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Natural Resource Management and InterCRSP in West Africa

Proceedings of the Regional Workshop: Technology Development and Transfer to Improve Natural Resource Management in West Africa

18-22 September 1995, Niamey, Niger

Virginia Tech

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

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Proceedings of the Regional Workshop: Technology Development and Transfer to Improve Natural Resource Management in West Africa

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Publication Editor

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The opinions expressed herein are those of the InterCRSP NRM West Africa Workshop Participants and do not necessarily reflect the views of the U.S. Agency for International Development.

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TABLE OF CONTENTS

Preface vii

Background and Objectives of the Workshop 1
Brhane Gebrekidan

Regional Collaboration in Natural Resource Management 5
Keint Simmons

Opening Address 8
Representative of the Minitster of Agriculture and Livestock, Niamey, Niger

Transfer and Diffusion of Water-Harvesting and Agroforestry Technologies: A Watershed Approach 10
A. S. R. Juo, T. L. Thurow, I. Zanguina, and A. Manu

Stratégies Disponibles Pour une Gestion Durable des Ressources Naturelles (GDRN) en Afrique de l'Ouest 15
Somé Salibo

Genetic Resources in Beans and Cowpeas 18
Russell Freed

Small Ruminant Collaborative Research Support Program Initiatives in Natural Resource Management 20
Will R. Getz

Existing Animal Genetic Resources in West Africa 24
Will R. Getz

Sorghum Hybrids: A Viable Technology for Sustaining Sahelian Agriculture 27
Issoufou Kapran, John D. Axtell, and Gebisa Ejeta

Les Sorghos Hybrides: Une Technologie Viable pour une Agriculture Durable au Sahel 32
Issoufou Kapran, John D. Axtell, and Gebisa Ejeta

Place et Rôle des Ressources Phytogénétiques dans la Gestion des Ressources Naturelles 37
Ousmane Ndoye

Summary Statement on Peanut CRSP Activities in West Africa 42
Olin D. Smith

Technologies for Improving Nutrient Cycling and Water Use Efficiency in the Sandy Soils of West Africa for Sustained Production 45
I. Mahaman, A. Manu, Z. Kouyate, A. Bationo, and A.S.R Juo

Pond Dynamics/Aquaculture Collaborative Research Support Program 49
J.R. Bowman

Crop Production Strategies: An INTSORMIL Perspective 51
Stephen C. Mason and Jerry W. Maranville

Présentation de Quelques Résultats Obtenus en Pathologie sur le Mil le Sorgho, le Niébé et l'Arachide 64
Issoufou Kollo Abdourahamane

Protection des Cultures 66
Kadi Kadi Hame Abdou

Peanut CRSP Activities in Burkina Faso 67
Philippe Sankara

Technologies Available for Post-Harvest Storage of Cowpea Grain 71
Larry L. Murdock

IPM, Natural Resource Management, and Millet Production in Sahelian West Africa 74
F. E. Gilstrap, O. Youm, H. Kadi Kadi, and I. Bayoun

INTSORMIL CRSP Utilization Projects 84
M. Oumarou, A. Aboubacar, S. Kaka, R. Seydou, B. Hamaker, A. Berthe, A. Toure, and L. Rooney

Food Science and Post Harvest Handling of Peanuts 86
E. Perez Castell

Food Science and Post Harvest Handling 88
Peanut CRSP

Unité de Production de Farine Composée au Mali Fabrique Alimentaire du Sahel (FAS) 90
Adama Coulibaly

Emerging Technologies for Regional NRM: Information Dissemination, Training & Communication 94
Ron Grosz

Rapporteur's Synthesis of Session II: Technologies Available for NRM in West Africa 99
Chair: Gaousso Traore
Rapporteur: Menwueyellet Moussie

Besoins de la Recherche en Gestion des Ressources Naturelles: Dimension Sous-Régionale au Sahel 103
Gaoussou Traore

Le Problème de Gestion de Ressources Naturelles en Chad 109
Aminou Bouba-Kaou

National Programme Needs for Natural Resource Management in Ghana 111
Joseph Kwasi Adu

Natural Resource Management in Cameroon 113
J.M. Ngeve

Recherches sur la Gestion des Ressources Naturelles au Sénégal: Acquis et Perspectives 118
Amadou Ba

Participatory Approach: The First Step to Rural Development and Technology Transfer 121
M. A. Osman and Carol McCormac Wild

Rapporteur's Synthesis of Session IV: Stakeholder Analysis 126
Chair: Mudiayi Ngandu
Rapporteur: Souleyman Ouedraogo

Summary of Working Group Discussions on Strategic Objectives for NRM in West Africa 130
Chair: Phillippe Sankara
Rapporteur: Steve Mason

Working Group Report on Policy and Socio-economic Constraints to NRM in West Africa 135
Chair: *Laurent Millogo*
Rapporteur: *Valerie Kelly*

Reports of the Working Groups
A. Political, Institutional, and Environmental (PIE) Constraints Group 139
Chair: *Jeff Hill*
Rapporteur: *Nango Dembele*

B. Socioeconomic (SE) Constraints Group 142
Chair: *Souleymane Ouedraogo*
Rapporteur: *Bengaly Berthe*

Presentation of Group Reports and Discussion in the Plenary Session 144

Quelques Déterminants Socio-Economiques: de l'adoption des technologies 148

The West and Central African Millet Research Network (WCAMRN/ROCAFREMI): An Overview 150
J. A. Nyemba, O. Youm, and B. Ouendeba

SANREM CRSP Experience in Participatory Research and the Role of Non-Governmental Organizations in Burkina Faso, 1992-1995 155
Mudiayi Ngandu

Rapporteur's Synthesis of Session X: Structural Model for InterCRSP NRM Project 159
Chair: *David Cummins*
Rapporteur: *Makan Fofana*

Constraints and Needs for Institutional Development: Technology Generation and Transfer to Improve Natural Resource Management in West Africa 162
David J. Sammons

Contraintes et Besoins du Développement Institutionnel: Mise au Point et Transfert de Technologies pour l'Amélioration de la Gestion des Ressources Naturelles en Afrique de l'Ouest 165
David J. Sammons

Problems and Opportunities for Seed Production and Distribution in Developing Countries: A Breeder's Experience 168
Leland R. House

Rapporteur's Synthesis of Session XI: Needs and Priorities for Training and Institutional Development in NRM 177
Chair: David Sammons
Rapporteur: Botorou Ouendeba

Notes on Developing a Collaborative Regional NRM Program 179
Jeff Hill

Where Do We Go From Here? 186
Brhane Gebrekidan

Discours de Clôture du Directeur Général de l'INRAN 190
Abdoulaye Gouro

APPENDIX 1 - LIST OF PARTICIPANTS 192

APPENDIX 2 - WORKSHOP PROGRAM 200

Preface

On March 22, 1995, the CRSP Council designated the IPM CRSP/Virginia Tech to be the Lead CRSP in implementing the Natural Resource Management (NRM) InterCRSP initiative in West Africa. As part of this initiative, the USAID/Niger Mission gave a special grant (No. 683-0261-G-00-5001-00) to the IPM CRSP/Virginia Tech to implement a regional workshop in Niamey, Niger, on NRM and related issues. With the active involvement of the CRSP Council and the USAID Niger Mission, the IPM CRSP and INRAN assumed the lead role of organizing this Regional Workshop.

All of the eight CRSPs, seven NARSs of West African countries, regional organizations, USAID, and IARCs participated in the workshop. A wide range of paper presentations, as well as a number of panel and working group discussions, took place. The main issues discussed and the conclusions reached in the workshop are reflected in these proceedings. Except for a few, the papers and reports appear here only in the language of the original presentation.

I would like to take this opportunity to acknowledge the contributions of the following organizations and individuals to the success of this workshop:

- USAID Niger Mission for financial contributions and Curt Nissly for his overall encouragement and support.
- INRAN for logistical support and active collaboration, in particular Dr. Issaka Mahaman, Dr. Botorou Ouendeba, Dr. Abdoulaye Gouro.
- The CRSP Council for its guidance and its unreserved support for the implementation of the workshop.
- USAID Global and Africa Bureau for their active participation in the planning and implementation of the workshop.

- The Workshop Organizing Committee for developing and implementing the workshop program under a very tight timeframe. Dr. David Cummins, the chair, deserves a special recognition.

- Bureau International de Prestations de Services (BIPS), in particular Mme Fatouma SANI, for handling the local logistics.

- Dr. Abdoulaye D. Harsuna and his colleagues for their effective simultaneous translations.

- Sharon Lawson for all her assistance in the organization of the workshop and the preparation of these proceedings.

- Jean-Pierre Amirault for proofreading the papers in French.

Brhane Gebrekidan, IPM CRSP
Workshop Overall Organizer and Editor

Background and Objectives of the Workshop

Brhane Gebrekidan
IPM CRSP, Virginia Tech, Blacksburg, VA, USA

Background

The background and the formative discussions of this workshop trace to the presence and activities, in West Africa, of several Collaborative Research Support Programs (CRSPs) supported by USAID.

Various CRSPs have been, or are, operating in seven West African countries as shown in the following table:

	Burkina Faso	Cameroon	Cape Verde	Ghana	Mali	Niger	Senegal	Total
Bean/Cowpea		x		x	x		x	4
IPM					x			1
INTSORMIL	x				x	x	x	4
Peanut	x			x	x	x		4
SANREM	x		x					2
Soil Mgt	x				x	x		3
Total	4	1	1	2	5	3	2	16

The six CRSPs, shown in the Table above, have worked and continue to work actively on a wide range of issues related to the sustainability of food production systems and natural resource management in the region. Although the individual CRSPs have worked effectively in West Africa for several years, the history of interCRSP activities and joint programs is relatively recent. The CRSPs have recognized that a stronger linkage and the development of joint collaborative programs, involving multiple CRSPs, will benefit both the participating host countries and the partner CRSP institutions in the US. This recognition should lead to the promotion and functional implementation of the interCRSP concept.

InterCRSP refers to a collective agreement among the CRSPs to plan and implement programs and activities jointly. This agreement provides access to the collective strengths and expertise available in the CRSP universities/institutions. The legal basis for the implementation of the interCRSP initiative is the Memorandum of Understanding and the bylaws of the CRSP Council .

In promoting the interCRSP, the USAID/Niger Mission has been in the forefront, and the primary proponent of the concept. Subsequently, earlier this year, USAID funds were provided through the Niger Mission to three CRSPs (INTSORMIL, Peanut, Soil Management) to initiate an interCRSP activity in Niger. That activity is underway now and uses the watershed management model for Technology Development and Transfer (TDT) through interCRSPing.

Simultaneous with the three CRSPs interCRSP work development, the Africa Bureau of USAID and the CRSP Council started developing a broader interCRSP initiative in which as many as six CRSPs are partners. NRM was identified as a cross-cutting theme for mobilizing the collaborative efforts of the six partner CRSPs and the geographical region identified for this activity was West Africa.

The NRM InterCRSP program is envisioned to support natural resource management technology development and transfer in West Africa. It should provide a mechanism to coordinate A.I.D. supported relationships with National Agricultural Research Systems (NARSs) and CRSPs working on natural resource management issues in West Africa. It should also facilitate coordination among CRSPs and International Agricultural Research Centers (IARCs), as well as NGOs/PVOs.

The rationale for the NRM InterCRSP is that natural resource management constraints cut across individual commodities. Bringing the joint skills and capacities of the CRSPs to bear on natural resources management should help create a critical mass from among existing but separate groups, and improve efficiency. It should also contribute to a more rapid integration of NRM findings and lessons into commodity programs. The InterCRSP agreement should enable Field Missions, NARSs and USAID Africa Bureau to coordinate NRM related activities implemented by CRSPs through a single management entity.

Consistent with the Memorandum of Understanding and the bylaws, the CRSP Council unanimously designated, on March 22, 1995, the IPM CRSP/OIRD, Virginia Tech to be the lead CRSP to implement this initiative. Accordingly, the IPM CRSP will serve as the Management Entity for this program and coordinate the activities of the participating CRSPs. The overall workplan will be collaboratively developed by the partner CRSPs and the collaborating national and regional institutions.

As a follow-up of the three CRSPs interCRSP work in Niger and also the six CRSP interCRSP NRM West Africa initiative, the USAID/Niger Mission made a special grant to the IPM CRSP for the following specific activities:

1. To field a team to Niger and other West African countries to make a strategic assessment of interCRSP NRM issues in the region.

2. To initiate a network of scientists and institutions for regional participation.

3. To host a workshop on "Advances in NRM Technology for West Africa".

With reference to Activities 1 and 2, the InterCRSP NRM West Africa Strategy Assessment Team traveled to Niger, Mali, and Burkina Faso from July 8-22, 1995 and submitted its report to the USAID/Niger Mission. The members of the team were:

1. Dr. Tony Juo, Soils, Soils Management CRSP, Texas A & M University
2. Dr. Jess Lowenberg-DeBoer, Agricultural Economics, Bean/Cowpea CRSP, Purdue University
3. Dr. Brhane Gebrekidan, Plant Breeding, Team Leader, IPM CRSP, Virginia Tech
4. Mr. Ron Grosz, Communication and Information Technology, HERNS Project, Rosslyn, VA
5. Dr. Issaka Mahaman, NRM Chief, INRAN, Niger
6. Mr. Makan Fofana, NRM Chief, IER, Mali
7. Dr. Gaoussou Traore, INSAH, NRM Chief, Bamako

With respect to Activity 3 dealing with hosting a workshop, the team's scope of work specifies that the workshop will serve as a groundbreaking example of the type and method of technology transfer envisioned for future interCRSP initiatives. The workshop should also serve as a forum for launching the "NRM interCRSP in West Africa" regional initiative to be supported under the AFR/PSGE project. The organizers of the workshop will be the interested CRSPs and INRAN. This is the workshop referred to in the team's SOW.

Objectives

The SOW, of the InterCRSP NRM West Africa Strategy Assessment Team specifies that the main objectives of the workshop will be to:

- Assess and catalogue available technologies developed by the CRSPs in and/or for West Africa.
- Identify needed technologies as well as related issues bearing on technology relevant to West Africa.
- Assess the applicability of the watershed management model for TDT and interCRSPing.
- Assess the needs and priorities for training and institutional development for NRM in West Africa. (a)
- Evaluate the policy and socio-economic frameworks and constraints influencing NRM TDT in the region.
- Examine alternative organizational and structural models for implementing NRM focused interCRSP in West Africa.
- Lay the groundwork for coordination among the participating CRSPs, NARSs, NGOs and IARCs.
- Utilize the workshop as a forum for future planning of the NRM interCRSP West Africa activities.

The workshop program has been designed and structured to address these main objectives through:

- Paper presentations on selected topics
- Panel discussions
- Presentation of a spectrum of perspectives
- Working group discussions
- Field visits
- Examination of a range of successful models of TDT
- Assessing alternative structural models for the interCRSP NRM initiative
- And finally concluding with a plan for the future or the initiation of the process for future planning of NRM interCRSPing in West Africa.

(a) The NARSs of the region emphasize that the most significant impact of the CRSPs has been the strengthening of the NARSs, both through staff training and research capacity building. It is acknowledged and highlighted by the management and scientists of the NARSs that the CRSPs have been critical players in assisting the NARSs reach their current stage of institutional development. The key staff in the region in management, as well as the leading research staff, were trained under the CRSPs.

In all of these discussions, it is expected that Niger will be the focal point and the regional model country for implementing many of the interCRSP NRM concepts.

Finally, the presentations, discussions, and recommendations of the workshop are planned to be published and these are expected to serve as a documented reference for further planning and implementation of the interCRSP NRM regional initiative.

We have a challenging and interesting assignment in this first interCRSP workshop in West Africa and I am confident that, at the conclusion of the workshop, we will have the expected product.

Regional Collaboration in Natural Resource Management

Keint Simmons, USAID, Niamey, Niger

Messieurs les Ministres
Messieurs les Ambassadeurs
Messieurs les Représentants des Institutions Internationales
Messieurs les Directeurs Généraux des Instituts de la Sous-Région
Monsieur le Directeur Général de l'INRAN
Messieurs les Directeurs Centraux
Messieurs les Chercheurs
Mesdames et Messieurs

Permettez moi, au nom du Directeur de l'Agence Américaine pour le Développement International, USAID/NIGER, vous remercier trés sincèrement de l'opportunité que vous me donnez de prendre la parole à l'occasion de cet important atelier sur la "Recherche Collaborative Sous-Régionale".

Cet atelier qui vient à point nommé, revêt une importance capitale pour l'USAID à un moment où l'un des grands défis à relever au Niger, est

la création d'un environnement économique favorable à des structures de productions rurales, également à un moment où notre programme de développement est entré dans une phase active de réorganisation.

Dans le cadre de cette réorganisation, la nouvelle vision de l'aide américaine est conçue de manière à lui conférer un impact plus direct et plus efficient au niveau du monde rural.

Il serait utile de rappeler que la mise en oeuvre des programmes de développement de l'Agence s'articule autour de quatre principes directeurs, à savoir:

1. **L'obtention de résultats identifiables:** cette obligation s'impose à l'USAID et au Niger, de concert avec les partenaires au développement.

2. **La focalisation sur les bénéficiaires ultimes:** ils sont intimement impliqués dans le processus de développement et occupent une place prépondérante dans la planification, l'exécution, le contrôle et l'évaluation des actions de développement durable.

3. **Le travail en équipe:** dans le processus de développement, l'USAID s'engage à travailler de concert avec nos partenaires et les représentants des bénéficiaires de laide, dans un souci de transparence et d'ouverture.

4. **La responsabilisation:** avec une approche participative, le responsable de l'équipe de chaque "Objectif Strategique" (SO) veillera à ce que toutes les parties concernées soient associées à toutes les decisions importantes prises par l'équipe. Dotée d'un pouvoir de décision, l'équipe sera tenue comptable des résultats escomptés.

La Mission de l'USAID/NIGER croît sincèrement et fermement que le concept de la recherche collaborative sous-régionale est la démonstration concrète et pragmatique de ces quatres principes directeurs.

A l'USAID/NIGER, nous croyons que la présente initiative est de nature à engendrer des résultats très significatifs pour le Niger.

Votre présence au Niger en votre qualité de chercheurs, est la preuve irréfutable de votre engagement à apporter l'appui nécessaire aux producteurs afr ica ins pour leur épanouissement et plus spécifiquement aux agriculteurs et aux éleveurs nigériens à travers la recherche collaborative sous-régionale.

Je peux affirmer sans risque de me tromper que nous poursuivons le même objectif à savoir: promouvoir et rehausser la productivité afin de stimuler la croissance économique du monde rural de manière durable.

En effet, il serait très intéressant de faire le bilan des expériences et des enseignements tirés par les chercheurs de l'INRAN, de l'INTSORMIL, de l'ICRISAT, les CRSPs et le Ministère de l'Agriculture et de l'Elevage. Durant ces 15 dernières années ils ont eu à intervenir dans plusieurs domaines tels que le "Programme d'Amélioration du Sorgho" avec la participations de techniciens et de paysans en vue de développer et de tester les meilleures variétés de sorgho dans les zones les plus humides du Niger.

