, mainly in the areas of national research strategy formulation; harmonizing and strengthening research programming, monitoring and evaluation; and human resources development. Specific specialist support may be required to prepare the introduction of CFMs, required complementary changes in budgeting and

accounting procedures, and related statutory reforms.

## **New Modes of Regional Collaboration**

### *Objectives*

Regional collaboration will seek to reinforce the reform efforts of NARSs, to exploit the "economies" of improved NARSs management systems and to focus the resources of the region in ways that significantly raises the 'likelihood' of technology generation. To this end, new forms of regional collaboration are expected to evolve as NARSs reform and consolidate their resources. The idea is thus to further tease out and exploit the relative strengths of NARSs. The following paragraphs are based on the recommendations of the meeting of the Directors and their close associates (deputy, scientific Director or head of department) from the national agricultural research institutes of the CILSS countries, which took place in Ouagadougou from 22-26 July, 1991.<sup>6</sup> The purpose of the meeting was:

1. To validate the draft FFA for the CILSS countries.
2. To discuss the implications of the decisions of the May 1991, SPAAR Plenary in Abidjan.
3. To decide on selection criteria and priority themes for regional collaboration and responsibilities (regional research poles).
4. To discuss and agree on a strategy for the implementation of national Consolidated Funding Mechanisms.
5. To develop an action plan (next steps) for the implementation of the FFA.

### *Regional Research Poles*

Collaborative programs which strengthen NARSs in research areas that they are best positioned to exploit relative to others in the region are called regional research poles (lead national centers). Various types of collaborative programs are foreseen, ranging from a critical mass of multi-disciplinary scientists working together as a team on one or several lead

research stations on an entire sub-sector (commodity or filière), to a team working in preferably one location on a single pervasive and common production constraint, such as *Striga*. New research avenues, such as genetic manipulation, that are at present beyond the scope of individual NARSs, could be tackled in a similar manner. In other words, the new approach should allow for substantial flexibility and pragmatism in its application and is based on scientific teamwork. Collaborative programs are not a substitute for more traditional forms of networking. They go beyond networking in that they provide an institutional framework for concentrating the best available scientific resources in the region and are based on a convergence of national interests into a *common regional research agenda*. Regional collaborative programs so defined are implemented within the confines of an individual NARSs. Their effectiveness will depend to a large extent on being supported by a regional network, to which they should provide intellectual leadership. A traditional network can be successful without a research pole, but a lead center without a well organized network has little basis for existence. In certain cases, such networks may benefit from extending beyond the confines of the region. This underlines the importance of carefully 'dove-tailing' the establishment of regional research poles with existing or future CORAF, SAFGRAD and IARC networks, while simultaneously trying to eliminate overlapping and conflicting interests. To accomplish this, NARSs could be provided funds to contract for IARC and other networking activities.

Regional collaborative programs are characterized by a number of common features: (a) a common or single research objective or thrust; (b) accountability for research goals and the quality and efficiency of program implementation; (c) a single financial management system through the 'earmarking and targeting' of financial resources for each program separately through the proposed Consolidated Funding Mechanisms; (d) a certain degree of operational autonomy within individual NARSs, and (e) the existence of a well-organized regional network. The success of regional

research poles will to a large extent depend on the successful implementation of the NARSs reforms described in previous paragraphs. Certain regional programs may even in the medium or long term evolve towards becoming autonomous institutions or foundations with their own constituents and resources. Where such a constituency will not evolve in the short to medium term (the case of research work for resource poor farmers and areas) governments will need to continue their support, but not necessarily through one single institution (page 48).

### *Selection Criteria*

One or several NARSs could be selected to host a collaborative program, on the basis of the following criteria recommended by the Ouagadougou Meeting:

1. Having prepared medium - and long-term national agricultural research strategies (master plans), which should define both research priorities and necessary institutional reforms that would give implementing research institutions adequate financial and administrative autonomy; thus, a collaborative program should respond to an important national priority (i.e. coincide with a significant program already undertaken in the country).
2. Having available a critical mass of experienced and qualified researchers that can provide the requisite scientific leadership in a regional context.
3. Being in a position to recruit and manage top quality scientists within a framework of regional collaboration.
4. Having available adequate research installations (stations, laboratories and equipment) and research support services to host a regional collaborative program, or having the means and capacity to develop such installations in cases where they are inadequate.
5. Having already implemented or having the capacity to implement common interest research programs, i.e. having in place adequate administrative and accounting procedures to administer the program.

6. Present agro-ecological conditions that suit the pursuit of one or several collaborative research themes.

In short, adherence to these criteria should lead to the gradual transformation of a limited number of selected ongoing national programs into regional collaborative programs. Over time, this should lead to a truly regional research agenda, based on voluntary collaboration and the sharing of responsibilities between independent and autonomous national institutions, whereby INSAH would provide services for coordination and scientific oversight under the political umbrella of the CILSS Council of Ministers.

#### *Dovetailing with the Evolving CGIAR Strategy*

A regional research agenda serving region-specific needs consists of the combined efforts of all the actors, i.e. the NARSs, INSAH, the IARCs and the various networks active in the region (CORAF, SAFGRAD, etc.). The new regional collaborative programs should seek an integration of ongoing or planned research activities with a similar thrust. This could take various forms, depending on the comparative advantage of the scientific partners concerned. In the case of the IARCs active in the region, collaboration could vary from simple back-stopping of a regional program, to the out-posting of IARC scientists, to an IARC being invited to initially take the lead in setting up and/or managing a program. The important underlying principles should remain that: (a) research objectives respond to specific research needs of the region, and (b) regional collaborative programs are executed by selected NARSs on existing research installations. The key to collaboration with IARCs and other international, regional and national institutions is their willingness to subscribe to the regional research agenda and priorities while maintaining their scientific and operational integrity.

#### *Regional Research Programs*

Based on the agricultural research strategies of each NARSs, the Ouagadougou Meeting identified the following priority research

domains as coinciding with national priorities, which should become subject for regional collaboration over time.

- *National Resource Management and Conservation*, including:

- (a) soil and water conservation (including soil fertility regeneration);
- (b) management, regeneration and conservation of natural landscapes (including natural forests); and
- (c) methodology development for communal management of natural resources.

- *Food Production Improvement and Stabilization*, including:

- (a) integrated pest management;
- (b) post-harvest technology and processing;
- (c) crop diversification;
- (d) animal nutrition;
- (e) small ruminants, and
- (f) processing of animal products;

- *Strategic research*, including:

- (a) collection, evaluation, characterization and conservation of genetic resources; and
- (b) biotechnology development.

- *Research Support Themes or Activities*, including:

- (a) agricultural policy research, both at the national and regional level, to guide, justify and adapt research objectives to a continuously changing economic environment;
- (b) scientific and technical documentation and information development.

Within these broad domains, a number of specific research themes were identified for immediate regional collaboration, including a distribution between countries, as follows:

1. Burkina Faso, Mali, and Senegal would each be responsible for components of a regional natural resources conservation and management research program, including:

- (a) developing indicators to characterize soil fertility,
- (b) optimizing plant water-use and run-off management,
- (c) biological nitrogen fixation,
- (d) developing degraded soil regeneration technologies, and
- (e) developing methodologies for communal land management.

2. The following countries would be responsible for genetic resources conservation and development, and host regional commodity research poles:

- (a) Burkina Faso for maize;
- (b) Mali for sorghum;
- (c) Niger for millet and cowpeas; and
- (d) Senegal for groundnuts.

3. Senegal's national livestock research laboratory was selected as the lead laboratory to host a regional small ruminant production and health research program, with components to be executed by the laboratories of Chad, Mali, and Niger.