Le concept de "Recherche Collaborative Sous-Régionale" a connu une nette évolution ayant permis d'associer la plupart des CRSPs intervenant en Afrique Occidentale. D'autres institutions nationales et régionales ont perçu les avantages d'évoluer dans le cadre d'un groupe de travail plus élargi permettant de regrouper les partenaires internationaux, américains et ouest africains.

Je crois que le défit que doit relever cet atelier est avant tout de développer entre les pays et les organisations, des relations de travail susceptibles d'aboutir à de résultats. Un modèle de travail en équipe est indispensable, tout en gardant à l'esprit les bénéficiaires.

Bien que cette conférence soit régionale, je vous demande de mettre l'accent sur les retombes qu'elle peut avoir sur l'accroissement de la production agricole des populations rurales nigériennes. A titre expérimental, elle permettra également aux équipes de chercheurs et aux paysans oeuvrant de concert sur le terrain, de tester les meilleures technologies agricoles, et de s'assurer si ces paysans les acceptent.

L'Objectif Stratégique relatif à la gestion des ressources naturelles au Niger vise à accroître l'adoption de meilleures techniques de conservation et d'utilisation durable des ressources naturelles limitées.

En ce qui concerne le Niger, l'adoption effective de meilleures techniques de conservation et d'utilisation de ressources naturelles, constitue l'indicateur de mesure pouvant permettre d'atteindre cet objectif et les résultats escomptés. Raison pour laquelle, nous pensons que les travaux de recherches collaboratives sous-régionales constituent l'élément clef qui permettra d'atteindre cet objectif.

Permettez une fois encore de plus de vous souhaiter la bienvenue et plein succès à vos travaux.

Vive la cooperation sous-régionale
Vive la cooperation entre le Niger et les Etats Unis d'Amérique.
Je vous remercie.

Opening Address

Representative of the Minitster of Agriculture and Livestock, Niamey, Niger

Monsieur le Directeur de l'AID,
Monsieur le. Directeur General de l'INRAN,
Messieurs les Directeurs des CRSPs

C'est pour moi un insigne honneur et un agréable devoir de prendre la parole devant votre auguste assemblée pour vous souhaiter la bienvenue à Niamey, à l'occasion de l'atelier sur le Développement et le Transfert de Technologie pour une meilleure gestion des ressources naturelles. La tenue de cet atelier au Niger est un heureux événement pour nous car la question des ressources naturelles, comme vous le savez, présente un intérêt capital pour le Niger.En effet la gestion des ressources naturelles constitue pour nous une voie incontournable pour assurer la sécurité alimentaire pour nos populations.

Votre atelier s'inscrit dans le cadre d'une approche originale d'interventions en milieu rural. En effet, rappelons que les Programmes Collaboratifs d'appui à la Recherche (CRSP) qui regroupent plusieurs universités américaines recelant une large gamme d'expertises, sont implantés en Afrique de l'Ouest et plus particulièrement au Niger depuis une décennie. Les chercheurs de ces universités menent en collaboration avec leurs partenaires des systemes nationaux de recherche agronomique, des activités de recherche sur des thèmes liés à la durabilité des systèmes de production et de gestion des ressources naturelles. Au Niger, 3 projets collaboratifs (CRSP) conduisent des activités de recherche en collaboration avec les chercheurs nationaux. Il s'agit du TROPSOIL dans le domaine des sciences de sol, de INTSORMIL dans le domaine de l'améioration génétique du mil et du sorgho, de la protection des cultures et de l'agronomie générale, et enfin

de Peanut CRSP, dans le domaine de l'amélioration de la production de l'arachide.

Ces Projets collaboratifs ont obtenu des résultats satisfaisants et intéressants; on peut citer l' expérience de Hamdallaye, la mise au point des variétés tardives de mil pour la zone sud du pays (régions à bonne pluviométrie), des variétés de sorgho à haut rendement et résistantes au *Striga*, pour ne citer que quelques uns. Bon nombre de ces résultats n'ont pas encore atteint le monde rural.

Votre atelier, sera j'en suis convaincu, un cadre idéal pour discuter non seulement de la mise au point de nouvelles Technologies mais aussi du transfert de technologies dans les terroirs en vue d'une meilleure Gestion des Ressources Naturelles. L'objectif final étant bien entendu l'amélioration des conditions de vie de nos braves paysans.

L'agriculture qui constitue dans notre sous-région, la principale activité économique, est soumise à des contraintes tant biologiques que physiques. La Recherche Agronomique s'avère être l'outil incontournable pour lever ces contraintes à la production agricole. Au Niger, la gestion des ressources naturelles constitue l'un des quatre "axes stratégiques" des principes directeurs de la politique de développement rural. C'est pourquoi, je peux d'ores et déjà vous assurer que le Niger et les autres institutions intervenant dans la gestion des ressources naturelles prêteront la plus grande attention aux résultats de vos travaux pendant les cinq prochains jours.

Au cours de cet atelier, vous aurez a vous pencher sur les objectifs suivants:

- La création d'une base commune d'entente entre les programmes collaboratifs d'appui à la recherche (CRSP) dans le domaine du Développement et de Transfert de Technologie.

- L'identification des contraintes prioritaires à la Gestion des Ressources Naturelles.

- La planification du Transfert de Technologies disponibles et des activités de recherche pour le Développement de Nouvelles Technologies.

- L'établissement de liens entre chercheurs, vulgarisateurs, organismes non-gouvernementaux et les organisations volontaires privées.

Vous aurez aussi à réfléchir sur la mise au point d'une unité de coordination des activités des différents CRSP, tant au niveau national que regional. Vu la qualité des participants, je demeure persuadé que vos travaux aboutiront à des résultats positifs qui contribueront à court ou moyen terme à une meilleure gestion des ressources naturelles qui restent très fragiles.

Tout en souhaitant un bon succès à vos travaux, je déclare ouvert l'Atelier Régional sur la Planification des Activités de Recherche Collaborative en Gestion des Ressources Naturelles InterCRSP.

Transfer and Diffusion of Water-Harvesting and Agroforestry Technologies: A Watershed Approach

A. S. R. Juo and T. L. Thurow, Soil Management CRSP, Texas A&M University, College Station, TX, USA
I. Zanguina, Soil Management CRSP and INRAN, Niamey, Niger
A. Manu, Soil Management CRSP, Alabama A&M University, Normal, AL, USA

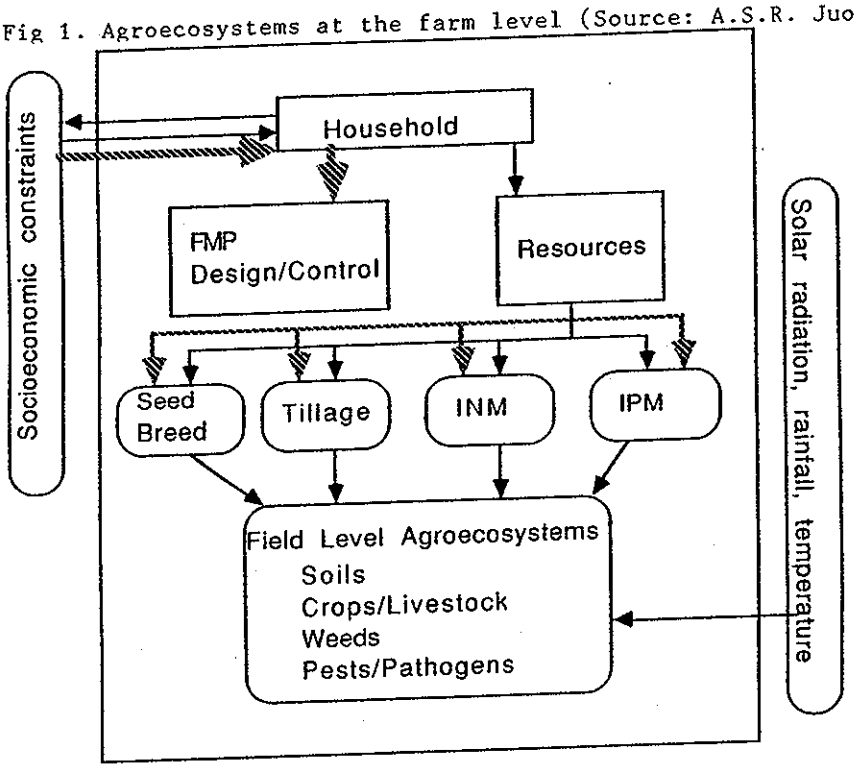
Component NRM technologies for rainfall harvesting and erosion control are well described in numerous publications. However, packaging, transfer and diffusion of these technologies are site-specific. A logical unit for technology transfer is a watershed. To synthesize and package NRM technologies, diagnostic surveys and GIS methods are used to characterize the physical and socioeconomic environments (i. e. drainage pattern, slope, soil quality and distribution, farming systems, land tenure and other social and cultural characteristics of the local community).

For the InterCRSP NRM initiative, research and extension should be conducted both at the farm and at the watershed or landscape level. At the farm level, the role of technology is depicted in a conceptual agroecosystem model given in Figure 1. The transfer and adoption of appropriate technologies or package of technologies to increase production and sustain productivity are determined by the climate, soil, and availability of inputs (i. e. human and material resources). Four types of technologies are needed to sustain agroecosystem productivity, namely, healthy seeds, appropriate tillage practices, integrated nutrient management (INM) and integrated pest management (IPM) strategies. The farm household is the ultimate control and decision making unit.

At the watershed or landscape level, the control and decision making processes are made at the village community level. Here, support from local or national government is needed (i. e. infrastructure and policy). The role of technology in NRM at watershed level may be illustrated in Figure 2. Here, we must recognize the interdependence of different land use within a watershed, namely, the croplands, the rangelands and the forestlands situated on land units with different slopes and soil quality. Thus, ecologically and economically sustainable management can only be achieved by adopting a holistic watershed management plan with full participation of the farming and non-farming communities that derive their livelihood in the watershed.

Due to the vast scope of degradation of grazing land (or common land) throughout the West African region, it is proposed that the InterCRSP NRM initiative adopts the following implementation strategies: (i) to synthesize and package NRM technologies that can be transferred to selected watershed sites; (ii) to demonstrate, through 'on-farm participatory research', land rejuvenation and rainfall harvesting technologies (physical and biological) that can be readily adopted by the farming and non-farming communities in the watershed; (iii) to develop a regional data base and GIS models or other form of decision support systems that can be used to facilitate information exchange among researchers, planners and extension workers and to accelerate technology diffusion and transfer to other areas in West Africa.

Fig 1. Agroecosystems at the farm level (Source: A.S.R. Juo)



Flow of energy & material

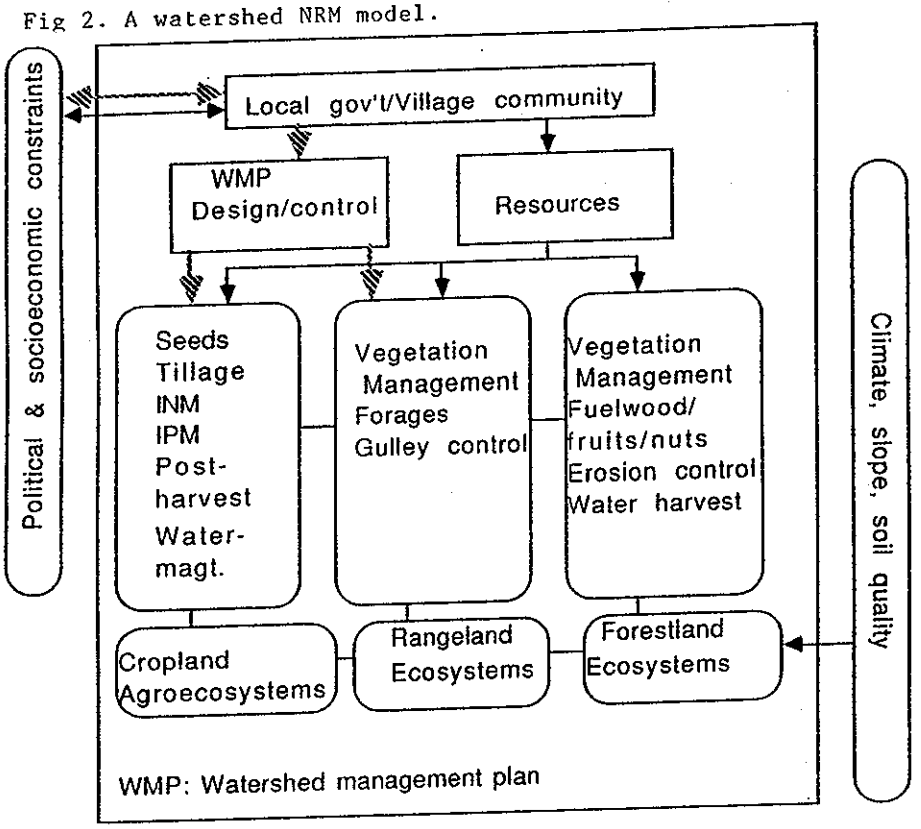
Flow of information

INM: Integrated nutrient management

IPM: Integrated pest management

FMP: Parm management plan

Fig 2. A watershed NRM model.



(Source: A. S. R. Juo, 1995)

SOME PROMISING NRM TECHNOLOGIES FOR WEST AFRICA

I. Semiarid tropics

Microcatchments
Fast growing, drought resistant trees and perennials
Rock (laterite) contour dikes
Tree-crop mixed systems
Vegetative windbreaks (trees or crops)
Soil nutrient management and cycling, especially P.

II. Subhumid tropics

Alley cropping (e. g. *Luecaena and Gliricidia*)
Minimum-till and crop residue mulch
Vegetative contour barriers for erosion control (e.g. Vetiver)
Green manuring and cover crops (e. g. *Mucuna and Sesbania*)
Water management (for rice and aquaculture)
Soil nutrient management and cycling, especially, N and P.

III. Humid tropics

Homestead agroforestry (fruits, nuts, timber, spice, etc.)
Root crop-based systems (e. g. cassava, cocoyams)
Green manuring and cover crops (e.g. *Peuraria phaseoloides)*
Water management (for rice and aquaculture)
Conservation of biodiversity of rain forest ecosystems

Stratégies Disponibles Pour une Gestion Durable des Ressources Naturelles (GDRN) en Afrique de l'Ouest

Somé Salibo, Université Ouagadougou, Ouagadougou, Burkina Faso

La gestion inappropriée des ressources naturelles explique la réduction des besoins de base et la dégradation des conditions de vie dans notre sous-région. Face à de tels enjeux, de nombreux efforts ont été entrepris pour y sensibiliser les populations ou former les producteurs aux diverses stratégies de restauration et de sauvegarde de ces ressources. Le présent exposé donne brièvement les différentes stratégies mises en oeuvre ainsi que les contraintes majeures de transfert des connaissances.

Strategies Disponibles Pour la GDRN

1. Dispositions générales

Comme dispositions générales nous notons: a) la répartition des terroirs villageois en zones distinctes d'élevage, de culture et de forêts pour non seulement en rationaliser la gestion, mais aussi pour réduire les conflits entre les éleveurs et les agriculteurs, b) la lutte contre les feux de brousses, c) la lutte contre la coupe abusive du bois, d) la vulgarisation des foyers améliorés pour permettre une économie du bois de chauffe, e) la lutte contre la divagation des animaux domestiques qui broutent non seulement les cultures, mais aussi les résidus de récolte.

2. Conservation des eaux et du sol

2.1. Ouvrages anti-érosifs. Les ouvrages anti-érosifs sont divers et comprennent a) les cordons pierreux, b) les bourrelets de terre, c) les "demi-lunes", d) traitements de ravines (digues filtrantes), e) la végétalisation des ouvrages anti-érosifs, f) les haies vives ou mortes.

2.2. Pratiques culturales conservatoires. Les pratiques culturales conservatoires se résument aux suivantes: a) labour en courbe de niveau, b) paillage des sols, c) billons cloisonnés, d) semis en lignes suivant les courbes de niveau et suivi de billonnage, e) semis directs, f) agroforesterie.

2.3. Pratiques de restauration et de maintien de la fertilité des sols. Elles incluent les pratiques ci-dessus mentionnées, mais plus spécifiquement les suivantes: a) le "zaï" [simple, paille, fumé, etc.], b) l'application de fumures organiques (fumiers, engrais verts, etc.), c) les techniques de compostage, d) les techniques d'épandage des engrais minéraux, e) l'utilisation des légumineuses (herbacées et ligneuses), f) les systèmes de rotations des cultures, g) les systèmes de cultures associées, h) l'agro-sylvo-pastoralisme.

3. Stratégies d'approche

La dynamique nouvelle observée a l'heure actuelle dans le processus de développement à travers l'Afrique de l'Ouest se caractérise par des approches sages, dites participatives, interdisciplinaires et inter-institutionnelles. Cela rompt avec les pratiques antérieures pour favoriser non seulement l'économie des ressources disponibles, mais aussi la coordination des efforts pour un développement plus rapide et durable. La participation des populations devient plus transformative que instrumentale en prévision d'une auto-gestion de la communauté rurale à long terme. Les programmes nationaux de Gestion des Terroirs (PNGT) et les Plans d'Action Nationaux pour l'Environnement (PANE) en sont très illustratifs. Au Burkina Faso en particulier, le Plan Stratégique pour l'an 2000 de l'Institut d'Etude et de Recherche Agricole (INERA) en fait une philosophie de base que partage largement le programme SANREM. La plupart des ONGs tels que le Plan de parrainage International (PPI), le ProSet Sahel/Burkina (PSB), la GTZ, etc. qui interviennent dans le monde rural en font aussi leur principe.

Contraintes de Transfert des Connaissances

En général, les enjeux liés à la dégradation des ressources naturelles sont mieux comprises à la suite de la dégradation des conditions de vie. Au niveau individuel, l'experience vécue au Burkina Faso permet de situer les contraintes d'adoption des technologies aux niveaux suivants:

1. Niveau nateriel

Les problèmes matériels couramment rencontrés par les producteurs dans le suivi des recommandations sont: a) le manque d'aliments pour les animaux en saison sèche, nécessitant l'exportation des résidus de récolte ou la liberation des animaux pour pâture libre dans les champs récoltés, b) le manque de moyen de transport des fumures organiques, et c) la faible disponibilité en fumures organiques, d) le manque d'eau pour la fabrication du compost.

2. Niveau économique et humain

Au stade actuel de paupérisation de nos populations, certains producteurs utilisent les ressources naturelles comme seul recours pour satisfaire leurs besoins financiers et matériels. L'exportation des résidus de récolte et la coupe du bois en sont des cas d'exemple. Cet état de fait engendre un cercle vicieux relatif à la durabilité de ces ressources.

L'exode des jeunes vers les villes à la recherche de travail remunéré prive certaines familles de leurs bras valides et rend difficile l'exécution de certains travaux tels que le creusage du zaï et parfois même la fabrication de la matière organique.

3. Niveau de connaissances théoriques et techniques

Les remarques suivantes peuvent être retenues: 1) Beaucoup de producteurs sont très intéressés par l'explication des phénomènes observés dans la vie pour mieux comprendre et apprécier les recommandations faites, 2) en effet, l'adoption des technologies nouvelles et surtout le degré de prise de conscience du producteur dépendent non seulement des résultats concrets, mais aussi de leur niveau de connaissance de la théorie qui explique ces résultats, 3) l'esprit de curiosité et l'envie d'apprendre du producteur sont facilement aiguisés lorsque ce dernier est lui-même associé à la recherche des solutions.

Conclusion

Le niveau de connaissances théoriques et techniques des producteurs apparait comme une contrainte prédominante dans l'adoption des technologies pour une gestion durable des ressources naturelles. Nous pensons qu'un accent particulier doit y être mis a travers des programmes integrés de formation continue qui pourrait éventuellement s'adresser à tous les autres agents du développement.

Genetic Resources in Beans and Cowpeas

Russell Freed, Bean/Cowpea CRSP, Michigan State University, East Lansing, MI, USA

Genetic resources are very important components of any natural resource management system. These resources are both plants and animals. This report will talk about one crop - cowpeas. This report will illustrate how genetic resources can make dramatic impacts on some of the goals that we want to accomplish, among them: 1) increase economic growth, 2) improve nutrition/health, 3) conserve our scarce resources, 4) enhance soil fertility/structure and 5) enable our low-resource farmers to exploit some of this planet's unlimited resources to enhance their food security and improve their quality of life.

Farmers play a very important role in the selection and preservation of our genetic resources. Farmers have for centuries been the people who have preserved the rich array of genetic material in their traditional varieties. Farmers have always been the "keepers of the trust", that trust being the genetic material necessary for enhancing our production systems. Farmers are also the main custodians/managers of the rural natural resources.

Cowpeas comprise nearly 90% of the area cultivated to cash crops in Niger. Cowpeas are extremely drought tolerant, excellent food for human and animal nutrition, and improve soil fertility by fixing atmospheric nitrogen.

The average crop production system in Niger can be characterized as follows:

1. Minimum resources are allocated to crop production (fertilizers/pesticides)
2. Cropping systems utilize unimproved seed, random plant spacing, and low plant populations
3. Marketing systems are immature
4. Hand labor predominates
5. Water is a major constraint

The introduction of genetically improved cowpea varieties can have a dramatic impact on the cropping systems as characterized above. Improved seed will spread very quickly. New varieties are also a "renewable" technology.

ISRA (Senegal) has developed several new cowpea varieties which are drought tolerant and have resistance/tolerance to some very important insects and diseases. Mouride is resistant to bacterial blight, *Striga,* cowpea weevil and is very drought tolerant. Melakh is a 55 day variety which is resistant to cowpea aphid-borne mosaic and the cowpea aphid.

These two varieties were bred to perform well in low-input and high-input environments. Breeders can select varieties which perform in both types of environments.

Plant breeders have identified a character which delays leaf senescence. This trait delays leaf drop and causes (when water is available) a second flush of flowers.

Biotechnology is a very important tool to consider when talking about genetic resources. Biotechnology has been a priority of the B/C CRSP for several years. Biotechnology is very important for cowpeas for several reasons; 1) insect resistance is not available via traditional breeding, and 2) need to get speciality (value-added) crops for farmers.

Many agricultural economies are evolving into a value-added knowledge-based industry. If our partners/collaborators are going to compete in the world economy, biotechnology needs to be available to them.

The B/C CRSP has been proactive in what can be called "reverse germplasm flow". Genes that are made in our biotechnology programs are being made available to cowpea breeders around the world. In the future, novel genes will increase the amount of genetic resources available to plant breeders. Novel genes will be used to help farmers harness the unlimited resources of the sun, CO_2, and water to produce raw materials which are unknown today.

"There is today a vast technological fault line. On the one side are the fast growing, adolescent, undercapitalized, undereducated societies; on the other, the rich, technologically inventive, yet demographically aging populations. The greatest challenge that global society faces is preventing this fault line from erupting into a world-shaking crisis." Paul Kennedy, Herald Tribune, July 23-24, 1994.

The Bean/Cowpea CRSP has committed it's resources to help strengthen national cowpea programs through collaborative research and training activities. The use of improved cowpea varieties has had a tremendous impact in Senegal, in both increasing production and farmers' income. We are eager to work with the other national

programs, CRSPs, IARCs, and regional centers to improve the quality of life for the low-resource farmers in West Africa.

Small Ruminant Collaborative Research Support Program Initiatives in Natural Resource Management

Will R. Getz, Small Ruminant CRSP/Winrock International, Morrilton, AR, USA

The goal of the Small Ruminant CRSP is to improve the efficiency of small ruminant production by developing technologies and interventions which generate economic development and which enhance and sustain the environment to benefit the social and economic well-being of people. In concert with this we seek to strengthen the research capacity of host-country research institutions as well as enhance the critical mass of small ruminant researchers in the United States. Small ruminants contribute significantly to the economy and food supply in many countries and the demand for sheep, goat, and candid products exceeds the supply. Improving the performance of small ruminants improves the standard of living and diet of many small holders.

The SR-CRSP was organized in 1978 with seventeen institutions. The University of California-Davis was designated the Management Entity. Because many projects and country programs have been completed, there are currently ten institutions involved. Work sites in which the SR-CRSP has been operational include Indonesia, Kenya, Morocco, Brazil, Peru, Bolivia, and the US. The program has direct influence on several additional countries. The SR-CRSP has enabled over 300 scientists to obtain master's or doctoral degrees.

A major consideration in the SR-CRSP has been to focus on the development of production systems which promote the responsible use of local natural resources. In recognition of the fact that animal and land management strategies must be based on farmer-derived information, the SR-CRSP introduced and has refined much of the early work in on-farm client-oriented research methodologies as applied to animal

agriculture. Much of the information going into these systems is derived from research in sociology, economics, feed resources, range management and issues related to land use, marketing, and disease control strategies.

Several of the production system components that impact on improved resource management include:

- The use of multipurpose trees which provide fuel wood, soil fertility enhancement, and animal feed. These provide a renewable source of wood close to home and higher crop yields on existing land thus negating the need to move onto more marginal lands.

- The use of animals in weed control strategies in rubber plantations, thus reducing the need for herbicides which are certainly a more expensive intervention and may be environmentally risky.

- Utilization of existing food crop pans, residues, and by-products to add energy, protein, or special elements to the diets of animals as they produce manure for the cropping system, cash for the household, and better nutrition for children. Under such a strategy, the need to allocate additional land to grow animal feeds is minimized.

- The development of thermal-stable multivalent virus-vectored vaccines against infectious and parasitic diseases which result in high rates of wastage and the depletion saved of household resources.

Institutionally, the SR-CRSP has intentionally promoted the establishment of farming systems research capability within the host-country research agencies. The mentality and way of thinking for those engaged in sincere systems research is conducive to an awareness of the big picture and consideration of the role of farming and livestock raising practices in the complex relationships found in the natural resource system and development of strategies for appropriate natural resource management.

Providing farmers and the agricultural sector with choices is one of the important outcomes of our research and outreach efforts. In the case of sheep breeding for example, elucidation of the mechanism controlling prolificacy and the identification of variation in this characteristic has provided farmers with information on the reproductive capacity of breeds and types within their own country. This information is then used to determine which type is most appropriate for their farming system and the resources associated therewith. This kind of information

is necessary for keeping the expected outputs in balance with available human, monetary, and natural resources.

In the more arid tropics the SR-CRSP has documented changes in the species mix of livestock herds as changes in the annual rainfall occur. Under such circumstances, marketing and feed resource use become increasingly important as farmers seek to maintain their asset base while attempting as well not to destroy the existing natural resources. Research on interventions which can create the necessary flexibility for food and income security mean a great deal to people in such circumstances.

The on-farm research approach that has been used extensively by SR-CRSP scientists, puts them in touch with farmers and rural communities. Many of the decisions regarding natural resource management are made locally by the same people who have an interest in animals and animal products. In other community-based natural resource management initiatives it has been observed that different members of a community view the use of various resources according to their particular vantage point. Community based research therefore has the potential to capture that information in the course of identifying constraints and testing interventions with farm families. Many local people, while appearing to be oblivious to what are acknowledged as short-sighted natural resource user habits, realize that long-term sustainability requires a different set of actions. Yet viable alternatives have not been identified. Thus farm-level research with small ruminants allows researchers and farmers to find solutions together.

In our efforts toward establishment of sustainable agropastoral systems on marginal lands, the SR-CRSP undertakes to develop new approaches to strategic interventions. Such interventions must have greater likelihood of success than previous development efforts, and must optimize offtake consistent with sustainable ruminant production in a ecosystem context and contribute to the equitable economic and social well-being of all participants. This represents an acknowledgment of the balance necessary between gaining knowledge and understanding in animal production, and the need to learn how grazing and browsing affects the local environment.

In all cases the annual research plans of the SR-CRSP take into consideration the environmental impacts and relevance, as well as the sustainability of various studies. This has resulted in research information from marginal lands relating to the severity of impact by humans and grazing animals on plants, the ability of forage plants to recover from grazing, and the phenological stages at which several native plants are most severely impacted by grazing. Sustainable animal

production systems are developed when information about quality and quantity of forage resources is documented and the basic deficiencies have been ameliorated in a socially, environmentally, and economically sustainable way.

Our economics research has examined the extent to which rural families depend on animals to provide cash and nutritional inputs that can come from a range of sources. The extent to which the small ruminant enterprise can provide these outputs, will influence the degree to which the more destructive farming practices will be used. There is evidence from some sites that population and market pressures are threatening the sustainability of drought-prone agropastoral zones. Livestock, particularly small ruminants, play a major role in risk management strategies in these sites. Sociological work has shown that the impact of institutional policy and environmental changes on resources management is crucial to understanding the resiliency of household production systems to the environment, and the role small ruminants play. One of the major results of our sustainable agropastoral systems work is that soil erosion seems more related to agricultural intensification than to the popular notion of overgrazing.

The case for improved natural resource management in the US is suggested by work on mixed livestock species grazing for better utilization of forest range and associated pasture; additionally, studies in the use of adapted sheep types in the hot and humid areas of the Southeast where heat tolerance, parasite resistance, and nonseasonal estrus are important.

Existing Animal Genetic Resources in West Africa

Will R. Getz, Small Ruminant CRSP/Winrock International, Morrilton, AR, USA

In West Africa, as in most other parts of the world, the function of animals in sustainable agricultural systems and in meeting rural household needs includes: 1) the provision of soil ammendments for enhancement of fertility levels and neutralization of acid soils, 2) more complete use of plant products and the ability to concentrate nutrients available from multipurpose trees, plant parts, residues, by-products, and field borders, 3) accumulation and storage of cash resources that can be liquidated on an as-needed basis for crop system inputs, support of family needs, community development, and 4) the provision of dietary essential elements including minerals, vitamins, and protein in concentrated and readily absorbed form.

The distribution of most farm-animal species in West Africa is influenced by three factors, 1) agroecological zone, and the kind and amounts of feedstuffs available; 2) disease prevalence, especially trypanosomiasis as transmitted by the tsetse fly, and 3) proximity to population centers which influences the cost of production inputs, and the availability of major markets.

A multitude of animal species exist and contribute to the livelihood systems of rural people in West Africa. Characterization of these species has been documented by FAO, ILRI, OAU-IBAR, and scientists in numerous national agricultural research institutes. The available genetic resources and essential role of animal agriculture in meeting the food system needs of Africa by the year 2025 has been documented by Winrock International (1992). A seminal study on hair sheep of western Africa and the Americas (Fitzhugh and Bradford, 1983) helped identify sources of sheep germplasm in the Region.

Several international and regional agricultural research organizations continue to be involved in germplasm evaluation in West Africa. The International Livestock Research Institute (ILRI), based in Nairobi/Addis Ababa and with program loci at IITA and Institut du Sahel, through their cattle, small ruminant, and forage research has established programs that examine genetic potential, nutritional needs, and the economic parameters of production systems and disease control. The Centre International de Recherches et Developpement sur l'Elevage en Zone Subhumide (formerly Centre de Recherches sur

Trypanosomoses Animales), based in Burkina Faso, has a program in applied and adaptive research, technology transfer, and training in broad aspects of livestock production and health. The International Trypanotolerance Centre (ITC), located in The Gambia, is devoted to the dissemination of genetic stocks of trypanotolerant livestock. This function might ultimately be taken up by the private sector, or ITC might redefine its program and become a regional research institution serving countries that share agroecological and other characteristics. Breeding research by the SR-CRSP in Morocco provided evidence of the essential variation in prolificacy among indigenous breeds of sheep and provided genetic resource options for several production systems. In Kenya, the SR-CRSP developed a composite dual-purpose goat for mixed crop-livestock systems, by combining indigenous and exotic germplasm in proportions suggested by systems simulation research. These methodologies are available now to meet the genetic resource needs of West Africa. The inclusion of social and economics elements of the system has been part of the program from the beginning.

The cattle in West Africa include humped (zebu and Sanga types) and humpless types such as the trypanotolerant N'dama. It is estimated that the zebu arrived in the Horn of African about 2200 years ago, but the humpless cattle were already in place by the time the zebu arrived on the scene. Authorities differ about whether the N'Dama is a descendant of the humpless longhorn cattle of ancient Egypt (Hamitic Longhorn) or of the Brachyceros which arrived some what later. By 4000 BC before historic times, long-horned humpless cattle had been domesticated in the Nile Valley. They migrated down the Atlantic coast as far as present-day Nigeria. Apparently they were not as hardy as the Brachyceros which followed them and were eventually replaced after interbreeding and natural selection took place. Both zebu and the humpless cattle are found today in West Africa. The zebu population is the larger of the two, and the humpless cattle located in more humid zones of the Region where the tsetse challenge is more pronounced.

Among the small ruminants there have been four rather distinct breeds of sheep, and three breeds or types of goat described and characterized by various authorities. Small ruminants tend to be somewhat more trypanotolerant than cattle, especially the zebu type. This tolerance is reflected in the more wide-spread distribution of small ruminants as compared to cattle. The distribution of various breeds and species of livestock tends to follow environmental or vegetative ecological zones in West Africa. These zones generally run from east to west and pass through several countries in the Region. So for example, the West African Dwarf sheep/goat is most often found in the warm, forest areas from Cameroon to Liberia.

Camels and donkeys are used as beasts of burden, and they can provide power for land preparation in West Africa. Camels have the added advantages that they can be milked, and are regularly used as a source of meat in meeting the nutritional needs of people. While camels tend to be utilized primarily in the dryer zones of the Region, donkeys appear to be ubiquitous and are utilized in most zones where serious health challenges do not regularily occur. Both of these species contribute to the livelihood systems of rural and urban people. In most cases they are both utilized in the same zone. From beast of burden and transport considerations, it is said the donkey is sometimes considered the poor man's camel. The camel is better adapted to the most extreme arid conditions, and the morphology of their feet contributes less to soil erosion as compared to other ungulates.

As in other regions of Africa, there is little use of the traditional breeds of poultry or pigs in commercial production systems. Their production level is not adequate to justify the usual investments in housing, feed, and health components of commercial production. On the other hand, in this era of genetic engineering and DNA manipulation, it is important to characterize the indigenous stock for potential useful characteristics related to food product quality, disease resistence, and other traits which can be transferred to commercial stocks for enhanced productivity. Recent studies have affirmed the role of these species in meeting the animal protein needs of Africa during the next 35 years. Much of the supply of food animal products used in urban areas will come from these species because of their reproductive cycle, high yields, and production efficiency. The utilization of concentrated animal waste in soil management strategies and cropping systems will tend to provide more relief for marginal lands which might be better utilized for tree crops of other less intensive use.

Finally, the animal genetic resources of West Africa include many smaller species such as rabbits, bees, guinea pigs. These species can contribute to the overall household food security by providing food products themselves or providing items that can provide household cash. Research-derived information from the farmers using these species, will provide a more accurate assessment of existing utilization patterns, and the base-line information for impact assessment within the household.

In building the technology development and transfer agenda in regard to the livestock component of agricultural and natural resource management systems in West Africa, constraints associated with each of these genetic resources will need to be identified. This can be done most appropriately through the review of previous studies, as well as

the initiation of farm-based research in collaboration with other biologists, economists, and sociologists.

Sorghum Hybrids: A Viable Technology for Sustaining Sahelian Agriculture

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Sorghum is the second most important food crop in Niger, with an estimated acreage on the rise from 768,070 hectares in 1980 to more than two million hectares in 1994 (Anonymous,1995). Productivity has however taken the reverse direction, and the average grain yield is less than 300 kg/ha for the same period. This trend was in fact observed from the late 1960s with average yield dropping from 589 kg/ha in 1969-71 to 390 kg/ha in 1974-76 (Dogget, 1988). This is very alarming because Niger has one of the highest population growth rates (3% per year), being observed for the developing world. The population in Niger has increased from 2.4 million in 1950 to an estimated 9.151 million in 1995 (Center for International Health information, 1995). In a country where more than 90% of the people are involved in farming, there is undeniably a lot of pressure on land use for cropping as well as herding, especially since the rainfall patterns have become more erratic in recent decades, reducing the total available area for agriculture.

The consequences on genetic resources and their use are very dramatic as can be observed for sorghum. In the absence of a reassuring alternative, most sorghum growers have the tendency to replace their old later-maturing varieties with new early-maturing types, which are more likely to escape drought periods, often at the expense of higher productivity. These early selections are taken from any source, even from grain obtained through food aid programs as seems to be the case for a three-dwarf local variety known as Tera; but the most common are in the 'MOTA' group (meaning car in the Hausa language, thus fast moving); selected by farmers from their own landraces probably on the basis of earliness, the Motas are more likely to escape the very frequent

drought periods. Concurrently, landrace varieties like Janjare, which was considered so well adapted that the French IRAT used it in the early 60s in developing the improved L30, and L30 itself, are becoming practically extinct, and are probably more visible at INRAN research stations than in farmers' fields. Local landraces are certainly the best source for crop improvement in the long term, because they have accumulated many adaptation traits that modern breeders can make use of in scientific approaches for increasing agricultural productivity. However, in the present situation of worsening environmental conditions and population pressure, alternatives are needed that can safeguard local germplasm while improving productivity.