#### *Recruitment and Oversight*

Starting with a nucleus of national scientists, recruitment should be open to CILSS member country nationals with the required profile (i.e. no administrative appointments). If the required profiles (skills-mix) cannot be found within the region, recruitment could be open to international scientists. This would also open the possibilities for twinning arrangements with foreign research institutions and universities, and the IARCs, providing for desired international collaboration. Research proposals should be considered for funding on the basis of: (a) a thorough analysis of the state of the art in terms of past research results; (b) evidence of responsiveness to significant production constraints of identified research clientele; (c) responsiveness to important priority challenges for agricultural development (i.e. anticipated economic impact); and (d) expected time required to achieve tangible results. It is proposed that scientists participating in colla-

borative programs should, for the duration of the program, work under contract according to existing CILSS regulations. Moreover, each regional collaborative program should have - in addition to the institutional review mechanisms of the NARSs concerned - its own independent scientific oversight committee, that would report on research quality, relevance and achievement of research objectives. These committees would be selected by INSAH in consultation with the program sponsor(s) and the host NARS(s). The Ouagadougou Meeting recommended the enhancement of the credibility of the external review process and to ensure its independence by inviting independent scientists of international repute to participate. External review committees would operate under the auspices of INSAH's Regional Agricultural Research Committee (CRR) according to its mandate as defined in INSAH's statutes. Operational oversight at the national level should be assured by the proposed CFM procedures (page 46) and independent financial and management audits as part of a NARSs audit. Such arrangements should be clearly spelled out and identified during the program design stage.

#### *Management System*

For day-to-day management, it is proposed that regional research pole leaders respond directly to the Director General of the host NARSs institution or his/her representative (scientific Director or department chief). Operationally, the regional collaborative programs are thus fully integrated in the host NARSs. The Ouagadougou Meeting proposes the development of a Regional Charter (Memorandum of Regional Collaboration) to be adopted by the CILSS Council of Ministers - that would contain 'rules of conduct' among collaborating parties (CILSS, INSAH and the NARSs) for the implementation of regional collaborative research programs (and regional poles). Individual regional programs would be executed by the NARSs under time-bound tripartite research contracts between CILSS member states (to ensure regional political support), the Institut du Sahel (to monitor regional program

progress and provide scientific oversight) and the national research institution concerned (as the executing or participating agency), and framed within the context of the Regional Charter. These contracts would also contain agreements regarding staff remuneration and status. It should be clear that a regional program or component thereof can only be successfully implemented by an executing or participating agency if such an agency has a transparent and "auditable" budgeting and accounting system. This implies certain similarities in the budgeting and accounting procedures amongst institutions participating in regional programs.

#### *Program Funding Arrangements and Donor Involvement*

Regional collaborative programs are proposed to have specific time-bound objectives clearly spelled out in the research contracts. These programs should be considered as an integral part of an institution's 'base program', eligible for "special program funding" (page 47). The programs can be sponsored by one or more donors together with the CILSS member country concerned, within the context of a CFM. The budget of a regional program should include all direct research operating expenditures and a realistic share of the fixed costs, services and overheads incurred by the host NARSs institution. The participation of CILSS member countries should be agreed to in the contract and could consist of salaries of national scientists participating in the program and the shortfall in its funding (page 47, "balancing mechanism"). The Ouagadougou Meeting agreed that regional contracts should include, as a matter of principle, funding of budget line items for external program reviews and INSAH services, in accordance with criteria and procedures to be spelled out in the Regional Charter. In many cases there will already exist one or more bilateral donor agreements for the same program in a given national context. It is therefore important to involve the donor(s) and possible scientific sponsors from the early stages of program design onwards.

#### *Timetable*

It is anticipated that some regional collaborative programs will start well before the NARSs reforms are completed, especially if these programs can be designed to move the reform process along. In cases where the comparative advantages of centers are clear or where networks have already evolved a critical mass on priority commodities and/or issues, regional poles can be established shortly after a consensus has been reached at technical levels. To this end, INSAH is preparing an implementation schedule for the establishment of regional poles. This implementation schedule will be presented to the CILSS Council of Ministers for approval.

This would then represent the go-ahead for the design teams to start preparing funding proposals for selected priority programs. These design teams are proposed to comprise the nucleus of scientists in the host NARSs institution (page 52), reinforced with some selected experienced outside scientists and, when appropriate, interested donor representatives. It would be important at this stage to continue and extend collaborative ties with other scientists in the region, with selected scientists from existing networks (SAFGRAD and CORAF), with the IARCs, and with institutions that are possible candidates for twinning arrangements (or are already in that position). Such ties could be fostered through the organization of one or two design workshops for each selected collaborative program.

#### **Complementary and Cross-Cutting Proposals for FFA Implementation**

##### *The Role of the Institut du Sahel*

INSAH will have major responsibility in orchestrating the various actors and actions called for under the FFA. INSAH's role is to facilitate and help bring about the needed collaboration amongst CILSS member states, NARSs, donors and IARCs. Specifically, INSAH will:

1. Guide NARSs through their reforms and provide a forum for national scientists so that they can present their views on priority setting, on the unfolding national and regional research agenda and on the mechanisms (NARSs institutional reforms and regional poles) through which it can be put into effect.

2. Broaden the client base for research, monitor the performance and impact of regional poles; share in the analytical work needed to track new market opportunities and macro-economic policies to inform the unfolding regional research agenda; and, maintain an information system on the regional research effort.

3. Define and implement a human resource strategy for the region which assures an increasing flow of indigenous resources needed to sustain the technology generation system, including the faculties of agronomy.

To accomplish these tasks INSAH proposes to create a Policy Analysis and Research Development Unit. The proposed mandate of such a unit would include:

- Macroeconomic and environmental analyses to develop proposals for regional and national research priorities to be validated by the NARSs.
- Prospective studies and surveys to indicate new market opportunities for Sahelian agriculture and to draw implications for research, e.g. new products, processes, technology development and transfer.
- Limited socio-economic research on issues related to rates of return to agricultural research, marketing of research results and diffusion, and broadening the client base, including models for private sector participation.

To coordinate the implementation of regional collaborative research programs, INSAH proposes to expand its Programming, Monitoring and Evaluation (PME) capability, in terms of : (a) analyzing the economic impact of technology generation and transfer; (b) identifying institutional bottlenecks and policy constraints for the creation and implementation of regional research poles; and (c) resolving

NARSs organizational, management and operational issues. An important first step in this process would be for INSAH to advise the NARSs on the improvement and harmonization (methodology and software) of their own PME systems, without which it will be difficult for INSAH to play its coordinating role. The better these mechanisms function, so much the better will INSAH be in a position to provide a forum (not an extra-institutional layer) for coordinated interplay between the various actors concerned with the evolving regional research agenda. The constitution of a PME unit will be an essential first step for INSAH as a necessary tool to coordinate the regional research programs and organize the external program reviews.

*Regional Research Data Bank.* The quality and relevance of the regional economic analysis and PME functions should be anchored in a solid, up-to-date and accessible regional research data base. Establishing such a data base would be one of the essential components of the proposed FFA. However, a regional data base would be only as good as the elements provided by the NARSs, and so the necessity to strengthen (or create) NARSs individual data banks. A systematic record of past and current (including not yet analyzed raw data) research results would be the foundation of the national and regional research data banks. A persistent problem is access by scientists to past research. It is therefore proposed to include under the FFA a systematic inventory of available published and non-published ("grey literature") research by experienced national researchers. Judgments will need to be made on what part of the material will have to be transferred (CD-ROM or other) to make it more readily accessible at regional and national levels. This also implies a judgement on the quality and relevance of past research. The inventory would eventually be published and made available to all researchers in the region. Presently ongoing efforts in France to review past research results relevant to the Sahel in the light of more recent findings, should be incorporated in this more far reaching proposal to actually transfer most of the relevant material and make it accessible to scientists in its original form.