With the help of the INTSORMIL project, a new dynamism has integrated the INRAN sorghum breeding program since the early 1980s. While new landraces are continuously brought in for evaluation, especially the early 'dune' sorghums specific to Niger, some of the best adapted have been incorporated in random-mating populations, providing a low maintenance broadbase source of local germplasm that we can select from or improve at any time. At the same time, we conduct variety development through the pedigree method, intercrossing germplasm that we select in Niger and that provided by our collaborators on the basis of its geographical origin similar to that of Niger (eg. Sudan), and/or because it has been improved for the same objectives as those of INRAN (high yield, early maturity, drought tolerance, *Striga*, mold).

The best success of our collaboration is however the demonstration that sorghum hybrids are an agricultural technology viable even for harsh environments, as is the case in Niger. This is essential, because it is recognized that in the context of today's population growth in developing countries, yield increases offer the best answer to meeting new food demands (Pinstrup-Andersen and Pandya-Lorch, 1995). Adoption of hybrids would also be beneficial to the environment since high and stable productivity may restrain the desperate use of marginal soils. Although introduced sorghum hybrids were tested during the IRAT program of the 1960s, they were not seen as a good alternative for Niger because of grain quality problems (Chantereau and Adamou, 1977), and the perception that they were too much input-dependent. It was not until two INTSORMIL supervised-M.Sc research projects were conducted in 1986 by Kapran and Tyler, respectively, that a systematic study of the value of heterosis was conducted in Niger. Kapran (1988) reports the comparison of a group of 90 hybrids to their parents in presence of local adapted checks, at several environments in Niger. Whereas parental lines were comparable to local varieties only under irrigation, hybrids were consistently better yielding than both: they surpassed the locals by 61% with irrigation and 49% under rainfed

conditions; yield advantage of hybrids over parents (heterosis) was 45% higher under irrigated conditions, and even higher in the rainfed experiments (66%). Tyler (1988) tested 40 hybrids under the same rainfed environments as Kapran, with male parental lines grouped as exotic, intermediate, or local. He also found that hybrids were higher yielding than parents or checks; grain yield heterosis over male parents was of 127% for exotics, 83% for intermediate, and 66% for locals. Following these clear expressions of heterosis in Niger, the best hybrids from both studies were re-synthesized and evaluated regularly.

Over the years, the cross between TX623A and MR732 (later named NAD-1) was consistently high yielding in comparison with other hybrids or varieties, including the best adapted landraces of Niger. Starting in 1989, it was entered in the regional sorghum trials covering at least six West and Central African countries, and was good yielding under most conditions. Specifically in 1989, it ranked third of twenty entries including a local check and other ICRISAT hybrids or varieties, tested at nine locations in Ivory-Coast, Mali, Burkina-Faso, Cameroon, Nigeria, and Niger (ICRISAT/WASIP, 1989).

Also starting in 1989, an experimental seed production was started at Maradi (Niger), and demonstrated at the level of a national breeding program in West Africa, the feasibility of a large scale hybrid seed production. The same year we also gave the first sample of hybrid seed to a few farmers in the village of Bazaga near the INRAN/Konni station, and the feedback was extremely positive. Incidentally, this is where for the first time, a farmer who heard us explain the system of seed production using A and R lines, compared the hybrid to a mule (Alfadari in Hausa, the 'A' in NAD1). This was the beginning of our on-going farm-level demonstration plots, which have increasingly attracted more farmer interest, to the point where today it is difficult to satisfy all requests for hybrid seed. At this point, again with the help of INTSORMIL, additional seed has been continuously produced since 1993 in the USA and shipped to Niger for the demonstration plots.

Overall, the average yield of NAD-1 between 1986 and 1994 is of 2758 kg/ha on-station, ten times the average yield of the farmer in Niger (273 kg/ha; Anonymous, 1995). Starting in 1993, we have quantified NAD-1 ' s productivity on some of the farm-level plots. For 1993, the average farmer yield for the Konni and Jirataoua region was 2365 kg/ha for NAD-1. In 1994, NAD-1 yielded an estimated 1725 kg/ha (Say), 3500 kg/ha (Jirataoua), 3800kg/ha (Cerasa), and 4600 kg/ha (Konni), for an overall average farmer yield of more than 3000 kg/ha.

Taking into account the food quality problems of an earlier INRAN release, Kapran (1988) and Tyler (1988) conducted preliminary food

(tuwo) quality tests of some of their test hybrids at the village level, and concluded on generally an acceptability similar to that of local varieties. This was taken a step further in 1990, in a collaborative INRAN/ INTSORMIL wide scale food quality test. Three of the improved genotypes (NAD-1, SEPON-82, SRN-39) were evaluated together with a local variety across four regions, to obtain farmer feedback and compare the ratings with physico-chemical traits in laboratory analyses. NAD-1 was always rated as a good tuwo-making entry. As can be seen, some ten years later after it was selected, NAD-1, is still a high-yielding medium-maturing hybrid, with good drought tolerance and acceptable food quality, both on-station and onfarm. Its consistency of production was also compared to that of other improved and local genotypes (Visser, 1992), and NAD-1 hybrid was the most stable.

The subject of yield stability was recently addressed by another INTSORMIL thesis project (Ibrahim, 1995). A total of 126 genotypes including 90 hybrids, their parents and other checks were evaluated across 15 different environments in Niger, the US, South America, and Sudan. Hybrids not only gave better yields in all environments, they in fact showed a greater yield stability under stress than non-stress environments. Ibrahim (1995) concludes that for stress environments in semi-arid tropics, hybrids are more reliable genotypes.

Despite the lack of a modern seed industry in Niger, the program of new hybrid production and testing, continues. Hundreds of new combinations are made and tested each year, and our preliminary observations indicate that a number of them have a yield potential similar to that of NAD-1. It is striking for example that some of them were obtained using as male parents, lines that we selected in Niger, from early generation germplasm provided by our INTSORMIL collaborators (90SN- series). Also, new A-lines like ABON34 appear to have similar good combining ability as TX623A, the female parent of NAD-1.

Based on elements including the continuously encouraging results obtained on-station since 1986, and farmer enthusiasm since 1989, it is realistic to suggest that hybrids may be the best route for increased sorghum productivity in Niger. The crucial problem to be solved is that of a viable seed production mechanism, and the history of its elaboration in countries like India, Zambia, and Sudan, is an encouraging signal.

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Les Sorghos Hybrides: Une Technologie Viable pour une Agriculture Durable au Sahel

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Le sorgho, deuxième culture vivrière du Niger, est cultivé sur des superficies croissantes ayant passé de 768,070 hectares en 1980 à plus de 2,000,000 d'hectares en 1994 (Anonyme, 1995). Sa productivité est cependant en chute, le rendement moyen étant de moins de 300 kg/ha pour la même période. En fait la tendance à une faible productivité s'observe depuis la fin des années 60, le rendement moyen ayant decliné de 589 kg/ha en 1969-71 à 390 kg/ha en 1974-76 (Dogget, 1988). Ces données sont alarmantes quand on sait que parmi les pays en développement, le Niger présente l'un des taux de croissance démographique les plus elevés (3%). La population totale du Niger a passé de 2.4 millions en 1950 à 9.151 millions en 1995 (Center for International Health Information, 1995). Dans ce pays ou plus de 90% de la population sont dans les activités agricoles, cela provoque certainement beaucoup de pression sur les terres, pour les besoins culturaux ou de pâturage, surtout qu'avec la pluviométrie erratique des dernières décades, il y a une forte réduction des superficies utiles.

Tout ceci a de sérieuses conséquences sur l'utilisation agricole des ressources génétiques végétales comme le sorgho. En l'absence de toute autre alternative viable, les producteurs de sorgho ont en effet tendance à semer des variétés précoces pouvant échapper à la sécheresse, à la place des anciennes variétés tardives, souvent au prix d'une baisse remarquable en productivité. Les nouvelles variétés peuvent provenir de n'importe quelle source, parfois même des graines reçues dans le cadre de l ' aide alimentaire comme semble être le cas pour une variété courte connue sous le nom de Tera; cependant les plus connues sont dans le groupe des 'MOTA' (signifiant voiture en Hausa, donc allant vite). Les Mota sont sélectionnés par les agriculteurs au sein de leurs propres variétés locales probablement sur la seule base d'un cycle végétatif précoce pouvant les aider à échapper aux deficits hydriques. Parallèlement, des variétés locales telles que la JanJare, considerée dans le temps comme l'une des plus adaptées par l'IRAT au point de l'utiliser dans la fabrication de la variété améliorée L30, et la L30 elle-même, ont pratiquement disparu et sont probablement plus disponibles a l'INRAN que chez les agriculteurs. Les ressources génétiques locales sont incontournablement la meilleure source pour l'amélioration des plantes à

long terme car elles ont accumulé beaucoup de caractères adaptatifs que les chercheurs peuvent utiliser scientifiquement pour augmenter la productivité. Cependant dans les conditions difficiles actuelles de l' environnement, il est nécessaire de trouver des alternatives pour conserver ces ressources tout en ameliorant la productivité agricole.

Avec l'aide du projet INTSORMIL, le programme d'amélioration du sorgho de l'INRAN a connu un nouveau dynamisme depuis le début des années 80. Tout en continuant à tester les variétés locales, en particulier les variétés de sorgho dunaire spécifiques au Niger, les plus adaptées sont incorporées dans des populations contenant un gène de stérilité nucleaire permettant le brassage illimité au hasard, ce qui constitue une source extensive de gènes locaux, facile à maintenir, en permanence disponible pour les sélections, et que l ' on peut toujours améliorer. En même temps des variétés et lignées sont développées par sélection généalogique à l'intérieur des populations issues des croisements entre souches localement retenues et lignées fournies par les collaborateurs INTSORMIL; ces lignées proviennent soit d'une région possédant des contraintes similaires à celles du Niger (par exemple le Soudan), soit des sélections en station opérées pour les mêmes objectifs que ceux de l'INRAN (rendement élevé, résistance à la sécheresse, au *Striga*, aux moisissures des grains).

Cependant le plus grand succès de notre collaboration INRAN/INTSORMIL réside dans la démonstration que les sorghos hybrides sont une technologie agricole viable même dans les conditions d'environnement difficiles telles que celles du Niger. Ceci est extrêmement important parce qu'il est reconnu que dans le contexte actuel de croissance démographique accélérée dans les pays en développement, la meilleure manière de satisfaire les besoins alimentaires est d' augmenter les rendements (Pinstrup-Andersen and Pandya-Lorch, 1995). En même temps l'adoption des hybrides est aussi bénéfique pour la conservation de l'environnement, car une productivité accrue est à même de réduire une exploitation incontrolée des sols fragiles. Bien que des hybrides introduits dans les années 60 aient été testés par l'institut français IRAT, ils n'ont pas été jugés intéressants pour le Niger du fait de leur mauvaise qualité des grains (Chantereau et Adamou, 1977), et à cause de la perception qu'ils sont plus exigeants en intrants. Une étude systématique de la valeur de l'hétérosis (supériorité des hybrides) dans les conditions du Niger n'a eu lieu qu'avec la conduite de deux sujets de thèse M.Sc en 1986 par Kapran et Tyler respectivement, sous la supervision des chercheurs de l'INTSORMIL. Kapran (1988) décrit la comparaison de 90 hybrides avec leurs parents en présence de deux témoins locaux, en plusieurs zones du Niger. Alors que les lignées parentales n'ont été similaires aux témoins qu'avec irrigation, les hybrides étaient toujours plus productifs que les deux

groupes: le rendement hybride était supérieur de 61% à celui des locales avec irrigation, et de 49% en régime pluvial; la supériorité des hybrides par rapport à leurs parents pour le rendement était de 45% avec irrigation, et relativement plus élevée en régime pluvial (66%). Tyler (1988), travaillant dans le même régime pluvial que Kapran, a testé 40 hybrides dont les parents appartiennent à trois sources: exotiques, intermédiaires, et locales. Il conclut aussi que les hybrides étaient plus productifs que leurs parents, par une marge de 127% pour les parents exotiques, 83% pour les intermédiaires, et 66% pour les locaux. Suite à une telle expression de la vigueur hybride au Niger, les meilleurs hybrides des deux etudes ont été refabriqués et régulièrement testés.

Au fil des années le croisement entre les lignees TX623A et MR732 (plus tard nommé NAD-1) s'est révélé le plus productif parmi les autres hybrides et variétés, y compris les variétés locales les plus adaptées. A partir de 1989, NAD-1 à fait partie des essais régionaux du réseau sorgho installés dans au moins six pays d'Afrique occidentale et centrale, et a été productif dans la plupart des conditions. En 1989 particulièrement, il s'est classé troisième en rendement parmi 20 cultivars dont toujours un temoin local, et d'autres hybrides et variétés de l'ICRISAT; l'essai était installé en neuf localités à travers la Côte-d'Ivoire, le Mali, le Burkina-Faso, le Cameroun, le Nigeria, et le Niger (ICRISAT/WASIP, 1989).

Par ailleurs toujours en 1989, une parcelle isolée de production des semences a été installée à Maradi(Niger), démontrant avec succès dans le contexte d'un programme national ouest-africain que la production en masse des semences hybrides est faisable. Au cours de la même saison nous avons remis pour la première fois un échantillon de semences hybrides aux agriculteurs du village de Bazaga non loin de la station de l'INRAN à Konni, et la réaction fut hautement positive. C'est ici qu'un agriculteur informé du système de croisement entre lignees A et R pour obtenir des semences hybrides a eu l'idée de comparer le croisement au mulet (Alfadari en Hausa, d'ou le A dans NAD- 1). Ceci a lancé les parcelles de démonstration que nous continuons d'installer en milieu rural , qui ont attiré de plus en plus l'intérêt des agriculteurs, au point ou il est aujourd'hui difficile de satisfaire les demandes de semences hybrides. Avec l'aide du projet INTSORMIL, nous avons à partir de 1993 commencé à produire des quantités supplémentaires de semences de NAD- 1 aux USA, pour les parcelles de démonstration au Niger.

Le rendement moyen de NAD-1 en station entre 1986 et 1994 s'élève à 2758 kg/ha, dix fois supérieur au rendement du sorgho chez les agriculteurs qui est de 273 kg/ha (Anonyme, 1995). A partir de 1993, nous avons commencé à évaluer les rendements de NAD-1 en milieu rural: ainsi pour 1993, son rendement moyen s'est élevé à 2365 kg/ha

pour Konni et Jirataoua; en 1994, il est évalué à 1725 kg/ha pour Say, 3500 kg/ha pour Jirataoua, 3800 kg/ha pour Cerasa, et 4600 kg/ha pour Konni, soit une moyenne générale supérieure à 3000 kg/ha .

A cause des problèmes de qualité alimentaires rencontrés anterieurement par les cultivars améliorés de l'INRAN, Kapran (1988) et Tyler (1988) ont conduit des tests sensoriels préliminaires (qualité du tuwo) avec certains de leurs hybrides et ont conclu qu'ils avaient la même acceptabilité que les variétés locales. Des tests similaires plus extensifs ont été menés en 1990 en collaboration entre les laboratoires de qualité céréalière de l'INRAN et INTSORMIL. Trois cultivars améliorés (NAD-1, SEPON-82, SRN-39) et un temoin local ont ainsi été comparés pour la qualité du tuwo ainsi que pour des données physico-chimiques mesurées au laboratoire. NAD-1 a partout reçu une bonne appréciation de ses qualités alimentaires. Ainsi, dix ans après sa selection, NAD-1 apparait toujours comme un hybride de bonne qualité alimentaire, de cycle moyen, avec une bonne tolérance de la sécheresse, et hautement productif en station et milieu rural. La stabilité de rendement de NAD-1 a été confirmée en comparaison avec les variétés locales et améliorées dans une analyse conduite par Visser (1992).

La question même de stabilité du rendement des hybrides a été traitée récemment dans un autre sujet de thèse supervisé par INTSORMIL (Ibrahim, 1995). Un groupe de 126 cultivars dont 90 hybrides, leurs parents, et d'autres témoins ont été testés dans 15 zones différentes comprenant celles au Niger, au Soudan, aux USA et en Amérique du Sud. Les hybrides étaient les plus productifs dans toutes les conditions, et surtout leur stabilité de rendement était supérieure dans les conditions de croissance les moins favorables. Ibrahim (1995) conclut que dans les zones tropicales semi-arides, les hybrides offrent une meilleure garantie de productivité que les variétés.

Bien qu'une industrie moderne de production de semences soit inexistante au Niger, les essais sur les hybrides continuent et les résultats préliminaires montrent que beaucoup de nouveaux croisements ont un potentiel agronomique similaire à celui de NAD-1. Il est remarquable que certains de ces nouveaux hybrides sont obtenus par croisement avec des lignées mâles sélectionnées au Niger (serie 90SN) à partir d'un matériel pédigrée en debut d'evaluation fourni par les collaborateurs INTSORMIL. Par ailleurs de nouvelles lignées femelles présentant une aptitude a la combinaison comparable a celle de la lignée TX623A font leur apparition, notamment la lignée ABON34.

Sur la base de tous les résultats encourageants obtenus en station depuis 1986, et l'enthousiasme généré par NAD-1 en milieu rural depuis 1989, il est au minimum réaliste de suggérer que les hybrides sont la meilleure

voie pour améliorer la productivité du sorgho au Niger. Il demeure bien entendu la nécessité de résoudre la question d'un système viable de production de semences, mais les succès obtenus dans d' autres pays en développement, notamment l'Inde, la Zambie et le Soudan, sont encourageants à plus d'un titre.

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Place et Rôle des Ressources Phytogénétiques Dans la Gestion des Ressources Naturelles

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Introduction

Les efforts menés pour assurer l'alimentation à une population toujours croissante ont fini par conduire à une réduction très significative de la biodiversité. Depuis les années 50, la diffusion de variétés améliorées, en particulier de blé, de maïs et de riz, a rapidement éliminé les variétés traditionnelles d'origine locales. Au cours des quinze dernières années, en Indonesie, 1500 variétés locales de riz ont ainsi disparu et les 3/4 de celles qui restent proviennent d'une seule plante mère (de Ravignan, 1993).

Près de 60% de la population mondiale, directement ou indirectement tire sa subsistance de l'agriculture. Au début du siècle prochain, la sécurité alimentaire sera le plus pressant besoin auquel nous devrons faire face, car chaque année la population mondiale augmente de 100 millions d'individus. Le probleme sera de savoir comment faire pour assurer une alimentation correcte a 6 milliards d'êtres humains à l'an 2000.

Wilkies (1989) à partir d'une prospective: constate que dans les 20 premières années du siècle prochain la nourriture produite en une seule année durant cette période sera égale à toute celle produite pendant la période 1850-1950 et que dans les deux décennies 2000 à 2020 nous produirons et consommerons autant de nourriture que depuis le début de l'agriculture il y a 10000 à 12000 ans.

En l'an 2000 il y aura, selon la FAO (1981), au moins 600 à 650 millions de malnourris dans le monde dont la plupart seront des enfants.