*Communications.* Many of the problems that continue to haunt agricultural research can be traced to a lack of adequate communication links. Research results are often only communicated once they are published. For research scientists it is often more important to be in instant contact with colleagues working on the same problem during the course of a research program. At present, their only contacts occur when they actually meet each other during conferences or workshops. This is however an insufficient substitute for direct communication on specific subjects. Similarly, most scientists in the region lack easy access to data banks and libraries, making it difficult to remain up-to-date on the state of the art in their respective fields. The proposed establishment of national and regional data banks could become useful tools if they are complemented by efficient modern communication links, both within countries and among countries within the region. It is therefore proposed to include improvements in communication links (facsimile services, modems and possibly satellite hook-ups) as an important component under the FFA.

#### *Human Capacity-building*

*Regional Consolidation of National Human Resources Development Plans.* Some countries in the region are in the process of or have just completed long-term human resources development plans based on their national research strategies. The majority of the Sahelian countries still have to develop such plans. The new approach to rationalized research and the use of human resources through regional collaborative programs and networks will inevitably lead to research staff requirements - in terms of quantity, quality and skills mix - that are different from the simple summing up of current individual NARSs requirements. If coordinated regional research is to be successful, national human resources development plans will need to be consolidated and adjusted to redefined requirements in a regional context.

*The Long-Term Strategy for Regional Agricultural Education and Training.* In terms of relevance and coordinated action, the agricultural education institutions in the region are a weak link in the education and training-research-diffusion triangle. There is however a growing realization that these institutions harbor considerable underutilized research potential. Putting this potential to use as an integral part of the national agricultural research systems would be one of the objectives for the preparation of a long-term strategy for regional agricultural education and training. A second no less important objective would be to improve the relevance of these institutions by making them more responsive to agricultural sector requirements, and by improving coordination and exchange (cross-fertilization) within the region and beyond, between educational institutions, and within the "triangle".

INSAH's mandate provides for it to play a role in coordinating regional education and training. Therefore, it intends to bring together the agricultural education and training institutions to draw up terms of reference for the development of a regional strategy, including arrangements for oversight (steering committee) and decision-making (policymakers). To avoid "educators" developing their strategy in isolation, representatives of the other two sides of the "triangle" should be included in the process. Attention should further be given to collaboration with faculties of agriculture outside the region and international collaboration (twinning arrangements, etc.). A small fund should be made available to attract some high level outside advice.

*Research Station Management Training.* The sound management of financially sustainable research station operations is a prerequisite for the efficient implementation of collaborative regional research programs. The most important function of a research station manager is to provide the best possible physical support services to realize the full production potential of the highly qualified scientists working at the

station. This function becomes even more important for coordinated multi-disciplinary and multi-sectoral research that is highly field oriented. Research station management exists primarily to serve the needs of the research staff. Its responsibilities include: maintenance of buildings and grounds; vehicle, tractor and equipment maintenance and repair; operation of the station's vehicle and tractor pool; soil preparation; cultural care; assistance in planting and harvesting experimental plots; the care of animals; seed and feed production; and other service duties.

Many of the problems concerning the quality of on-station research are related to inadequacies in station management. The number of research stations in the region provides a sufficient critical mass of station management staff to establish a regional training facility. It is suggested that one existing station be designated as a management training center. In this manner such a center could be set up with minimal costs, using existing facilities. Also, one should avoid permanently staffing the selected center with specialized trainers, but rather use existing station staff as trainers, complemented by outside consultants for the duration of a course. Since it would probably not be used full-time for station management training alone, consideration should be given to possibly developing it into a regional conference center for networking, training, etc.

*Timetable.* To accomplish these tasks, INSAH will hire additional staff: one senior economist to start-up the Policy Analysis and Research Development Unit; one senior research coordinator who would have responsibility for coordinating the design, monitoring and evaluation of regional collaborative programs, and INSAH would have recourse to short term consultants. INSAH also intends to seek an arrangement with ISNAR for methodological support in designing its research PME system, in providing support for NARSs reform, and to assist in the regional consolidation of national human resources development plans. For the research station management training component it is suggested that INSAH seek the assistance of specialized institutions (CIMMYT, University of Arkansas, etc.). Similarly, INSAH may wish to seek a collaborative arrangement with IFPRI to develop its Policy Analysis and Research Development Unit. It is recommended that these resources be made available to INSAH shortly after the FFA is validated. As to the timing of the various actions to be coordinated by INSAH, experience has shown that completing a research inventory and simultaneously setting-up national and regional research data banks may take anywhere from between three to five years. Preparing a long term regional strategy for agricultural education and training, may take two to three years, including the time needed to build political support.

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## ***7: Modalities for Implementation of the Proposed Framework for Action***

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### **Introduction**

The preparation of the proposed Framework for Action has been a collaborative undertaking by INSAH and SPAAR staff, based on preliminary recommendations and suggestions provided by the NARSs Directors and the Deans of Faculties of Agriculture during their January 1991 workshop in Bamako. Following the May 1991 SPAAR Plenary in Abidjan, where the proposed FFA was approved in substance, the July 1991 Ouagadougou Meeting (page 49) provided its technical validation. Subsequently, the document was revised, taking into account the comments received to date, and expanded to reflect the decisions made at the Ouagadougou Meeting. Next, a process of validation was initiated, within the countries at the level of technical ministries and at the level of ministries of finance and plan, and at the regional level by the CILSS Council of Ministers. Formal endorsement by the SPAAR membership was sought and obtained during their December, 1991 Plenary. In April, 1992, the CILSS Council of Ministers formally endorsed the FFA recommendations. Also, the United States Agency for International Development (USAID) has designed a long-term support program to strengthen INSAH's capabilities in three broad subject areas: agricultural research, food security and natural resources management. This arrangement would provide INSAH with the resources necessary to coordinate the start-up of the regional collaborative research programs and to set up mechanisms to monitor, evaluate and disseminate research results. INSAH has also initiated discussions with ISNAR to see how the two institutions could collaborate in providing institutional support to the NARSs of the CILSS countries.

This process of obtaining political commitment for the FFA in the countries concerned,

together with soliciting a similar commitment from the donor community, may change a number of the guidelines of the FFA as now presented. Therefore, the following paragraphs, detailing proposals for implementation under the FFA, should be considered as tentative.

### **Proposed Implementation Schedule**

#### ***NARSs Reform***

Formal adoption and endorsement of the FFA should signal the start-up of a series of activities, some of which can go on in parallel, while others should be carefully sequenced. Implementation of institutional reforms of the NARSs is country-specific, each of the NARSs being at a different stage of development (see Annexes). However, in almost all cases these reforms will hinge on designing and formalizing the necessary statutory changes and the introduction of Consolidated Financing Mechanisms. Second, in the light of the newly proposed research orientations, management systems and national research and human resources development strategies will need to be adapted to each other in a regional context, so that each NARSs can play its role and reap the benefits of the evolving regional research agenda. It is therefore proposed that INSAH organizes in consultation with the NARSs Directors three working groups of NARSs staff for each of the following domains:

- National agricultural research and human resources development strategies.
- Agricultural research program management (research programming, monitoring and evaluation) and data bank development.
- Agricultural research resource management (funding mechanisms; budgeting, budget control

and accounting systems; and personnel management systems).

Each of these regional working groups should be presented at the level of individual countries by similar national groups. The national groupings should have the specific mandate to prepare and guide the reform process and the reshaping of NARSs statutes in each country concerned (the groups may need to be combined or have slightly different mandates depending on the size and present institutional make-up of the NARSs). At the regional level, the groups would have the responsibility for ensuring that national research program and resource management systems are tuned to each other and that the necessary training is provided. Over time, the regional groups may evolve into standing statutory committees of INSAH.

#### *Regional Research Poles*

Regional collaborative research programs were to be designed under the responsibility of a "nucleus" of national research scientists (pages 50 and 52), using "design workshops" as the mechanism to involve all the actors involved in the regional research agenda, as well as the traditional or prospective donors and collaborating scientific institutions. For the regional research poles to be launched over the next five years, it is estimated that ten to twelve "design workshops" would need to be organized by INSAH. Three research design workshops are currently being planned by INSAH, with funding from the African Development Bank (AFDB) channelled through SPAAR. These workshops will initiate the following research poles - sorghum improvement (genetic resource conservation and varietal improvement); live-stock (small ruminant productivity improvement and pathology); and natural resources conservation and management (soil fertility management, soil and water conservation, village land resource management). The lead institution for the three workshops are IER (Mali), ISRA (Senegal) and INERA (Burkina Faso), respectively.