Les terres arables dans les pays en développement deviendront de plus en plus rares car les systèmes naturels qu'elles devront remplacer auront autant sinon plus de valeur. En conséquence, le développement agricole pouvant permettre de faire face à cette demande alimentaire se fera par l'utilisation de plus en plus accrue d'engrais, de pesticides, de l'energie pour l'irrigation et de matériel végétal plus performant. Tous ces moyens, sauf le matériel végétal, sont des intrants qui devront, pour leur mobilisation, compétir avec d'autres secteurs à l'octroi de ressources financières très insuffisantes dans les pays en développement. C'est

pourquoi, la selection pour de meilleurs rendements sera le point focal autour duquel toutes les nouvelles stratégies vont se développer. Pour arriver à cette fin, le nombre de sélectionneurs dans le monde devra doubler.

Diversité Spécifique et Potentiel Alimentaire.

Le nombre des plantes alimentaires dans le monde, en incluant les plantes de cueillette, est estimé à plus de 10000, soit environ 4% des plantes supérieures connues (de Ravignan, 1993).

Historiquement près de 5000 espèces végétales ont contribué à l'alimentation de l'Homme. Ceci représente moins de 1% de la flore mondiale. Seules 1500 espèces ont jamais été cultivées. Les Indiens d'Amérique du Nord dépendaient pour leur nourriture de 1112 espèces de plantes reparties en 444 genres et 120 familles. Au moment de la conquête espagnole, les Incas cultivaient autant de plantes que tous les agriculteurs d'Asie ou d'Europe (Yanovsky, cité par Charrier et al., 1993). Face aux progrès de la génétique et de l'amelioration des plantes, la liste des plantes cultivées s'est raccourcie. Actuellement seules 150 espèces végétales avec environ 250 000 races fournissent les calories nécessaires à la nutrition humaine. Selon Mangelsdorf, cité par Anishetty et Esquinas-Alcazar (1988), la population mondiale se nourrit actuellement avec pas plus de 12 espèces de plantes.

La population urbaine qui compte pour 1/3 de la population mondiale se nourrit principalement de 3 céréales: riz, blé, et mais et d'une tubercule, la pomme de terre (Prescott-Allen et Prescott-Allen, 1990). Ces 3 céréales fournissent à elles seules 41% de notre alimentation végétale, et une vingtaine suffisent pour assurer les 4/5.

Erosion de la Diversité Génétique des Plantes.

En Afrique la diversité génétique des plantes a été, pour très longtemps, préservée naturellement par l'agriculture traditionnelle pratiquée par les paysans. Durant les 4 dernières décennies il y a eu cependant une rapide détérioration des ressources naturelles et une perte subséquente de la diversité génétique. Le rythme de croissance rapide de la population à travers le continent a induit une pression constante sur l'environnement et pour nourrir cette population toujours croissante de nouvelles variétés plus productives ont été créées ou introduites. L'acceptation de ces variétés a conduit a un abandon des variétés traditionnelles au détriment de la riche diversité génétique qui existait (Reid et *al,* 1988).

Des changements significatifs sont opérés au moment ou, dans le système agraire africain, l'extension de la monoculture entramait

l'abandon de certaines spéculations. En plus, de larges surfaces de forêts ont été défrichées pour faire place à de nouvelles exploitations agricoles, ceci a conduit à la perte de la diversité génétique des espèces sauvages.

Le surpâturage, le nombre important des feux de brousse ainsi que l' érosion éolienne ont joué un grand rôle dans la réduction des ressources génétiques des plantes en Afrique. La plupart de ces phénomènes se déroulent depuis des siècles à une vitesse très lente. Mais la sécheresse des années 1970 en Afrique a eu pour effets une pression considérable sur l'utilisation des terres et également l'accélération de la vitesse de dégradation de la diversité génétique si importante pour une agriculture durable.

Les Banques de Gènes.

Gérer les ressources génétiques c'est assurer un avenir à l'humanité (Pernes, 1984). Bien gérer les ressources phytogénétiques c'est sécuriser l'avenir de l'humanité.

Les banques de gènes ont été créées pour combattre l'érosion génétique et la perte de matériel important et aussi pour préserver le patrimoine génétique des plantes qui constituent notre alimentation. Les banques de gènes ont comme fonction, en plus de la conservation et de la préservation de semences viables:

1. L'exploration des zones sous-prospectées pour maintenir une diversité génétique représentative de ces zones

2. L'évaluation et la caractérisation de la diversité génétique pour disposer d'une base de données utilisable.

3. La " pre-breeding " ou l'augmentation de la diversité génétique du matériel végétal conservé de telle sorte qu'il peut être directement utilisable par les sélectionneurs.

Les banques de gènes fournissent des gènes; elles ne créent pas des variétés achevées. Les utilisateurs des banques de gènes ont besoin d'échantillons bien caractérisés et de grande qualité. Mais souvent les banques de gènes ne sont pas capables, à la fois de conserver efficacement, de bien caractériser et d'assurer une bonne viabilité des semences.

Dans le monde il y a environ 700 centres de collection de germplasme, dont approximativement 100 endroits de conservation de semences à court-terme, 30 points de conservation à long-terme et moins de 10

centres étant de véritables banques de gènes bien gérées (Wilkies, 1993).

Différents Types de Ressources Phytogenetiques

Une meilleure comprehension des banques de gènes nécessite une appréciation correcte des différentes sortes de matériels génétiques que l'on peut conserver sous forme de graines. Wilkies (1977) a défini 6 catégories basés sur leur niveau de développement au moment ou ils sont conservés:

1. Variétés actuellement cultivées: souvent ce sont des variétés élites.

2. Cultivars dépassés: ce sont les variétés élites d'il y à 20 à 50 ans qui peuvent être les ascendants des variétés actuelles.

3. Cultivars primitifs que sont les variétés traditionnelles, locales ou encore indigènes, sont un réservoir important de gènes interéssants pour les variétés actuelles.

4. Variétés sauvages et les "mauvaises" herbes apparentées avec les plantes cultivées, recèlent des gènes utiles à l'adaptation des variétés actuelles.

5. Stocks génétiques spéciaux renferment les mutants induits artificiellement.

6. Stocks génétiques co-adaptés c'est le cas de deux formes d'une même espèce, ou une espèce et son symbiote, ou encore une espèce et les bactéries responsables de la nodulation.

Le matériel végétal le plus intéressant du point de vue des ressources génétiques est constitué non seulement des cultivars traditionnels mais aussi des espèces sauvages et des formes adventices liées aux espèces cultivées. La sauvegarde du potentiel génétique concerne toutes ces sources de matériel végétal (Pernes, 1984).

Conclusion

Le defi pour le siècle à venir est de créer du matériel végétal encore plus performant, de définir des stratégies de gestion de l'agriculture incluant la diversité inter et intraspécifique d'une part et d'autre part de prendre les dispositions légales pour pallier les effets négatifs de l'agriculture et de l'urbanisation effrénée sur l'environnement.

Le but doit être une agriculture bien pensée qui n'exclut aucune région géographique, qui ne se fasse pas au détriment des générations futures et qui ne menace pas le reste de la biodiversité de la planete.

Pour terminer je vous invite à méditer avec moi les paroles de Harlan (1972): "l'agriculture moderne est une entreprise à rendement élevé et à risques élevés". Alors que faire pour assurer l'avenir de l'humanité?

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Summary Statement on Peanut CRSP Activities in West Africa

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Texas A&M University (TAMU), as a part of the Peanut CRSP, is a participant in two projects: Breeding and Cultural Practices (BCP), and Mycotoxin Management (MM). Collaboration has been with coworkers in Senegal, Burkina Faso, Mali, Niger, and Ghana.

The breeding project has provided technical and financial support to peanut variety testing and breeding programs in four West African countries. Some 350+ germplasm and breeding lines have been introduced into the breeding programs of the host countries. These have included Texas breeding lines and varied Texas accessions. Entries transmitted were chosen after preliminary evaluation and seed increase in Texas. Serious effort was made to focus seed exchange on germplasm with potential for enhancing country programs, and to avoid burdensome random inclusions of genetic materials. Additionally, we have encouraged the evaluation and advancement, where appropriate, of HC materials. This project was a collaborator in the evaluations that led to the release in Senegal of Fleur 11. Additional advanced lines are currently under on-farm and extension agency evaluation in prospect of

release. Area-wide evaluation of select breeding lines is in progress by collaborators in Senegal, Mali, and Burkina Faso.

The BCP project, in consultation with the Georgia-Nigeria virus project established a rosette virus screening program in southwest Burkina Faso. One-hundred-forty plant progenies from populations of rosette resistant x adapted variety parentage were screened near Niangoloka, Burkina Faso in 1994. The results (preliminary) showed significant variation among the breeding lines in reaction to the virus. Confirmation of results and selection of superior plants is in progress.

The breeding project has collaborated with the Georgia-Burkina Faso Insect Management project in investigating the heritability of host plant resistance to termite. Hybridizations were made of termite resistant x West Africa adapted variety parents, and selected F3 and F4 progenies were screened for termite resistance near Gampela. Marked differences in yield and termite invasion were apparent in single year 1994 data.

The effect of soil amendments on three peanut genotypes was examined collaboratively with Soil Management CRSP scientists near Bobo Dioulasso because of repeatedly poor test yields in the 1100 - 1200 mm rainfall zone of Burkina Faso. Soil tests revealed a strongly acid (pH 4.8) soil layer at a depth of 17 to 35 cm and the Al exchange concentrations were excessive (to 2.0 cmol kg ha^{-1}). Three-year results revealed a highly significant (65%) yield increase at Bobo Dioulasso from the annual application of 2 ton ha^{-1} of ash. Yield increases from applications of P_2O_5 and $CaSO_4$ were insignificant.

The focus of the TAMU-MM project for several years was time and sites of infection of peanut by toxin producing mold, reduction of aflatoxin contamination through management, host plant resistance, and aflatoxin detection and elimination. The importance of good peanut culture, and good harvest and post-harvest management was affirmed. Genotypes were identified with some to moderate levels of host plant resistance to aflatoxin production; among the latter was germplasm line TxAG-6, the source population for the Texas variety Tamspan 90. Among the most notable achievements was work that involved the inclusion of selected clays in animal diets containing contaminated feedstuffs. In this research, the intake of small quantities of specific aluminosilicate clays were effective in binding aflatoxin in the gut of animals such that the deleterious effects of aflatoxin were negated. Also, technology was outlined whereby mycotoxin could be markedly reduced if not eliminated in village pressed oil.

Recent efforts in mycotoxin research have focused on the pathway of aflatoxin synthesis and avenues of genetic engineering to disrupt that

pathway in the fungus. Remarkable progress is being achieved but further gain will be required before the results will be at the applied level. Other results of prospective benefit for research and other uses concerns the utilization of fungal mutants to evaluate the comparative susceptibility of germplasms to aflatoxin production and the points of aflatoxin proliferation in seed and shell. The technology involves visual screening of fungal challenged seed for a colored aflatoxin precursor. Sites and relative concentrations of aflatoxin accumulation can be assessed.

We have had some success during the short time frame of this program in introducing into the region cultivars or breeding lines *per se* which will impact food supply and grower income. It is my expectation, however, that hybridization and persistent careful selection in important ecological zones will be required to meet the challenges of the future. Germplasm maintenance, evaluation, and appropriate utilization is a high priority for a sustainable agriculture. Because of environmental economical, and other factors, germplasm maintenance and exploitation in the subsahelian region is difficult and slow. External assistance is needed to meet growing needs. Texas A & M has been a leader in collaborative germplasm collection, maintenance, classification, enhancement, and utilization.

Technologies for Improving Nutrient Cycling and Water Use Efficiency in the Sandy Soils of West Africa for Sustained Production

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A.S.R Juo , Soil Management CRSP, Texas A&M University, College Station, TX, USA

A major thrust of the collaborative activities between Institut National de Recherches Agronomiques du Niger (INRAN),the Soil Management Collaborative Research Support Program (SMCRSP), ICRISAT, and ILCA in the Sahel is to promote integrated management of natural resources. A component of this research and development program is to integrate chemical (inorganic fertilizers and lime) with organic and biological inputs (crop residues, farmyard manure, green manure) into production systems that will sustain crop productivity and enhance the environmental integrity. It is imperative also that the introduced system fits into the socioeconomic structure of the region.

The current status of soils in the region is the reflection of many environmental, technical, economic and social factors. Soils are inherently low in soil fertility. Farmers are obliged to abandon the once sustainable land rotation system, resulting to the continuous cereal -legume intercrop cropping system. In this system, nutrient budgets are often negative because nutrients lost through crop harvest, erosion and leaching are not adequately replaced.

Fertilizers increase and sometimes sustain crop yields in certain agroecosystems. Farmers in the Sahel rarely use these inorganic amendments because of difficulties in obtaining them or due to the prohibitive prices of these inputs. Also, fertilizers are known to promote nutrient imbalance in the poorly buffered soils of the Sahel. Nitrogen fertilizers induce leaching of bases that result in lowering soil pH. While they increase yields in the short-term, these yields are not sustainable (Figs. 1 and 2).

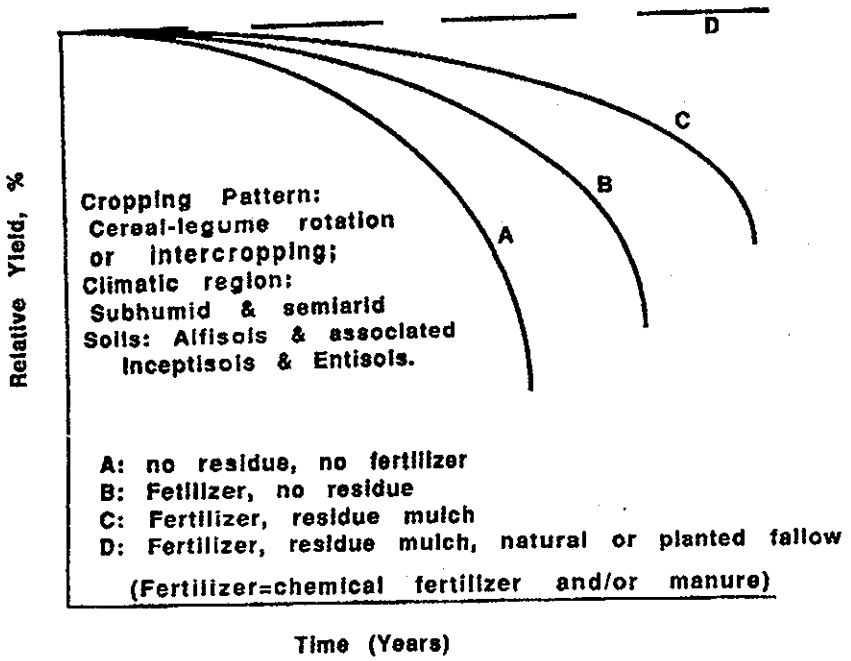
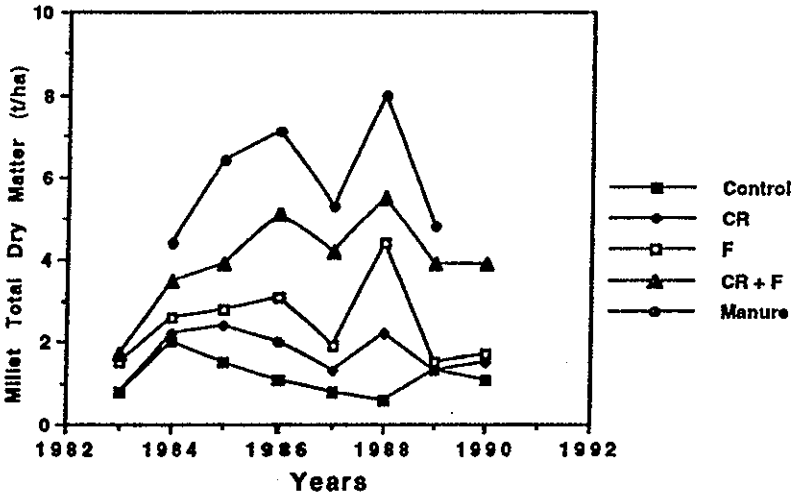


Figure 1. Conceptual models depicting yield sustainability as affected by different nutrient management strategies in West Africa (Juo and Hossner, 1994)



Source: Bationo et al., 1994, (unpublished)

Figure 2. Long-term pearl millet total dry matter yield as affected by different management

Millet straw and other residues are beneficial for their nutrient cycling effect and also for their ability to trap and hold fertile dust. Paradoxically, residues are also excessively needed for use as fodder, fuel and as construction material in the homesteads. Farmyard manure has always played a significant role in maintaining soil fertility in the traditional farming system. However, farmers complain of unavailability of manure due to reduced herd size in the region.

The above factors underscore the urgency for nutrient management systems that will integrate the organic, biological and chemical inputs and that will also fit the dominant cereal- legume cropping system of the region. Significant quantities of N can be obtained from biological sources such as green manures. The wisdom of green manure use as nutrient source in the Sahel is often questioned. However, Franzluebbers et al, (1994) observed that incorporation of cowpea green manure between millet rows increased mineral nitrogen to almost 20 mg kg^{-1} in the surface soil only two weeks after incorporation. Research is currently underway by INRAN and the SMCRSP to study the practical implications and potential benefits for the combined use of wild legumes (e g. *Sesbania)* as green manure crops.

Phosphorus, the most limiting nutrient in the region, needs to be applied from inorganic sources for sustained crop yields. Phosphate fertilizers will be essential to prime the system to obtain a basal fertility level. This could be regarded as a long-term investment because of low P fixation capacity of the soils and hence the significant residual P for the region. The generated fertility will be maintained through the efficient use of crop residues. This way, an agroecosystem is created in which nutrients will be generated, recycled and maintained without putting an additional financial strain or imposing any labor additional requirements on the poor resource farmer of the region.

Pond Dynamics/Aquaculture Collaborative Research Support Program

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The Pond Dynamics/Aquaculture CRSP focuses on improving the efficiency of pond aquaculture systems. This CRSP began its work in 1982 in Thailand, the Philippines, Honduras, Rwanda, Indonesia, and Panama. Research continues today in Thailand, Honduras, and the Philippines. At all sites the goal is the same: to identify constraints to aquaculture production and to design responses that are environmentally and culturally appropriate.

Several valuable technologies have resulted from the past work of the PD/A CRSP and are now available for application in other areas. One of these is the development of the world's largest database on tropical aquaculture, the CRSP Central Database. Data collected from standard experimental protocols at each of the research sites are compiled into a single database managed by the CRSP. These data are available to anyone, and can be used for analysis of the results of single experiments at individual sites, for regional comparisons, or for complex modeling work.

Another PD/A CRSP technology now available is a computerized decision support system called POND. This is a user-friendly program designed to provide pond management guidelines such as how much lime or fertilizer to apply to a given pond. The program can also be used to simulate production cycles in individual ponds or for entire aquaculture facilities. Model results feed directly into an economics function that generates enterprise budgets for a pond facility. The program can be useful to researchers, pond managers, educators, and students. French and English versions of the POND manual are now available, and a Spanish version is in preparation.

In many regions a major constraint to aquaculture production is a shortage of fingerlings for stocking. CRSP researchers in Egypt addressed one aspect of this problem by determining the relationships between temperature and tilapia fry production. Knowledge of these relationships can now be used to determine when and how fry production should be undertaken to achieve optimum results, and can be transferred to areas other than Egypt.

Many improved pond management techniques and strategies have resulted from the 13 years of PD/A CRSP research. These have included the combined use of inorganic and organic fertilizers in tilapia ponds, reducing the recommended protein content of fish feeds, the use of organic fertilizers in place of feeds early in shrimp production cycles, and reducing fertilizer input rates in tilapia ponds. These improved strategies have resulted in reductions in resource use and production costs, increases in pond productivity, and improvements in the quality of water leaving ponds. The improved strategies thus have a direct bearing on natural resource use, and similar approaches can likely be successful in countries other than those where the research was originally conducted.

A specific pond management strategy resulting from research conducted in Rwanda grew out of the need to use low-cost, locally-available inputs for pond production. Researchers at the Rwasave Station found that cut green grass could be composted directly in the ponds to increase pond productivity, thus avoiding the prohibitive expense of using commercial fertilizers. This strategy can be applied to fish pond management in any area where the use of inorganic fertilizers is not economically feasible. Other research conducted in Rwanda focused on the effects of temperature on productivity of tilapia ponds. The resulting temperature-based production technologies are transferable to any area with cooler temperatures resulting from high altitude.

In addition to the technologies developed from previous research, the Host Country and U.S. member institutions of the PD/A CRSP provide a pool of expertise in a broad range of fields that are important in aquaculture, including marketing, socioeconomic aspects of fish production, site suitability evaluation, pond design and construction, parasites and diseases of fish, water quality analysis and management, fish nutrition, fish breeding, and general pond management. This high level of technical expertise becomes available to all new projects the CRSP becomes involved in. Many of the CRSP researchers have considerable experience in the areas of extension education and training. Through contact with fish farmers, by conducting on-farm trials, and by holding short courses and workshops in CRSP host countries, the technologies developed by CRSP research are transferred directly to the fish farmers.

Crop Production Strategies: An INTSORMIL Perspective

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Introduction

From 1960 to the early 1980's, the area of rice, maize, grain sorghum, and pearl millet production in West Africa increased greatly (Fig. 1 - 4). At the same time, yields of these crops increased slightly, but in a very erratic pattern across years due to the variable weather conditions (Fig. 5 - 8). Since the early 1980's, the area of these principal cereal crops and their yields have not increased dramatically in spite of considerable investment by national and international programs in research on these crops. There is little doubt that the germplasm (genetic) potential of these crops has increased as is illustrated on experiment stations with higher inputs and/or better soil quality. However, on-farm yield levels have remained constant due to lack of the use of inputs and management practices by producers to realize this increased yield potential. This is further complicated by the "mining of the soil fertility" by crop production without appropriate means to replace the nutrients removed in the harvested grain and stover (van der Pol, 1992).

The human population of West Africa is expanding at a rapid rate (World Bank, 1994), increasing the demands on the soil natural resource to produce adequate food. Natural resource maintenance should not be considered as the sole objective by national programs. Rather, maintenance or improvement of the soil natural resource must be accompanied by greatly increased grain production to meet the increasing food needs in the region. Thus, we view agricultural producers as the primary managers of the soil natural resource. We think that it is evident that crop production schemes will require wise use of inputs, particularly improved cultivars and fertilizer, to simultaneously increase crop yields and to thwart further nutrient mining of the soil resource. This implies that "fine tuning" the present production systems will likely not allow us to reach our goal, and that large changes in input availability and production practices will be required. A viable seed industry must evolve! Rock phosphate deposits in the region have to be commercialized and utilized! Grain prices have to be at levels to make the use of nitrogen fertilizer a viable practice! Production agronomists and extension services have to develop and be able to extend new practices to a large number of producers! In some

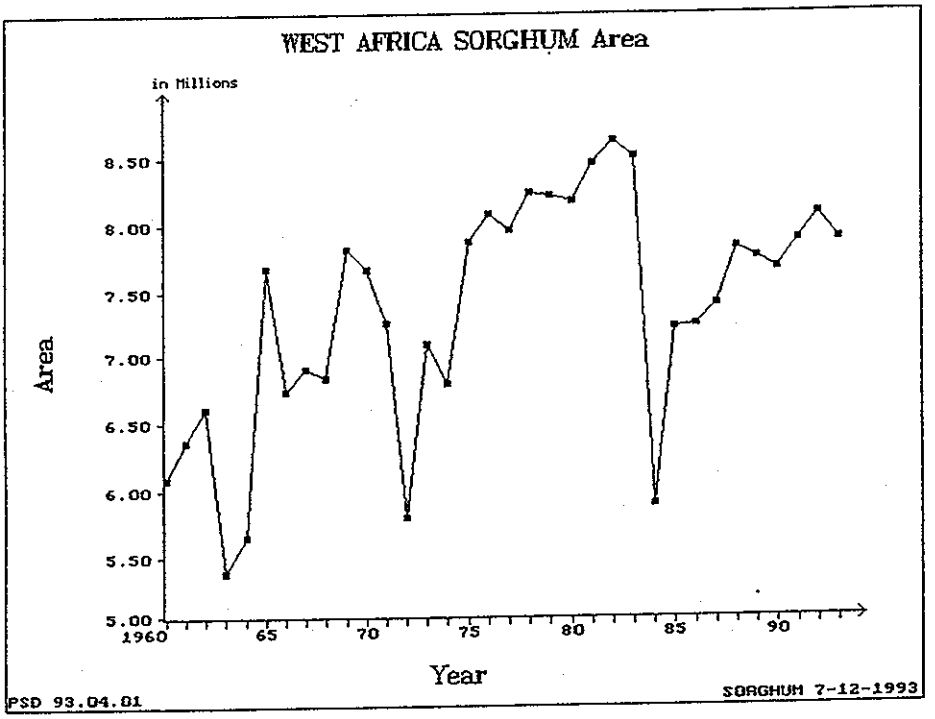

Fig. 1. West Africa sorghum production area from 1960 to 1992 (USDA, 1994).

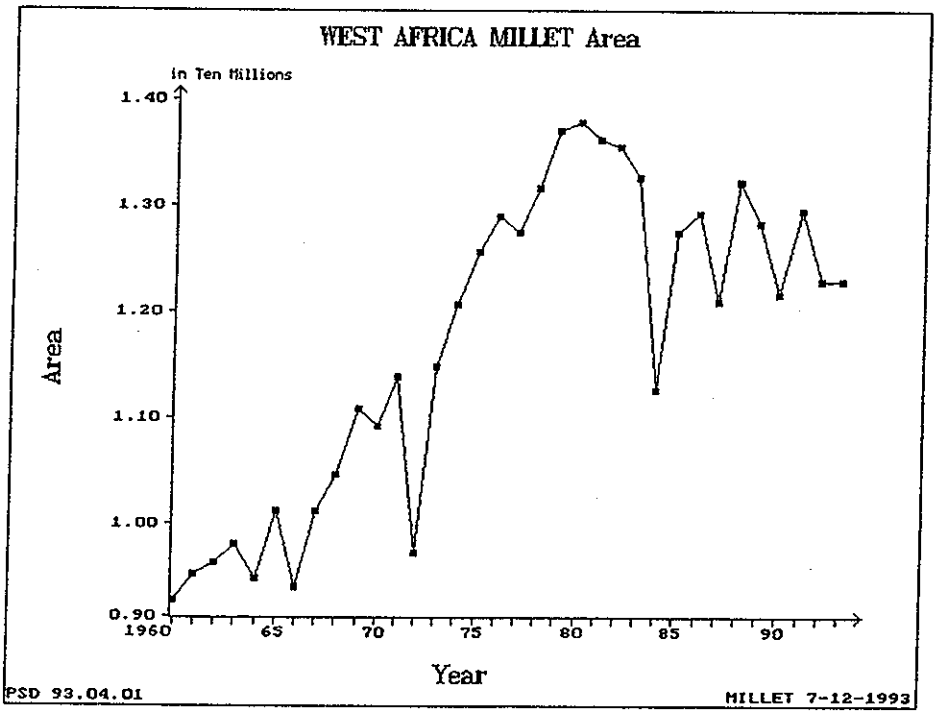

Fig. 2. West Africa millet production area from 1960 to 1992 (USDA, 1994).

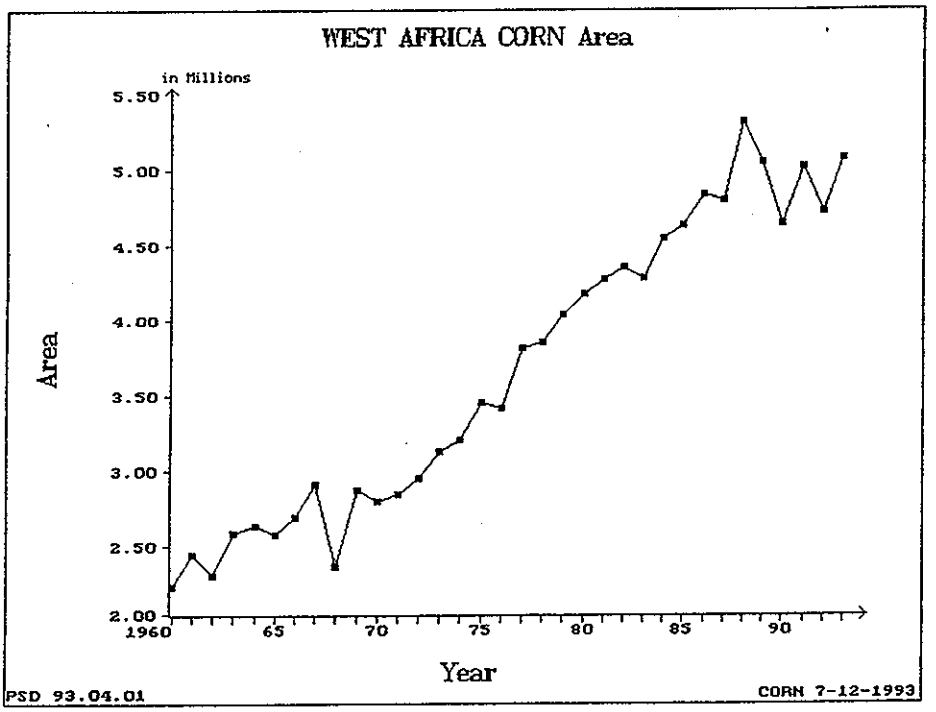

Fig. 3. West Africa corn production area from 1960 to 1992 (USDA, 1994).

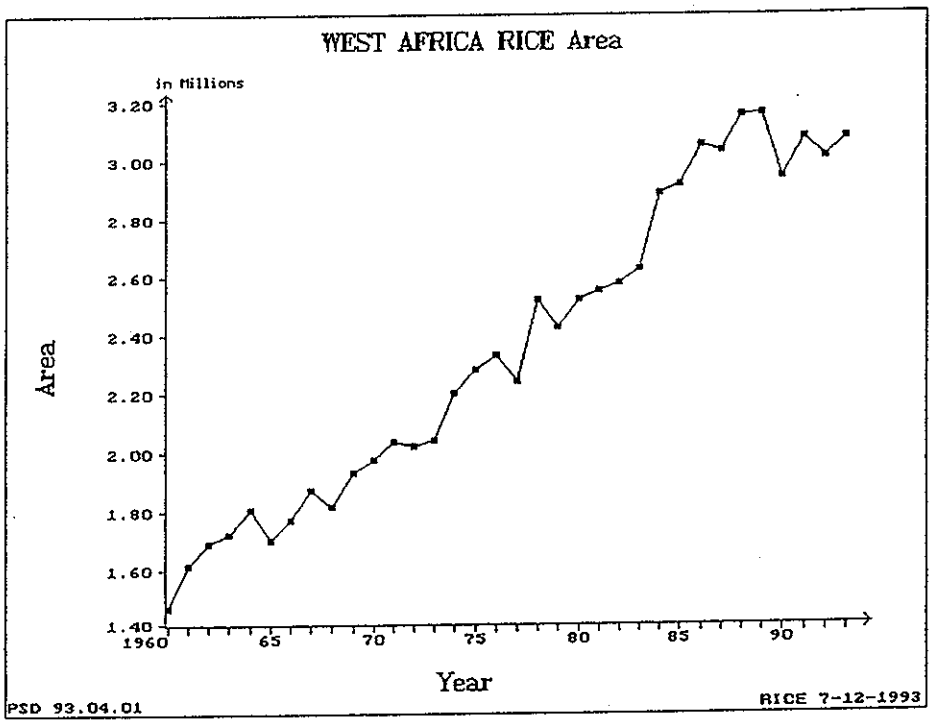

Fig. 4. West Africa rice production area from 1960 to 1992 (USDA, 1994).

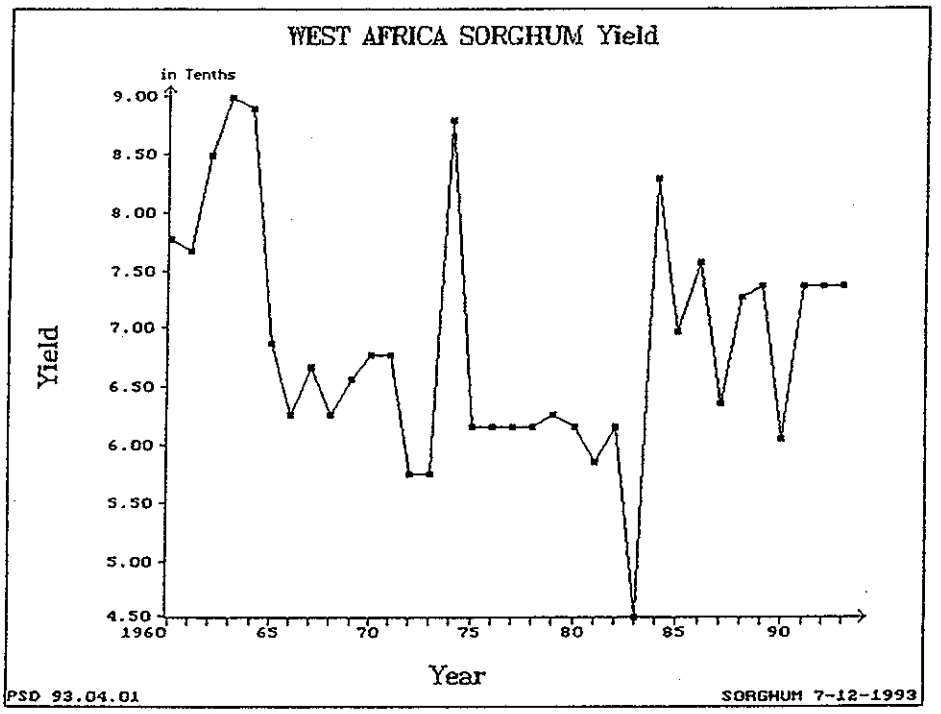

Fig. 5. West Africa sorghum yield from 1960 to 1992 (USDA, 1994).

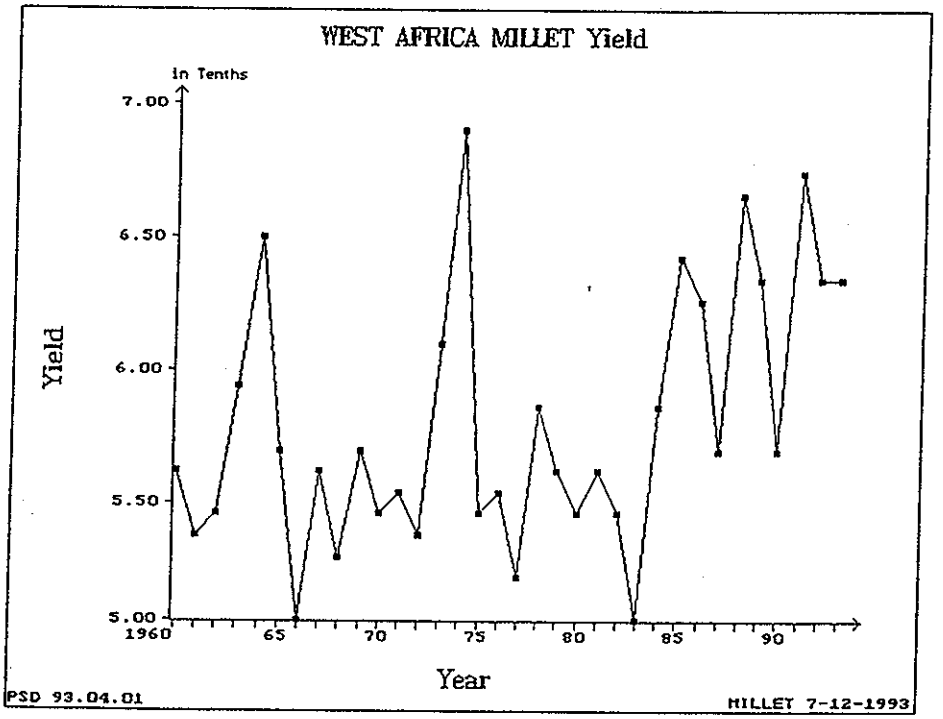

Fig 6. West Africa millet yield from 1960 to 1992 (USDA, 1994).

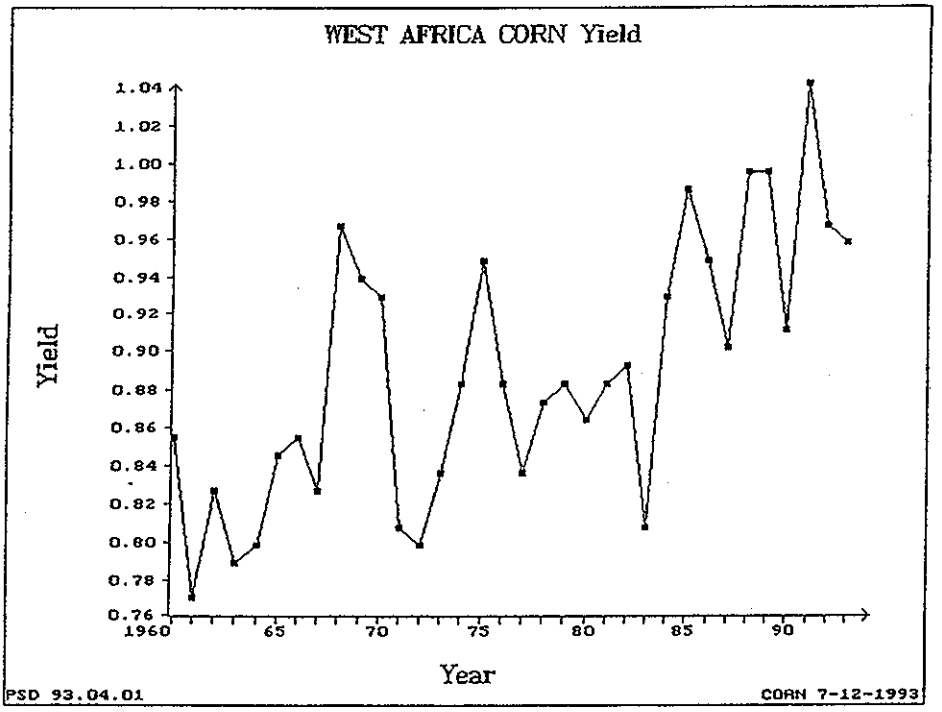

Fig. 7. West Africa corn yield from 1960 to 1992 (USDA, 1994).