Regional collaborative research programs are supposed to be considered as time-bound

research contracts, under formal tripartite agreements between CILSS, the concerned host country(ies) and INSAH (page 52). These forms of contractual arrangements are not only interesting in terms of introducing a sense of accountability for performance (page 44), but will also allow the region to use for certain very specific research objectives new approaches such as public tendering to introduce an element of competition while at the same time trying through extensive publicity, to attract the best possible scientific capacity. In several cases regional poles will become the extension in scope of already ongoing donor(s) funded activities. These activities may, in the light of the new regional focus, need to be redesigned, but should not require vast additional sums of money. Conversely, in the case of entirely new activities such as germplasm conservation, natural resources management research, genetic manipulation (biotechnology), post-harvest technology, processing and the development of agricultural equipment, where there is at present limited existing human capacity in the region (page 32) and no funds, additional financial resources are expected to be required.

#### *Institut du Sahel*

To accomplish its expanded tasks under the FFA, INSAH will hire additional staff (one senior economist and one senior research coordinator), have recourse to short-term consultants, and seek an arrangement with ISNAR and possibly IFPRI (page 56). To keep the momentum going, it is important that these resources be provided shortly after the FFA is validated. The senior economist, who is to head INSAH's new Policy Analysis and Research Development Unit, should also play a lead role in organizing the regional working group on national agricultural research and human resources development strategies (page 12). The senior research coordinator, who is to be responsible for (a) coordinating the design of the regional research poles and monitoring their implementation, should also (b) coordinate the activities of the regional working group on agricultural research program management, and

(c) organize and coordinate the work of the independent scientific oversight committees (i.e. act as a permanent secretariat for the oversight of the poles - page 52). ISNAR could possibly provide support and training to the three regional working groups for the execution of their tasks, and assist INSAH in setting up research programming, monitoring and evaluation systems, in combination with a regional research data bank. Short-term consultant funds could be made available to pay for the start-up of the working groups, to assist the regional program design teams (page 58), *ad hoc* specialist advice, and for the design of a regional research communication system (page 55) and a research station management training program (page 55).

*Regional Agricultural Education Strategy.* INSAH intends to initiate a fourth working group on regional agricultural education, which should have the widest possible representation from within the region (agricultural educators and research scientists, extension services, farmer organizations, processors, seed companies, etc.), but also from neighboring West African countries. Over a two to three year time-span, this group would be responsible for drawing up a "blueprint" for a long term agricultural education strategy.

#### **Proposed Organization, Management and Funding Arrangements**

Under the FFA, funds are proposed to be provided for: (a) preparing NARSs institutional reforms, (b) regional program preparation and training, (c) the preparation of a regional agricultural education strategy, and the start-up costs of INSAH's policy analysis and PME functions. Over time, such expenditures should be recovered from the NARSs as payments for

services rendered (page 53). It is recommended that the totality of the start-up costs for INSAH's services for the first few years of FFA implementation be borne by *all* donors together through SPAAR. This should transmit to the CILSS member states the commitment of the SPAAR members to the causes pleaded in this document, while at the same time leaving room for flexible, yet coordinated, bilateral funding arrangements, both at the national and regional levels. More importantly, such an initiative should create a climate for the evolving regional research agenda that would balance political and donor interests. Formal endorsement in April, 1992 by the CILSS Council of Ministers of the recommendations contained in the FFA with respect to NARSs reform and regional research orientation, has signalled to the NARSs and the donors the birth of a new partnership for the advancement of agricultural research in the Sahel.

INSAH prepared and presented a detailed work program and budget to the SPAAR Plenary in December 1991. INSAH will also prepare annually a detailed budget for approval by its own (CILSS) oversight mechanisms and the SPAAR Secretariat. Similar to what has been proposed for the funding of regional poles (page 52), SPAAR funding of INSAH activities may be subject to the conclusion of a formal tripartite agreement with CILSS. For the first couple of years, the SPAAR Secretariat may under such an agreement simply transfer the funds to an INSAH commercial bank account, in agreed instalments and subject to annual verification by independent auditors. As experience with the implementation of the FFA progresses, different funding mechanisms may be considered, such as the establishment of a Regional Agricultural Research Trust Fund or other suitable arrangements.

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## 8: *Expectations*

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A market-oriented agriculture requires that the Sahel regain its competitiveness in national, regional and international markets, and gain it in new ones through diversification. This imperative shapes the research agenda. The research system has started reform to effectively respond to the challenge. The FFA outlined in Chapter 6 builds on these changes. The priorities - substantive and institutional - are clear and mechanisms are proposed for NARSs in the region to respond to these priorities. However, while a more productive research system can contribute significantly to agricultural growth, it cannot do it alone. A deepening of reforms at broader macroeconomic, institutional and political levels is needed so that agricultural research can perform and its impact be clearly demonstrated.

A successful national agricultural sector policy needs a solid underpinning supported by a relevant agricultural research system. This highlights the importance of political support for and recognition of a national agricultural research system for it to be motivated, creative and successful. The FFA is designed to gain such support at the highest political level. If such support cannot be maintained, the success of the FFA could be greatly compromised. Hence, the need for agricultural research to gain recognition by showing significant results.

Agricultural research in the Sahel has for a long time been supported by high levels of external funding (page 34), a situation that is expected to continue for the foreseeable future. This has made the Sahelian NARSs extremely vulnerable and dependent, up to the point where the sustainability of some of the systems is now in question. Many donor-funded programs remain "enclaves" within the system, putting into doubt the lasting effects of their interventions. The FFA proposes solutions to escape from this vicious circle through "statutory reforms" of the NARSs and the introduction of Consolidated Funding Mechanisms, combined

with "contractual arrangements" for the implementation of research programs. From this perspective, donors have as much responsibility for the success or failure of the proposed FFA as the CILSS member state governments.

### **Expected Benefits and Key Indicators for Progress**

Successful implementation of the proposed FFA is expected to be indicated by the following:

1. Increased number of technological innovations well adapted to local situations and higher rates of technology diffusion and adoption.
2. The organization of vibrant interchanges between researchers and their clients so that the research agenda is more demand-driven.
3. Gradual broadening of the research agenda and its client base to incorporate issues important to a market-driven agriculture, including emphasis on trade, utilization, agro-processing and market and product development.
4. Stability in the institutional environment of NARSs, including funding, programming and staffing.
5. Increased participation of faculties of agronomy, private sector institutions, farmers/herders, NGOs and extension in human capacity-building and technology generation.
6. Gradual decrease in outside technical assistance and greater use of indigenous human resources.
7. More substantial interaction with relevant IARCs as equal partners and for mutual benefit.
8. Rationalization of the regional agricultural research system, perhaps through a reduction in the number of networks not driven by national and regional priorities and by the elimination of uncoordinated regional efforts.

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## 9: *State of Play (end-1992)*

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By the end of 1992, the nine concerned Sahelian countries had progressed towards implementation of the FFA recommendations. The following paragraphs briefly highlight the dimensions and content of that progress.

### **BURKINA FASO**

CNRST/INERA organized in April 1992 a multi-donor mid-term review of the National Agricultural Research Project. The general conclusions of this review were that, in comparison with other countries in the sub-region, Burkina Faso had made, over a relatively short three year time-span, impressive progress with the reform of its institutions to focus its agricultural research effort on priority problem areas. ISNAR has prepared a synthesis of the mid-term review, on the basis of which CNRST/INERA presented in December 1992 an action plan to collaborating donors for further improvements in the system.