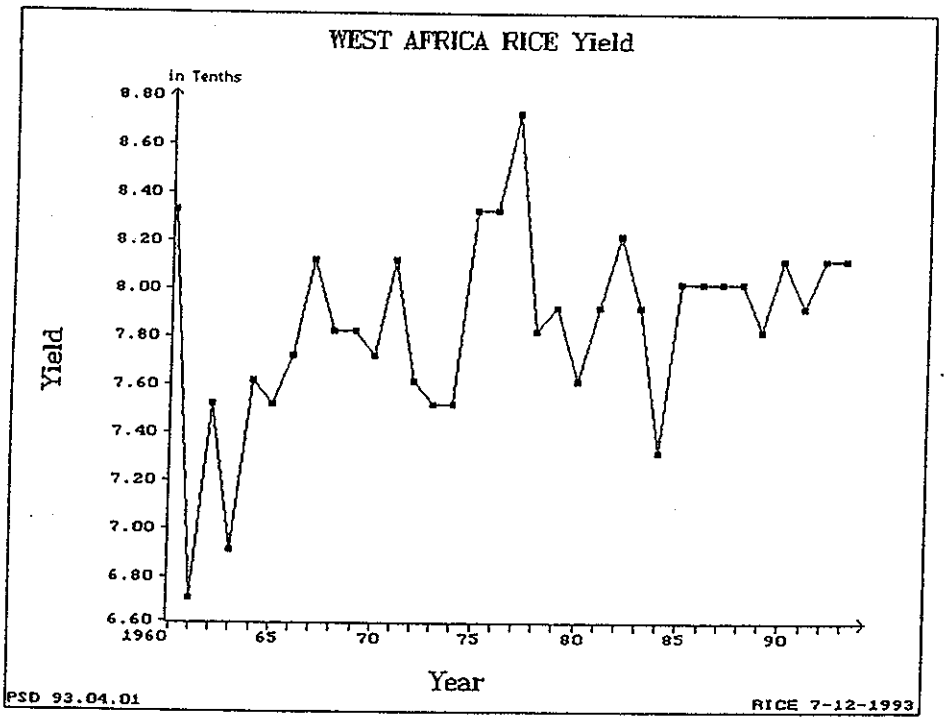

Fig. 8. West Africa rice yield from 1960 to 1992 (USDA, 1994).

way we have to function in a "systems mode" that promotes change that results in increased yield and at the same time maintains the soil and genetic resources of the region.

INTSORMIL collaborative activity with national programs in West Africa has focused primarily on the countries of Mali and Niger with a major emphasis on genetic improvement of grain sorghum and pearl millet. This effort has been based on introduction of broad based genetic diversity to develop improved cultivars in national plant breeding programs These efforts have been supported by projects working on integrated insect and disease management, and food quality/utilization. Crop physiology and agronomy research on grain sorghum and pearl millet has been conducted on cropping systems (continuous, intercropping, and rotational), crop residue management, stress tolerance (water and nitrogen), and recently on developing recommended production practices for new, improved cultivars to be released by national programs for farmer use. INTSORMIL past and present efforts in breeding for stress tolerance and host-plant resistance, integrated pest management, and resource-efficient cropping systems has been consistent with wise natural resource management. INTSORMIL has also been involved in educating and mentoring national program scientists to improve the "human capital" of national research programs. Each of these will be discussed below to show the knowledge available, potential impacts, and constraints.

Cropping Systems

INTSORMIL research has shown large yield increases occur in response to rotation of grain sorghum with peanut, and pearl millet with cowpea (INTSORMIL, 1989; 1993; 1994). Although this yield increase is often discussed in terms of the nitrogen contribution of the legume crop, nitrogen uptake data indicates that more nitrogen is taken up in the increased grain and stover yield that is harvested than the commonly reported nitrogen fixation rates of the legume crop. Obviously, legumes are good scavengers of nitrogen in the soil also, and potentially can reduce the losses of nitrogen from the system and make them available to the succeeding crop. However, this would appear to be minimal in production systems on low organic matter soils utilizing low nitrogen fertilizer rates and with harvest of both the grain and stover. It is likely that at least part of the yield increase from crop rotation is due to breaking pest cycles, especially nematodes. The yield enhancement resulting from crop rotation certainly leads to more rapid depletion of phosphorus and potassium which are also at low levels in many West African soils.

INTSORMIL research on intercropping has shown increases in Land Equivalent Ratio (LER) over those of sole cropped pearl millet, grain sorghum, cowpea, and peanut (INTSORMIL, 1989; 1994). Benefits to the succeeding crop have been shown when the legume crop yield is high, or good vegetative growth occurred without grain production due to insect problems. Intercropping provides more continuous cover of the field and often makes more complete use of solar radiation, water and nutrients during the growing season. If this results in increased yields of grain and stover, then mining of soil nutrients likely occurs more rapidly. Shading of the legumes in intercropping probably reduces the amount of nitrogen fixation that occurs, reducing one of the benefits of including legumes in a cropping system. Intercropping reduces the severity of incidence of some pests, but is also less likely to break pest cycles.

Intercropping is a widely accepted practice in West Africa, but many of the benefits resulting from the use of legumes in cropping systems are greater with crop rotation. Crop rotation is not a widely accepted practice in the region, and thus adoption requires a significant change in mindset. Peanut is an important cash crop in the region, and cowpea is widely grown. However, problems with grain storage, insect control and stable markets presently limit expansion of production, and thus limit the opportunity to take advantage of the rotation effect. It is unlikely that greater inclusion of grain legumes (especially if both grain and stover are harvested) will add more nitrogen than is removed in the harvest. Green manure crops and improved fallow systems would add nitrogen to the system and improve soil organic matter content, but this option removes land from grain production for one or more years, and may be more expensive than use of fertilizer.

Crop Residue Management

INTSORMIL and INRAN research in Niger has shown large yield increases after one year of leaving crop residues on the soil surface (Verma et al., 1992) as has also been documented by ICRISAT and the Soil Management CRSP. However, after four years in Mali, the differences among residue removal, residue incorporation and leaving residues on the soil surface has been small (INTSORMIL, 1994). Agronomically speaking there is absolutely no doubt that some crop residues need to be left on the soil to minimize soil erosion, maximize nutrient recycling, and maintain soil organic matter content. This practice often requires producers to focus on long-term objectives rather than the short-term needs of livestock feed, building material, fuel and other common uses of crop residues. From a natural resource perspective, these short-term benefits seem to be more important to producers, and as a result, crop residues are often removed from fields.

Stress Tolerance (Water And Nitrogen Use Efficiency)

INTSORMIL research in this area has shown that water and nitrogen stress tolerance are related, and should be approached jointly. Stress tolerance is affected by both genetic characteristics and the production practices used. INTSORMIL physiology efforts have helped plant breeders identify stress tolerant lines, and helped explain the basis for differences among genotypes. For example, Maranville (INTSORMIL, 1995) recently found that high nitrogen use efficiency in sorghum lines is associated with levels of photosynthetic enzymes. Use efficiency of water and nitrogen are also influenced by cropping systems. Clegg (unpublished data) found that nitrogen use efficiency was similar for rotated and continuous grain sorghum at high nitrogen application levels, but was greater for continuous sorghum at low nitrogen rates since more nitrogen was taken up by the rotated crop.

The research clearly show that plant breeding cannot solve the stress tolerance issue by itself, but rather improved genotypes must be combined with a production system that provides adequate water and nutrients for the genetic potential to be expressed. These future needs require not only maintenance of the soil resource, but an actual improvement in the soil resource to provide the conditions needed by improved cultivars. Attempts to combine discipline-oriented research into systems is essential if efforts to increase production and maintain the soil resource is to be successful.

Production Practice Packages for Improved Cultivars

Valuable interactions between agronomy/physiology and breeding disciplines has always occurred, and have helped in the release of improved cultivars. However, only recently have INTSORMIL and national program scientists consciously developed studies with plant breeders to understand the response of new cultivars to different production environments/production practices and to use this information to develop specific production practices for these new cultivars. We expect that high-yielding cultivars will require a better production environment and/or higher inputs and more intensive production practices for their yield potential to be expressed. It is our hope that increased production (stover as well as grain) combined with wise use of external inputs (improved cultivars and fertilizer) would allow for an Improvement of the soil resource largely due to increased soil organic matter content.

Human Capital

INTSORMIL has always focused on assisting national programs in research on grain sorghum and pearl millet. An important element of this effort has been short-term and degree training of national program scientists. These efforts have paid large dividends and contributed to functioning national programs in Niger and Mali. This task is far from over with many new scientists needed to replace the natural turnover in national programs, and increase expertise in the natural resource arena. In our opinion, funding agencies should continue to be aware of the tremendous needs for training and scientific interaction of national country scientists. Initiatives to improve natural resource management should take into account the important role played by short-term and degree training.

Conclusion

At present INTSORMIL has assisted national grain sorghum and pearl millet programs in Mali and Niger, and to a limited extent in Senegal. During the next five years a system of scientific research, technology transfer, and farmer production practices must evolve to meet the food and natural resource management needs of West Africa. INTSORMIL has some components of this system, but they will need to be further integrated with national programs, other CRSPs, IARCs, NGOs and funding agencies to be successful.

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Preséntation de Quelques Résultats Obtenus en Pathologie Sur le Mil le Sorgho, le Niébé et l'Arachide.

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Cette présentation concerne beaucoup plus le *Striga* que les maladies foliaires. Nous allons mentionner notre travail et les résultats obtenus sur les moisissures des grains de sorgho et aussi le charbon allongé.

Pour le niébé (cowpea en anglais) dans presque tous les pays de l'Afrique de l'Ouest il existe des sources de résistance au *Striga gesnetrioides.*

Au Niger le programme avait permis d'identifier 2 variétés qui ont un très bon niveau de résistance à *S. genesrioides* (121-80 et 93-80). Ces variétés se sont revélées résistantes dans tous les pays de l'Afrique de l'Ouest à travers les tests multilocaux de SAFGRAD.

Quant au sorgho, l' identification de la SRN39 comme très résistante au Niger; nous a permis de développer un bon programme de sélection pour la résistance au *Striga.* De nouvelles populations développées avec la collaboration d'INTSORMIL ont été testées au Niger. Ces populations montrent un très haut niveau de résistance au *Striga hermonthica* et possèdent une bonne réponse à l'azote. Nous avons noté une très forte interaction entre l'azote et la résistance génétique.

La combinaison azote et génotype résistant permet de controler très efficacement le *Striga* et d'augmenter de manière importante les rendements . Avec le génotype résistant la quantité d'azote nécessaire varie de 46-60 kg/N. Tandis qu'avec le génotype sensible pour réduire significativement le *Striga* il faut apporter 90-120 kg N/ha.

Concernant le mil, aucune source de résistance n'a été identifié jusqu'à présent. Cependant les variétés locales possèdent un bon niveau de tolérance au *Striga.* De ce fait les techniques culturales et la lutte chimique constituent des alternatives prometteuses.

Pour les techniques culturales, la rotation du mil avec l'arachide et le niébé a prouvé son efficacité contre le *Striga.* Là où il n'existe que la souche de *S. hermonthica* qui attaque le mil, le sorgho peut être utilisé en rotation et vice-versa. Il existe plusieurs herbicides efficaces contre le

Striga (Dicamba et 2-4D); mais leur disponibilité et leurs coûts peuvent être des obstacles.

Une autre contrainte à l'adoption des variétés améliorées de sorgho par les paysans des zones Sud, c'est la très grande sensibilité de ces variétés aux moisissures des graines. Plusieurs variétés de la collection de T A&M University ont été introduites et criblées dans les conditions du Niger, ainsi que plusieurs variétés de la collection nationale.

Plusieurs sources de résistance aux moisissures ont été identifiées. Ces sources servent à l'amélioration du sorgho. En 1988 nous avons installé une pépinière de criblage pour la résistance au charbon allongé avec l'aide d'INTSORMIL et de Dr Frederiksen de Texas A& M University. De 1988-1990 nous avons mis au point une technique de criblage qui est très efficace et très fiable, tout en criblant les entrées de sorgho sous infestation naturelle. Nos travaux ont permis d'identifier une dizaine de variétés résistantes au charbon allongé.

Le programme pathologie arachide a été en veilleuse pendant plusieurs années, par manque de phytopathologiste. Actuellement le programme a été ravivé. Déjà 30 variétés et lignées avancées sont en train d'être criblées contre les deux cercosporioses tardives et précoces.

Nos travaux futurs concernent les points suivants:

- effet de l'association céréales (mil et sorgho) avec l'arachide, sur le développement des cercosporioses;
- effet des cercosporioses sur la valeur fourragère de l'arachide (collaboration avec les zootechniciens).

En nous voulons mentionner deux maladies du niébé:

1. La pourriture grise (*Macrophomina phaseolina*).
2. Les brûlures et chancres bactériens. (*Xanthomas campestri* pv phaseolina).
3. Les fontes de semis.

Ces trois maladies sont sévères au Niger; plus de 300 entrées ont été criblées contre la pourriture grise, en collaboration avec l'IITA. Mais aucune source de résistance n'a été identifiée.

L'étude des techniques culturales ont montré que la densité n'a aucun effet, mais les dates de semis ont un effet sur la pourriture grise. L' application de la chaux (250-500 kg/ha) réduit l'incidence de la pourriture grise et augmente les rendements du niébé. Bien que la

brûlure bactérienne soit très sévère au Niger, aucun travail important n'a été entrepris sur cette maladie.

Nos travaux ont montré que le traitement de semence de mil et de niébé avec Benomyl ou Apron plus 50 DS permet de contrôler les fontes de semis.

Il ressort de cette présentation que des résultats importants n'ont été obtenus grâce à la collaboration avec INTSORMIL et avec l'ICRISAT (sorgho et mil).

Protection des Cultures

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Au Niger, le mil, *[Pennissetum glaucaum* (L.) R. Br.] est une céréale de subsistance produite pour l'alimentation humaine et pour le bétail. Plusieurs stresses biotiques et abiotiques sont des facteurs qui affectent la production du mil. Les insectes, en particulier la mineuse de l'épi est une contrainte majeure qui cause des dégâts sévères et la détérioration des grains. Les infestations approchent 95% avec des pertes énormes de grains. Les principales méthodes de lutte sont les pratiques culturales qui sont généralement impraticables. La mineuse est un bon candidat pour la lutte qui a un accent sur les ennemis naturels. Avant de recommander l'utilisation de la lutte biologique, l' évaluation de la quantité des ennemis naturels est nécessaire. La recherche conduite à Maradi vise la compréhension des contributions des ennemis naturels sur la mortalité de la mineuse. Les principaux objectifs sont :

- Etude expansive sur la biologie de la mineuse.
- Evaluation de l'impact des ennemis naturels.
- Construire des tables de vie de la mineuse (analyses de K. facteur).

L' expérience consiste au principe d' exclusion par cages des ennemis naturels par rapport à des épis infestés par la mineuse (un certain

nombre est exclu des cages et un autre groupe d'ennemis est permis pour parasiter la mineuse sur les épis infestés). Les épis de mil sont préalablement infestés par des oeufs de la mineuse avant de placer les cages. Des assiettes peintes avec de la colle sont placées en dessous de chaque cage pour recueillir les différents insectes (agents de lutte biologique) qui attaquent la mineuse et autres insectes qui attaquent le mil. Cette étude est actuellement en cours au niveau de l'INRAN Maradi, Niger. C'est un travail collaboratif entre l'ICRISAT/ICS, INTSORMIL et INRAN. Un travail similaire a été réalisé pendant deux années au Centre Sahelien de l'ICRISAT. Des résultats très importants ont été obtenus et sont consignés dans un rapport préliminaire sur l'évaluation des ennemis de la mineuse.

Peanut CRSP Activities in Burkina Faso

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A tremendous amount of accomplishment has been realized under the Peanut CRSP program in Burkina Faso. The variety trial, disease resistance test, and soil amendment were geared toward a better management of the resources. Today we ought to consider peanut as a component in a global system if innovations have to be brought into the natural resource management.

1. Variety Trial

The goal in this sub-project was the development of high yielding peanut variety for the semi-arid region of West Africa.

During the past 10 years, Over 200 advanced Texas breeding lines, US cultivars, ICRISAT lines and germplasm from diverse origins and local checks (TS32-1 RMP 12) were evaluated over 5 locations in Burkina Faso. Soil types at these locations were fine clay sand at Bobo, Gampela and Tenkodogo, sandy clay at Saria, and fine sand at Niangoloko. Average rainfall during the growing season was usually over 1000 mm at two locations (Niangoloko, Bobo) and around 600 mm at Gampela, Tenkodogo, and Saria.

- Stand was very good at all locations except Bobo and Niangoloko. The yield trends were similar among years. Gampela, Tenkodogo and Saria had the highest yields for all varieties put together. Despite the high rainfall in Bobo and Niangoloko, yields at these locations were lower compared to the rest of the locations.

- Based on the multilocation trial of these germplasm from diverse origins, we concluded that most varieties are not adapted to the agroecological zones of Burkina.

- However, we have identified four varieties which did as well as the best check for at least two years at more than two locations.

2. Pest Resistance

2.1. Disease Resistance

Leafspot and rust are endemic at the Niangoloko site and probably explain the reduction in yield in absence of pesticide. These two factors were more limiting to peanut production in these sites than is water.

Each year, foliar disease evaluation was made on entries in Bobo, Gampela, and Niangoloko. The results varied from year to year.

The screening of material for disease resistance has revealed the followings:

- AUDPC (area under disease progress curve) was computed based on biweekly ratings of leafspot infestation. Certain US germplasm, for example US Pi 390593, US 834-3 and RMP 12, had the least rating and were selected for inclusion in the breeding program. During our survey and collection, a variety called Nama was determined to have some mechanism of resistance to both early and late leafspot. This variety, although not immune, has the ability to resist defoliation caused by leafspot and also has a reduced number of lesions compared to susceptible cultivars. However, it has very small pod and seed and should, therefore, be improved.

- For rust, different mechanisms of resistance were found in the germplasm available and can be used in an improvement program. We are in the process of achieving a determination of an ideotype of resistance to rust.