The action plan includes concrete proposals to:

1. Update and revisit over the coming two to three years the National Agricultural Research Master Plan to take into account possible changes in national priorities and to reflect the new regional dimension developed under the FFA.
2. Implement necessary institutional reforms to improve scientific management and station operations.
3. Improve the budgeting, accounting and financial management system, as a necessary step prior to the introduction of a Consolidated Financing Mechanism (CFM).
4. Develop a human resources development and management system, possibly with ISNAR assistance, to upgrade staff quality and to introduce an incentive system.

### **CAPE VERDE ISLANDS, GUINEA-BISSAU AND MAURITANIA**

In principle, Cape Verde, Guinea-Bissau and Mauritania are in a situation similar to the one in The Gambia in that they, as the smallest among the NARs in Sub-Saharan Africa, would benefit most from their participation in regional collaborative research efforts. The agricultural research leaders of these countries actively participated in the Bamako and Ouagadougou workshops in January and July 1991, that were jointly organized by SPAAR and INSAH to formulate the Sahel FFA recommendations. Since then, no further activities have been developed in these countries, with the exception of Mauritania where the World Bank has identified an Agricultural Services Project which will include a component to strengthen the national agricultural research system.

### **CHAD**

Chad has the most "pluralistic" system of the sub-region in that it has four separately managed institutions involved in agricultural research (animal production, cotton, other crops and the university). Despite the political instability, parts of the system are performing remarkably well (cotton and livestock research). In 1989, the World Bank has made US\$200,000 grant (SPPF) available to the Government to prepare with FAO assistance a long-term national agricultural research master plan. A first analysis of the entire system has been completed. Since then, working groups of Chadian scientists have been established to prepare the long-term strategy.

## MALI

Institut d'Economie Rurale (IER) staff prepared with assistance from ISNAR a long-term Master Plan for agricultural research, which was endorsed by a broad-based national conference in September 1991. In the meantime, following the 11th SPAAR Plenary in Abidjan, Mali was selected as a pilot country for the implementation of the FFA recommendations. In December 1991, the Council of Ministers agreed in principle to adopt the FFA recommendations in Mali. The Council specifically endorsed granting IER financial management autonomy as a precursor to the introduction of a Consolidated Funding Mechanism (CFM).

IER had originally planned to call for a Donor Round Table in December 1991, immediately following the 12th SPAAR Plenary in Rome, to present its long-term Master Plan. Since then, the proposed Round Table has been postponed several times to allow IER to develop a vision on necessary institutional reforms to ensure a successful implementation of the Master Plan, and to ensure that such a vision will be supported by the new government. A donor meeting was held in October, 1992 which was generally supportive of the suggested reforms.

The legal documents for the USAID-funded SPARC project, "Supporting Research Planning and Research on Commodities" under contract with a consortium of US universities led by Texas A & M, were signed in May, 1992. This project has the following components:

1. Designing and implementing a budgeting, budget control and accounting system for all of IER, acceptable to donors, and leading to USAID 121 (d) certification (management of funds by the recipient institution (IER) rather than the contractor, Texas A & M) three years from now.
2. Introducing an integrated research programming, monitoring and evaluation system in ways that would promote active consultation with extension staff and farmers; and

3. supporting, in line with the Master Plan, commodity-based interdisciplinary research on sorghum, millet, and forage/animal nutrition, and assisting IER's food technology laboratory on crop utilization and value-added technologies, including work on marketing and policy constraints as well as crop diversification options for export.

A possible World Bank-funded project will complement the SPARC project and other ongoing donor funded activities<sup>7</sup> in that it would focus on:

- improving and strengthening scientific management;
- human resources management and development;
- research station management and support services;
- consolidating donor financing arrangements to ensure adequate funding of research program and station operating expenditures; and
- research infrastructure rehabilitation and investments in agricultural and scientific equipment.

A multi-donor appraisal mission visited Mali in April 1993 and reached broad agreement on research programs to be supported and the necessary institutional reforms.

## NIGER

In October 1987, Institut National de Recherches Agronomiques du Niger (INRAN) presented its long term plan for Agricultural research to its principal donors (France, USAID and the World Bank). At that time, INRAN operated as a service of the Ministry of Agriculture. In 1991, INRAN was transformed into a public enterprise Etablissement Public à Caractère Administratif (EPA), with an independent administrative and financial management structure. Since then, a financial and a scientific director have been appointed. In early 1992, INRAN presented its first coherent set of research programs and budgets. The World Bank had been instrumental in internal organizational changes.

## SENEGAL

The situation in Senegal is quite different from the other countries in that it has the oldest agricultural research system in the sub-region. Institut Senegalais de Recherches Agricoles (ISRA) has a hard core of well-trained national scientists, a well-established scientific management and review system, and a donor coordinating mechanism that has been in operation for more than ten years. However the system is still plagued by problems that are inherent with its parapublic status, and that are related to its management, in particular budgeting, budget control accounting and financial management. A second set of management problems are partly donor-induced and relate to insufficiencies in research station management as a result of serious underfunding of station operation and maintenance. A third set of problems relates to the absence of career opportunities and incentives for research staff.

For Senegal, to move towards consolidating and sustaining financial support for its agricultural research system will require major improvements in financial and personnel management. This may only be possible if coupled with substantial institutional reforms that would make ISRA directly accountable for results vis-a-vis its providers of funds (i.e. contractual arrangements). This would require institutionalizing the donor consultation arrangements, by transforming them into a coordinating committee whose decisions would be binding. Through its Natural Resources-Based Agricultural Research Project, USAID is providing consulting services to re-design ISRA's budgeting and accounting system, with a view to make it eligible for USAID 121 (d) certification. ISNAR will finalize during the course of the year generic job descriptions of ISRA staff. These should become the basis for the establishment of career the development plans and a new personnel evaluation and remuneration system. The USAID project also provides for the introduction of research contracting arrangements.

## THE GAMBIA

The Gambia, as one of the smallest countries of the sub-region, has most to gain from the INSAH/SPAAR initiative, in that the efficiency of its agricultural research system depends on testing, and perhaps in a few cases adapting, technology developed elsewhere. The success of such a strategy depends on the strength of the system's linkages with other NARSs and the relevant IARCs. From 1985 up until recently, investments and non-salary operating costs of the system were provided under the USAID-funded Gambian Agricultural Research and Diversification (GARD) Project with assistance from the University of Wisconsin. The recently appraised Agricultural Services Project will assure the sustainability of the system for another five to seven years. USAID is shifting its emphasis towards natural resources management.

The National Agricultural Research Board (NARB), established under the Second Agricultural Development Project (ADP II, Cr. 1476-GAM), has with ISNAR assistance prepared new draft statutes that will transform it into an autonomous "body corporate", that would let research contracts with national and international (or regional) institutions to implement its research programs. The benefit from such contracts, the Department of Agricultural Research (DAR) in the Ministry of Agriculture, responsible for operating The Gambia's two research stations (Yumdum and Sapu), would also need to be transformed into an independent institution. Details of these reforms are to be worked out during the coming months prior to the Negotiations of the Agricultural Services Project, tentatively scheduled for October/November 1992. These institutional reforms are amongst the most radical contemplated so far by any of the NARSs in the sub-region. They do allow for much greater pluralism in the implementation of research contracts by research institutions and NGOs. In many respects these proposals reflect the spirit of the Sahel FFA recommendations with respect to the revitalization of national institutions.

**Annex 1: FACT SHEET - BURKINA FASO**

**Table A 1.1: Breakdown of Scientists by Discipline**

	<i>National</i>	<i>Foreign</i>
<b>INERA</b>		5
Agronomy	15	1
Plant biology	-	3
Plant breeding	15	1
Phytopathology	5	1
Entomology	7	3
Soil Science	5	2
Agricultural Economics	4	1
Sociology	1	-
Animal husbandry	9	-
Agricultural engineering	2	-
Animal physiology	1	-
Veterinary science	1	-
Micro-biology	1	-
Geography	1	-
Food technology	2	-
 Sub-total (of which in managerial positions)	 69	 18
<b>IRBET</b>		-
Ecological science	1	-
Forestry	1	-
Botany	1	-
Hydro-biology	1	-
 Sub-total	 4	 -
<b>Total System</b>	<b>73</b>	<b>18</b>

**Table A 1.2: National Scientists by Level of Education**

<i>Degree</i>	<i>Number</i>
<b>INERA</b>	
Ph.D	19
M.Sc	26
B.Sc	24
 Sub-total	 69
<b>IRBET</b>	
Ph.D	2
M.Sc	2
 Sub-total	 4
<b>Total</b>	<b>73</b>

Table A 1.3: Financial Resources and Use of Funds-1990 (as budgeted)

	Resource		Use of funds	
	CFAF (millions)	US\$	CFAF (millions)	US\$
<i>INERA</i>				
Government budget	459	1.53	Investments	521 1.74
Own Resources	16	0.05	Training/T.A .	51 0.17
Contracts	15	0.05	Staff (local)	380 1.27
			Operating Costs	1,223 4.08
Sub-total	490	1.63		
External resources	1,685	5.62		
<i>Total</i>	<i>2,175</i>	<i>7.25</i>	<i>Total</i>	<i>2,175 7.25</i>
<i>IRBET</i>				
Government budget	71	0.24	Investments	44 0.15
Contracts	13	0.04	Staff (local)	19 0.06
			Operating Costs	34 0.11
Sub-total	84	0.28		
External resources	13	0.04		
<i>Total</i>	<i>97</i>	<i>0.32</i>	<i>Total</i>	<i>97 0.32</i>
<i>Total System</i>	<i>2,272</i>	<i>7.57</i>	<i>Total System</i>	<i>2,175 7.57</i>

## Key indicators

Investments total	: 25 percent
Government budget/total	: 23 percent
External resources/total	: 74 percent
Own resources + contracts/local	: 3 percent
Staff (local)/total O.C (incl. staff)	: 24 percent
Staff (local)/government budget	: 75 percent
O.C. (excl.staff)/scientist (incl.foreign)	: CFAF 14 m/US\$46,000
Total budget/scientist (incl. foreign)	: CFAF 25 m/US\$83,000
(Ph.D. + M.Sc.)/total scientists	: 67 percent

**Annex 2: FACT SHEET - CAPE VERDE**

**Table A 2.1: Breakdown of Scientists by Discipline**

	<i>National</i>	<i>Foreign</i>
Agronomy	9*	-
Agronomy/Entomology	-	-
Phytophatology	6	-
Biology	2	-
Sociology	2	-
Soil science	3	-
Agro-climatology	1	-
Irrigation engineering	1	-
<i>Total</i>	24	-

\* Of which 2 are in management positions

**Table A 2.2: National Scientists by Level of Education**

<i>Degree</i>	<i>Number</i>
Ph.D.	2
M.Sc.	3
B.Sc.	19
<i>Total</i>	24

Table A 2.3: Financial Resources and Use of Funds-1990 (as budgeted)

<i>Resources</i>		<i>Use of funds</i>	
	<i>US\$ (millions)</i>		<i>US\$ (millions)</i>
Government budget		Investments **	1.97(?)
Recurrent Budget	0.30	Training/T.A	
Capital Budget*	0.36	Staff (local)	0.30
		Operating costs	
Sub-total	0.66	Total	2.27
External resources	1.61		
<i>Total</i>	<i>2.27</i>		

\* Counterpart funds.

\*\* Including equipment, training and possible foreign staff costs.

#### *Key Indicators*

Investments/total	: 87 percent
Government budget/total	: 29 percent
External resources/total	: 71 percent
Own resources + contracts/local	: n.a
Staff (local)/total O.C.(incl. staff)	: n.a
Staff (local)/government budget	: n.a
O.C.(excl. staff)/scientist(incl. foreign)	: n.a
Total budget/scientist (incl. foreign)	: US\$ 95,000
(Ph.D. + M.Sc.)/total scientists	: 21 percent

**Annex 3: FACT SHEET - CHAD**

*Table A 3.1: Scientist-years\* by Activity*

	<i>National</i>	<i>Foreign</i>
Rainfed Foodcrops	3	2
Cotton	3	7
Animal health and production	11.5	3.5
Other (University)	3	-
<i>Total scientific institutions</i>	20.5	12.5
Other Rainfed Foodcrops and Natural Resources Management (Development Institutions):	12	13
<i>Grand total</i>	32.5	25.5

\* "Scientist-years" refers to 12 months of scientific research.

*Note:* Chad has a total of 32.5 "scientist years" in the context of the number of national scientists by level of education (B.Sc level and above).

Table A 3.2: Financial Resources and Use of Funds-1989

	Resources		Use of funds		
	CFAF (millions)	US\$		CFAF (millions)	US\$
<b>Government budget</b>					
Rainfed food(BRA)	40	0.13	Scientific Inst.		
Cotton (IRCT)	-	-	Staff (local)	190	0.63
Animal health and production (LRVZ)	130	0.43	Staff (foreign)	340	1.13
University	35	0.12	Operating Costs		
Sub-total	205	0.68	(incl. investm.)	385	1.28
Other development institutions	70	0.23	Other	120	0.40
<i>Total</i>	275	0.91	Sub-total	1,035	3.44
<b>External resources</b>					
Rainfed food crops (BRA)	130	0.43	Other Dev't Inst.	60	0.20
Cotton (IRCT)	405	1.35	Staff (local)	360	1.20
Animal health and production(LRVZ)	280	0.93	Staff (foreign)		
University	10	0.03	Operating costs		
Sub-total	825	2.74	(incl.investmts)	355	1.18
Other development institutions	1,035	3.45	Other	330	1.10
<i>Total</i>	1,860	6.19	Sub-total	1,105	3.68
<i>Total System</i>	2,135	7.10	<i>Total System</i>	2,135	7.12

*Key indicators*

Investments/total	: n.a	Staff(local)/government budget	: 91 percent
Government budget/total*	: 19 percent	O.C (excl. staff)/scientist	: n.a
External resources*/total*	: 81 percent	Total budget*/scientist (incl.foreign)	: CFAF 25m/US\$83,000
Own resources + contracts/local	: n.a	(Ph.D. + M.Sc.)/total scier.'ists	: n.a
Staff(local)/total O.C (incl. staff	: n.a	* Excluding foreign staff costs	

**Annex 4: FACT SHEET - THE GAMBIA**

**Table A 4.1: Breakdown of Scientists by Discipline**

	<i>National</i>	<i>Foreign</i>
Agronomy research	23*	-
Animal production Research	- 10	- -
Water resources Management research	- 4	- -
Fisheries research	1	-
Forestry research	1	-
Agricultural policy Research	- 2*	- -
<i>Total</i>	41	-

\* Includes 3 scientists with a social science degree.

*Note:* The Gambia has 26 scientists with a post-graduate degree, 63 percent of whom have an M.Sc. or Ph.D.

**Annex 5: FACT SHEET - GUINEA-BISSAU**

**Table A 5.1: Breakdown of Scientists by Discipline**

	<i>National</i>	<i>Foreign</i>
Foodcrops	8	-
Fruits and vegetables	-	-
Animal production	-	-
Forestry	-	-
Plant protection	3	-
Agronomy and natural resource management	5	-
Farming systems research	3	3
<i>Total</i>	19	3

\* Includes 2 agricultural economists and 1 soil scientist.

**Table A 5.2: National Scientists by Level of Education**

<i>Degree</i>	<i>Number</i>
M.Sc.	3
B.Sc.	14
<i>Total</i>	17

Table A 5.3: Financial Resources and Use of Funds-1991

<i>Resources</i>		<i>Use of Funds</i>	
	<i>US\$ (millions)</i>		<i>(US\$) (millions)</i>
Government budget	n.a	Budgeted expenditures on	
Own Resources	n.a	local resources not available	
Contracts	n.a		
Sub-total		Budgeted expenditures on	
		foreign resources	
External resources	1.04	Investments	0.58
		Training/T.A.	0.07
		Staff (local)	0.00
		Operating Costs	0.39
<i>Total</i>	n.a.	<i>Total</i>	1.04

*Key Indicators*

Investments/total	: n.a
Government: budget/total	: n.a
External resources/total	: n.a
Own resources/local	: n.a
Staff (local)/total O.C.(incl. staff)	: n.a
Staff (local)/government budget	: n.a
O.C.(excl. staff)/scientist(incl. foreign)	: n.a
Total budget/scientist (incl. foreign)	: n.a
(Ph.D. + M.Sc.)/total scientists	: 18 percent

**Annex 6: FACT SHEET - MALI**

**Table A 6.1: Breakdown of Scientists by Discipline**

	National*	Foreign
Agronomy	55 (44)	9
Entomology	8 (8)	-
Weed Science	3 (3)	-
Phytopathology	4 (3)	-
Plant physiology	2 (2)	-
Plant breeding	17 (15)	1
Economics	1 (1)	3
Agricultural economics	15 (14)	3
Sociology	6 (3)	2
Anthropology	1 (1)	-
Demography	-	3
Animal husbandry	17 (14)	1
Animal husbandry (breeding)	3 (3)	-
Animal breeding	3 (3)	-
Agrostology	1 (1)	-
Animal nutrition	11 (10)	-
Range management	10 (9)	-
Veterinary science	11 (10)	-
Bee keeping	1 (1)	-
Food technology (meat/milk)	1 (-)	-
Biochemistry	1 (1)	-
Chemistry	2 (2)	-
Soil science	4 (4)	-
Agro-climatology	-	1
Land development management	2 (1)	1
Irrigation engineering (hydraulics)	-	3
Agricultural engineering	4 (4)	-
Agro-Forestry	2 (1)	-
Ecological science	3 (2)	-
Forestry (silviculture)	5 (4)	-
Wood technology	1 (-)	-
Hydro-biology	1 (1)	3
Fish zoology (ichthology)	1 (1)	-
Fish production (pisciculture)	1 (1)	-
Biology (fish)	-	2
Computer science	1 (1)	3
Biometry	-	2
Management	-	2
<b>Total</b>	<b>198 168</b>	<b>39</b>

\* Between brackets: LGP (approximately Ph.D. or equivalent) + PP (M.Sc. + 5 years experience or B.Sc + 12 years experience).

*Note:* Mali has a total of 199 national scientists broken down as follows: PS (M.Sc with less than 5 years experience or B.Sc. with less than 12 years experience) =31; PP=91;and LGP=77.

Table A 6.2: Financial Resources and Use of Funds-1988

	<i>CFAF</i> (millions)	<i>US\$</i> (millions)
<i>IER</i>		
Government budget	497	1.66
External resources	1,066	3.55
Sub-total	1,563	5.21
<i>INRZFH</i>		
Government budget	240	0.80
External resources	-	-
Sub-total	240	0.80
<i>Total</i>	1,803	6.01

*Note:* Data on distribution by category of expenditures not available.

*Key Indicators:*

Investments/total	: n.a
Government budget/total	: 41 percent
External resources/total	: 59 percent
Staff (local)/total O.C (incl.staff)	: n.a
Staff (local)/government budget	: n.a
O.C (excl. staff)/scientists (incl. foreign)	: n.a
Total budget/scientist (incl. foreign)	: CFAF 9m/US\$ 29,000
(Ph.D. + M.Sc.)/total scientists	: n.a

*Annex 7: FACT SHEET - MAURITANIA*

Mauritania has a total of five scientists of whom three are agronomists. Of the other two whose disciplines are unknown, one is the Director of CNRADA. As of end-1990, seven researchers, disciplines unknown, were expected to return from the USA.

While data on the educational level of the country's scientists were not available, they were assumed to be of at least B.Sc. level.

*Table A 7.1: Financial Resources and Use of Funds-1990*

	<i>UM</i>	<i>US\$</i>
	<i>(millions)</i>	
<b>Government Budget:</b>		
Regular (staff costs)	15.0	0.11
Counterpart funds	7.0	0.05
Own resources	5.0	0.04
Sub-total	27.0	0.20
External Resources*	41.3	0.29
<b>Total</b>	<b>68.3</b>	<b>0.49</b>

\* Includes UM 10.0m. for technical assistance

*Key Indicators*

Investments/total	: n.a.
Government budget/total	: 38 percent
External resources**/total**	: 54 percent
Own resources/total**	: 9 percent
Staff(local)/total O.C(incl.staff)	: n.a
Staff (local)/government budget	: n.a
O.C.(excl.staff)/scientist(incl.foreign)	: n.a
Total budget**/scientist(incl.foreign)	: UM 12m/US\$ 80,000
(Ph.D. + M.Sc.)/total scientists	: n.a

\*\* Excluding foreign staff costs.

**Annex 8: FACT SHEET - NIGER**

**Table A 8.1: Breakdown of Scientists by Discipline**

	<i>National</i>	<i>Foreign</i>	
<b><i>INRAN</i></b>			
Agronomy	11	1	
Phytopathology	4	-	
Entomology	2	-	
Economics	3	-	
Sociology	1	-	
Animal husbandry	1	-	
Veterinary science	2	4	
Soil science	2	1	
Geography	1	-	
Hydrology	1	-	
Sub-total	28	1	
<b><i>Agricultural Faculty</i></b>			
Agronomy	1	1	
Phytopathology	1	1	
Entomology	-	1	
Economics	1	-	
Veterinary science	2	4	
Soil science	2	1	
Rural engineering	-	1	
Forestry (Sylviculture)	-	1	
Sub-total	7	10	
<b><i>Institut des Radio-Isotopes</i></b>			
Agronomy	-	4	
Veterinary science	-	1	
Nuclear physics	1	-	
Applied electronics	1	-	
Sub-total	2	5	
<b><i>AGRHYMET</i></b>			
			<b>(of which Sahelian:)</b>
Agronomy	1	2	(-)
Meteorology	1	1	(1)
Remote sensing	-	2	(1)
Hydrology	-	2	(1)
Computer science	-	1	(1)
Sub-total	2	8	(4)

Table A 8.1: Breakdown of Scientists by Discipline (Cont'd)

	<i>National</i>	<i>Foreign</i>	
<i>ICRISAT</i>			
Agronomy	-	16*	(1)
Biology (Phyto-pathology)	-	3	(-)
Animal husbandry	-	1	(-)
Soil science	-	1	(-)
Climatology	-	1	(-)
Sub-total	-	22	(1)
<i>ORSTOM</i>			
Plant breeding	-	3	
Veterinary science	-	2	
Hydrology	-	2	
Sub-total	3	7	
<i>Total system</i>	39	53	(5)

\* Includes one from IBPGR

Table A 8.2: National Scientists by Level of Education

<i>Degree</i>	<i>Number</i>
<b>INRAN</b>	
Ph.D.	9
M.Sc.	12
B.Sc.	16
<b>AGRHYMET</b>	
Ph.D.	-
M.Sc.	1
B.Sc.	1
<b>ICRISAT</b>	
Ph.D.	-
M.Sc.	-
B.Sc.	-
<b>ORSTOM</b>	
Ph.D.	-
M.Sc.	-
B.Sc.	-

Table A 8.3: Financial Resources and Use of Funds-1989

	<i>Resources</i>		<i>Use of Funds</i>	
	<i>CFAF</i>	<i>US\$</i>	<i>CFAF</i>	<i>US\$</i>
	<i>(millions)</i>		<i>(millions)</i>	
<i>INRAN</i>				
Government Budget	700	2.34	Investments	n.a
Own Resources	n.a		Training/T.A	n.a
Contracts	n.a		Staff (local)	500
			Operating costs	200
Sub-total	n.a			
External resources	n.a			
<i>Total</i>	n.a		<i>Total</i>	n.a

*Key Indicators*

Investments/total	: n.a
Government budget/total	: n.a
External resources/total	: n.a
Own resources + contracts/local	: n.a
Staff (local)/total O.C.(incl. staff)	: n.a
Staff (local)/government budget	: 71 percent
O.C.(excl. staff)/scientist(incl. foreign)	: n.a
Total budget/scientist (incl. foreign)	: n.a
(Ph.D. + M.Sc.)/total scientists	: 56 percent (total system)

**Annex 9: FACT SHEET - SENEGAL**

*Table A 9.1: Breakdown of Scientists by Discipline*

	<i>National</i>	<i>Foreign</i>
Agronomy	16	5
Entomology	7	-
Phytopathology	2	-
Plant physiology	3	-
Plant breeding	7	1
Economics	4	1
Agricultural economics	5	-
Sociology	2	-
Animal husbandry	4	2
Agrostology	1	-
Animal nutrition	2	1
Veterinary science	12	1
Physics	1	-
Chemistry	1	-
Soil science	5	-
Agro-climatology	1	-
Geography	-	1
Rural engineering	1	-
Water resources management	3	-
Agricultural engineering	2	1
Ecological science	4	-
Forestry (Sylviculture)	3	-
Wood technology	1	-
Oceanography	3	2
Biology	9	1
Micro-biology	3	2
Biometry	1	-
Discipline unknown	1	17
<i>Total</i>	<i>104</i>	<i>35</i>

*Table A 9.2: National Scientists by Level of Education*

<i>Degree</i>	<i>Number</i>
Ph.D.	22
M.Sc.	46
B.Sc.	34
Unknown	2
<i>Total</i>	<i>104</i>

Table A 9.3: Financial Resources and Use of Funds-1990 (as budgeted)

	Resources		Use of Funds	
	CFAF (millions)	US\$	CFAF (millions)	US\$
<i>ISRA</i>				
Government budget	1,204	4.01	Investments	49 0.16
Own resources	234	0.78	Training/T.A	1 0.01
Contracts	-		Staff (local)	1,129 3.76
Sub-total	1,438	4.79	Operating costs	937 3.12
External resources	678	2.26		
<i>Total</i>	2,116	7.05		2,116 7.05

*Key Indicators*

Investments/total	: 2 percent
Government budget/total	: 57 percent
External resources/total	: 32 percent
Own resources + contracts/local	: 9 percent
Staff (local)/total O.C.(incl. staff)	: 55 percent
Staff (local)/government budget	: 94 percent
O.C.(excl. staff)/scientist(incl. foreign)	: CFAF 10m/US\$
Total budget/scientist (incl. foreign)	: CFAF 23m/US\$
(Ph.D. + M.Sc.)/total scientists	: 67 percent

## **NOTES**

1. INSAH/SPAAR. 1991. Rapport Final "Atelier regional INSAH/SPAAR: Finalisation du plan d'action sur la recherche agricole au Sahel." Ouagadougou, Burkina Faso.
2. Data in this and following paragraphs till the end of the section are approximate and incomplete. For details, see Annexes with fact sheets. Only part of the university system is included (Niger). Scientists working in NGOs, development institutions and individual projects are generally not included, except for Chad.
3. The West Africa Rice Development Association. (1991). "A Program of Partnership: WARDA's New Vision and Approach to Collaboration with National Agricultural Research Systems". Bouake, Cote d'Ivoire.
4. Includes all research programs executed by an institution, irrespective of the source of funds.
5. If an institution meets the eligibility criteria for part of its programs, and actually receives funding for it through a CFM, the institution should be required to provide an independent auditor certified statement that programs not meeting such criteria or for which no funding is requested, are fully funded, including an appropriate share of the fixed and variable indirect overheads and operating costs of the institution.
6. INSAH/SPAAR. 1991. Rapport Final, "Atelier regional INSAH/SPAAR: Finalisation du plan d'action sur la recherche agricole au Sahel." Ouagadougou, Burkina Faso.
7. The Netherlands [(Royal Institute for the Tropics (KIT)] and the Centre for Agrobiological Research (CABO, France (ORSTOM and CIRAD), USAID (Auburn University), Switzerland, and Germany (University of Hohenheim).

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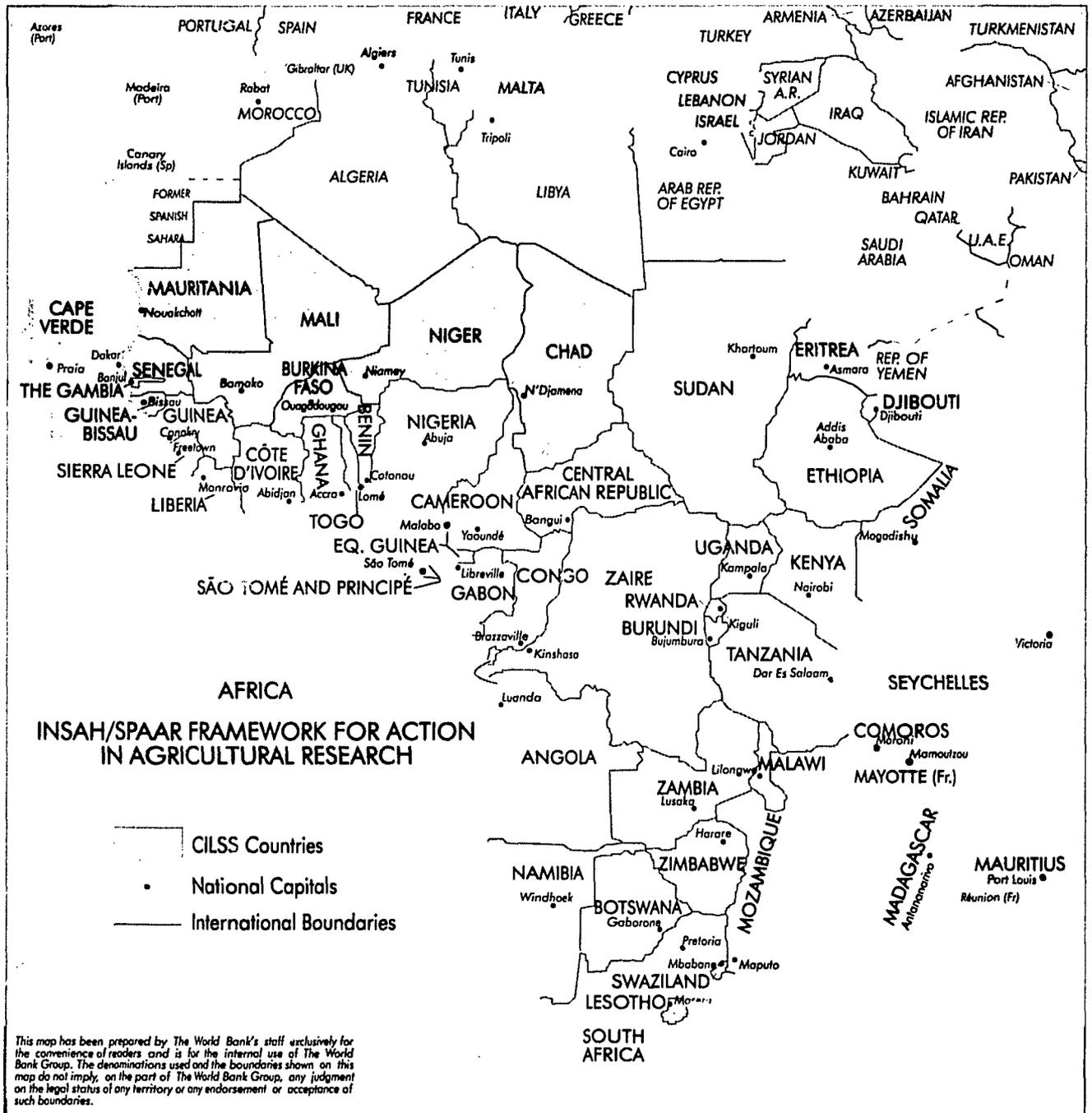
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