- Our screening for rosette resistance is done in collaboration with Dr. Olorunju from Nigeria. Our work is at its infancy and promising material will result from it. This material is at the F_6 generation and some lines resistant to rosette were identified. Also resistant varieties were crossed at Texas A&M and the field screening done in Burkina Faso.

- The use of fungicide for control of foliar disease was also investigated. It was shown that fungicides do not significantly improve yield in Gampela, while in Bobo the yield almost doubles with the use of fungicide.

2.2. Termite Resistance

Populations with resistance to termites were tested in collaboration with the entomology section. Twenty lines were found to have a reduced number of pod damage by termites as well as acceptable yield. Cultural practices that reduce termite attacks were also investigated in this study.

3. Soil Amendment

The soil amendment originated after a field study in collaboration with TROPSOILS revealed that the test site at Farakoba were too acidic. Acidity is very common in the semi-arid tropics and two alternatives exist in treating this problem:

- The use of acid tolerant variety

- Soil amendment

Over the past four years, we combined 5 levels of soil amendment ($CaSO_4$, P_2O_5, $CaSO_4 + P_2O_5$, ash, and control) and three varieties in order to determine the factors that will improve production of peanut in the test site and perhaps in the region.

Soil Treatment

- There was a significant year x soil treatment effect. Mean pod yield per plant in ash were increased by 45 %, over the control, in 1992. Addition of $CaSO_4$ or P_2O_5 or the combination of the two did not have any effect on pod or seed yield of peanut. The effect of soil treatment is very important because most farmers in South West Burkina practice burning of crop residue during the dry season or just before planting.

- Soil treatment did not have any effect on plant stand. Addition of $CaSO_4$ was not expected to increase soil pH. The use of ash as determined by its high pH might have affected the soil pH. The long effect of ash application observed over the four years of the study can be explained by its effect on the soil pH.

However, those differences among varieties were usually not significant.

Varietal Effect

The most appropriate manner of overcoming the problem of low yield in these soils in Burkina is the identification of varieties that are adapted. All varieties tested showed a little stability over the years. The best stand was observed with the local check TS32-1 while RMP12 usually had the worst.

4. Future Prospect

The end users of these new technologies are the farmers. Today the critical question that we should ask ourselves is what has been extended to the farmer. It is necessary that a linkage between farmers, researchers and extension agents finally materializes so that the results we have are available to the farmers.

A new approach in technology transfer is critical at this stage of action. Many networks have existed in West Africa since the 80's. Their advantage is quite obvious, since all the countries in this region have similar problems. A consultation among scientists in different countries would therefore be beneficial so that our efforts are not duplicated. Centers with high research capacity can take on some specific problems while lesser manpowered research systems can look at the location specific application of these technologies.

The existence of these networks for many crops such as maize, sorghum, cowpea, and millet reveal the symptomatic approach in peanut research in the subregion .

Today the need for conserving already scarce natural resources calls for the investigation of all agronomic aspects of peanut production. Use of peanut in rotation, in association with cereals (intercropping) etc... Our breeding objectives as well as yield trials should now involve all these aspects.

The CRSP should now work toward building and strengthening the host country scientists' capacity in defining and carrying out their own research agendas .

Our research needs in peanuts are still numerous and different and need redefining. Our absence in the area of development should make us wonder whether we need not to rethink our strategy and approaches.

Our experience in collaborative research has started to expand in the region. This year, a regional uniform peanut variety test was established in Burkina Faso, Mali and Senegal. We believe that such initiative should be continued and encouraged by the CRSP.

In conclusion, the orientation of the CRSPs toward Natural Resources Management is welcome in Burkina Faso. Our research agenda should include an aspect in the protection of the environment. The aim is to increase productivity without depleting natural resources. As an ending note, I would like to call upon all scientists to join efforts for better natural resources management. This is the only way towards sustainable agriculture.

Technologies Available for Post-Harvest Storage of Cowpea Grain

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1. Plastic Solar Heaters

These use the rays of the sun to heat cowpea grain to temperatures that kill all stages of cowpea weevil (eggs, larvae, pupae, adults). Any other insects present in the grain are also killed. The technology is based upon reusable 3 m x 3m polyethylene (or other plastic) sheets, one translucent, the other black. The sheets are laid upon an insulating mattress of dried weeds, with the black sheet down. By folding the borders under and securing them with stones, an envelope is formed which holds up to 60 kg of grain. After 2 h exposure to full sun, the grain reaches temperatures of 60-70 deg C.. When the solar-disinfested

grain is stored in ways that prevent reinfestation, it can be kept indefinitely, without loss to insects. There is no evidence that solarization of the grain reduces germination or seedling vigor. Solarization does not affect cooking time or other culinary properties of the grain.

An economic analysis of the solar technology indicates that use of the heaters can provide a positive economic return compared to insecticides.

Technical bulletins describing the construction and use of the solar heaters are available in French and English versions.

2. Improved Ash Storage

In many regions of sub-Saharan West Africa, sieved wood ash from cooking fires is commonly admixed with threshed cowpea grain in the hope of suppressing seed weevil infestations. Systematic studies of ash storage at Purdue University and at IRA-Maroua, Cameroon, revealed that it works, but only if the proportions of ash to grain are right. The research resulted in an improved ash storage technology in which threshed grain is admixed with grain in a ratio of one to one. After mixing grain and ash and packing it tightly in a container (a clay pot, metal drum, or heavy plastic bag) the grain can be kept indefinitely.

An advantage of this technology is that it utilizes very common, low cost materials available in virtually every household. A disadvantage is that it is practical for only relatively small amounts of grain -- generally a few tens of kg's.

Technical bulletins describing improved ash storage are available in French and English languages.

3. Sealed-Container Storage

If cowpea grain infested with cowpea weevils is held in a closed space, the metabolism of the insects will eventually use up the oxygen. When this happens, the insects cease feeding, growing and developing -- and damaging the grain. Exhaustion of the oxygen occurs well before serious damage to the grain. Two technologies that take advantage of this principle for cowpea preservation have proven effective in Senegal and Cameroon.

Storage in Metal Drums. In some areas of West Africa (e.g., Senegal), used 55 gal. metal drums are widely available. They are relatively low in cost. These drums can be filled with cowpea grain, sealed to be airtight, and be kept for long periods without loss to storage weevils. Filled

drums should be stored in the shade and never opened until the grain is to be used -- opening reintroduces fresh air and allows the resident insects (which are not killed by oxygen deprivation) to resume active feeding, growth and development. Because it is critical that the container be completely sealed, the addition of a packet of the insecticide K'othrine (deltamethrin) can be used to provide insurance against air leaks.

Storage in Double or Triple Plastic Bags. A variant of the drum storage technique involves the use of plastic bags. One plastic bag is filled with grain; its mouth is then tied extremely tightly shut. This bag is then completely enclosed by a second bag, which is tied shut. A third bag may be used, enclosing the first two. A promising adaptation of this triple-plastic bagging procedure, developed in Senegal, involves using a single heavy inner plastic bag and a single tough, woven plastic bag as the outer bag.

The method of choice depends upon the materials available locally, their costs, the owners' purposes for storing the grain, the term the grain is to be stored, and other factors. Drum storage and plastic bagging each have their advantages and disadvantages. Any tightly sealable container that can be filled with grain can prevent losses to cowpea weevils.

Technical bulletins describing the triple bagging technique are available in French and English Versions.

4. Seed-Resistant Cowpea Varieties and Germplasm

IITA scientists discovered that some landraces of cowpea have seeds that resist cowpea weevil. The resistance is only moderate, but it nevertheless retards the development of cowpea weevil infestations in grain stores. Thanks to IITA cowpea breeders and the work of National Program and CRSP breeders, several cowpea lines adapted to numerous ecologies with seed-weevil resistance are available (e.g., Mouride and Melakh from Senegal).

5. Storage of Cowpeas in Pod Form

The cowpea pod wall provides a substantial barrier to the entry of cowpea weevils. Cowpea genotypes with pods that don't easily break or dehisce can be stored for long periods of time with relatively small losses to weevils compared to the losses seen when threshed grain is stored. New weevil-resistant lines with combined seed-and pod wall resistance and which will be storable for long periods of time in pod form are expected to be available in Cameroon in one or two years. An

improved local, VYA, with good pod storage characteristics, is already in wide use there and may have applications outside Cameroon.

IPM, Natural Resource Management, and Millet Production in Sahelian West Africa

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Integrated Pest Management (IPM) traces its beginnings to 1967 (Smith & van den Bosch 1967), and evolution of the concept is reviewed by Cate and Hinkle (1994). Despite changes in definitions for IPM, economic thresholds and naturally occurring pest population growth suppressers are consistent ingredients of good IPM practices. Another consistent IPM ingredient is that of recognizing key pests, or commonly serious and persistent species that account for major crop losses. In brief, effective IPM manages pests by conserving effective naturally occurring pest controls (i.e., pest diseases, predators, and parasites), using selective pest behavior modifiers (e.g., baits, pheromones, etc.), and using resistant hosts and crop production practices. In IPM, these crop protection tactics are integrated into a sustainable and mutually complementary system of crop production.

Among IPM tactics, biological control, host plant resistance, cultural controls, and insect pheromones are strategies most compatible with farmers' practices, specially in subsistence farming in West Africa. Effective biological control seeks to suppress damaging populations of a pest at a level below economic injury, that is under the economic threshold level. Such reduction in population densities can be achieved using natural enemies through conservation, augmentation, or importation. Each of these tactics in biological control promotes not only biodiversity, but also effective natural resource management. Host plant resistance on the other hand provides means for controlling pests through antibiosis, nonpreference and tolerance. Cultural control tactics

have been practices for centuries and consist of many tactics such as uniform planting, crop residues management to reduce pest carry-over, mixed cropping, trap cropping, etc. The use of insect pheromones has also been effectively developed against many insect pests such as stem borers. Insect pheromones are specific and have no adverse effect on non-target organisms and humans, and therefore promote environmental stability. This tactic takes advantage of naturally produced pheromone compounds, and often uses synthesized compounds to alter pest behavior in order to enhance control. It is therefore clear that IPM must be a key component in natural resource management which seeks to improve pearl millet production in marginal areas typical of the Sahelian West Africa.

Effective implementation of IPM requires a multi-disciplinary, multi-institutional approach and effort. This means that International Institutes, Universities such as those comprising the Sorghum-Millet CRSP (INTSORMIL), regional organizations, Research Networks such as ROCAFREMI, specialized institutions, NGOs, and NARS can effectively contribute to developing and transferring IPM technologies that emphasize natural resource management and promote environmental stability. Both complementarity and synergism can occur in these technologies, and should be encouraged to enhance IPM development and implementation.

The following two examples demonstrate how IPM tactics can be used not only to enhance effective natural resource management, but also to contribute to environmental stability. One of these includes management of the millet head miner using biotic mortality, namely predators and parasitoids. Research on the millet head miner biological control has been initiated through an INTSORMIL, INRAN, and ICRISAT collaborative project. The second example provides evidence that naturally produced insect pheromones can be identified, synthesized, and effectively used to manage insect populations such as the millet stem borer. Work on the millet stem borer pheromone is a collaborative research activity of ICRISAT and NRI. In both examples, dissemination of research results and technology occurs through NARS and the West and Central Africa Millet Research Network (ROCAFREMI).

Millet Head Miner Research

The millet head miner (MHM) commonly causes significant crop losses of pearl millet in Sahelian West Africa. Infestations sometimes approach 95% with a collective grain loss of 60% (Guevremont 1983). Current management options are mainly cultural practices (e.g., late planting and deep plowing) (Gahukar et al. 1986), and these are generally impractical. However, MHM is a good candidate for a control strategy that emphasizes effective natural enemies, i.e., biological control. It supports a relatively large number of natural enemies (Bhatnagar 1990), occupies a predictable habitat in an ecosystem with relatively consistent annual habitats, and has one generation per year.

Before advocating a strategy using biological control, extant natural enemies must be assessed. This is especially important for low input and fragile Sahelian farming systems. Thus, research on MHM survival is underway to understand the contributions of MHM natural enemies to total mortality. Specific research objectives are to 1) expand aspects of MHM biology; 2) evaluate the impact of MHM enemies; and 3) construct an age-specific life table (k-factor analysis) for MHM.

Materials and Methods. Our experiments were conducted mainly in fields at and near the ICRISAT Sahelian Center (ISC) in Niger. We began experiments during the summer of 1993, and continued these through the fall of 1994. To date, we have conducted four series of experiments on MHM (Bayoun et al. 1995), but the most important were caged experiments that measured the contributions of natural enemies to total MHM mortality. These experiments excluded natural enemies from MHM on some experimental plants, and permitted free access of natural enemies to MHM on others. Experiments were conducted in fields at ISC during the summer-fall of 1993 and 1994.

Single-panicle cages were constructed using a wire frame covered with screening (21 X 21 cells per cm^2). Cages were placed over panicles at the boot stage of development, and this prevented natural infestations of MHM on caged panicles. A cone painted with nondrying glue was attached at the bottom inside of each cage to capture dispersing prepupal larvae. Cones were inspected daily for trapped prepupae, and were replaced weekly. Some cages were designated as "open," and were managed to allow natural enemies easy access to MHM developmental stages inside. Other cages were closed to prevent access to natural enemies. On cages designated as open, screening was raised ca. 20 cm to provide an entrance for natural enemies. Cages were opened daily at 6 a.m. and closed again at 6 p.m. Closing cages during night hours prevented oviposition by natural populations of MHM. Larvae falling

from open cages were trapped in plastic trays painted with nondrying glue and placed under millet panicles.

During the 1993 millet growing season, we conducted three series of cage exclusion experiments in a millet field in ISC. The first series used a total of 10 cages infested with MHM adults. When ca. 25-cm long, panicles were infested with MHM eggs by releasing four female and two male MHM into each cage; the MHM adults were removed after 24 h. Four panicles were cut and the number of eggs oviposited on each panicle were counted (panicles had an average of 15.5 eggs). The remaining 10 cages were divided into three groups. A group of two cages remained closed for the entire growing season, and served as a control treatment for assessing MHM mortality without natural enemies. A second group of four cages was opened immediately after removing adult moths, and remained open for the 48 h of MHM egg incubation. These cages were then closed and remained closed thereafter to measure the impact of natural enemies attacking the MHM egg stage. A final group of four cages also was opened after MHM adult removal, remained open during the entire millet growing season, and measured the collective impact of natural enemies attacking all MHM egg and larval stages. When the MHM in these experiments reached the prepupal stage, all caged millet panicles were cut, and the contained MHM were counted and held for emergence of adult moths or parasites.

A second series of cage exclusion experiments was conducted during 1993, and consisted of 12 cages. Each cage was infested with 15 first-instar MHM larvae by transferring recently hatched larvae to individual panicles. After infestation, cages were divided into four groups. Cages of the first group were maintained closed during the entire season, cages of the second group were maintained open from panicle infestation until the appearance of the first mine (i.e., measured enemy mortality to early MHM larval stages), cages of the third group were opened only after the appearance of the first mines and remained open for remainder of the experiment (i.e., measured enemy mortality to late MHM larval stages), and the last group was opened immediately after MHM infestation and remained open for the entire season (i.e., measured enemy mortality to MHM eggs and all larval stages).

A third series of cage exclusion experiments was conducted during 1993, and included a total of 10 individually caged panicles each infested with 20 first-stage MHM larvae. Five of these cages remained closed during the whole season, and five remained open for the entire millet growing season.

Caged exclusion experiments conducted in 1994 used a total of 32 cages, each infested with 25 first-instar MHM larvae. Eight of these cages remained closed during the whole season, eight were opened after panicles infestation and until the appearance of the first mine, eight were opened after the appearance of the first mines and remained opened thereafter, and eight cages remained open for the entire millet growing season.

Results and Discussion. Results of the cage exclusion experiments are presented in Figures 1 to 4. Data generally showed that numbers of living larvae differed markedly between closed and open cages. This was most apparent when comparing closed cages with cages opened during the entire season (Figs. 1 and 4). Cages opened during the egg stage (Fig. 1) did not differ from closed cages in the numbers of larvae at the end of the season, indicating insignificant impact of enemies attacking the egg stage. Cages opened during either early or late larval stages did not differ greatly from closed cages (Figs. 1-4); however, cages opened during late larval stages contained fewer total larvae than those opened during early larval stages (Fig. 1). Thus, we conclude that the collective impact of enemies attacking all MHM stages on the millet panicle was significant. Our sampling further indicated that most mortality occurred on later instars.

Though experimentation is incomplete, these data suggest that natural enemies are a significant source of mortality in MHM populations. However, the greatest impact of these natural controls appears to occur on later MHM larval instars. When this research is complete, the mortality sources will all be identified and, where possible, methods of manipulation will be described for those that can be effectively managed to cause optimal MHM mortality. Such techniques and methodologies are being shared and transferred through NARS and networks such as ROCAFREMI. Their relevance is evident, given that one of the four projects of ROCAFREMI focuses on the IPM of millet head pests.

Millet Stem Borer Management

Management of millet stem borers puts emphasis on biological control, cultural control through crop residues management, use of tolerant varieties, and use of pheromone technology. Aspects on the use of crop residues management to reduce millet stem borer carry-over has been documented by Youm et al. (1993a), Youm and Gilstrap (1994), Youm et al. (in press). Crop residues management as part of natural resource management is a means of enhancing soil fertility and reducing wind erosion. However, care should be taken in residues management to reduce population carry-over of the millet stem borer. Thus, it is clear that effective natural resource management requires a multidisciplinary

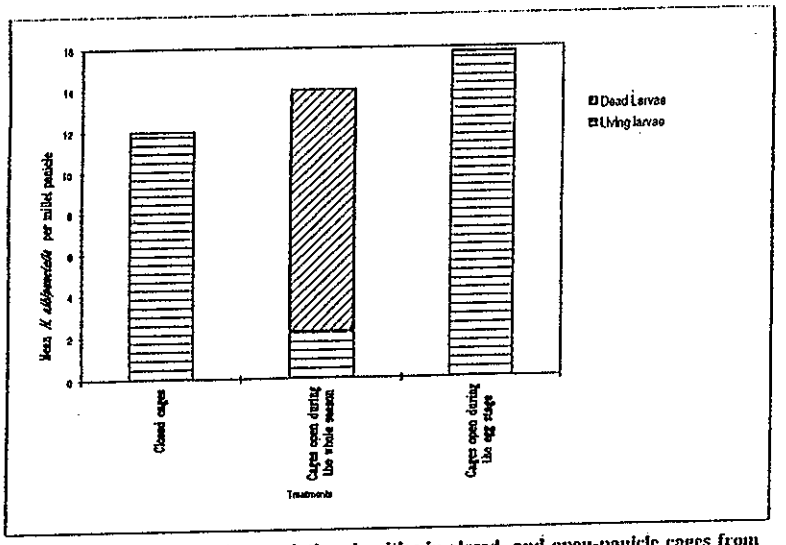

Figure 1. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (first series), 1993 rainy season at ISC, Niger.

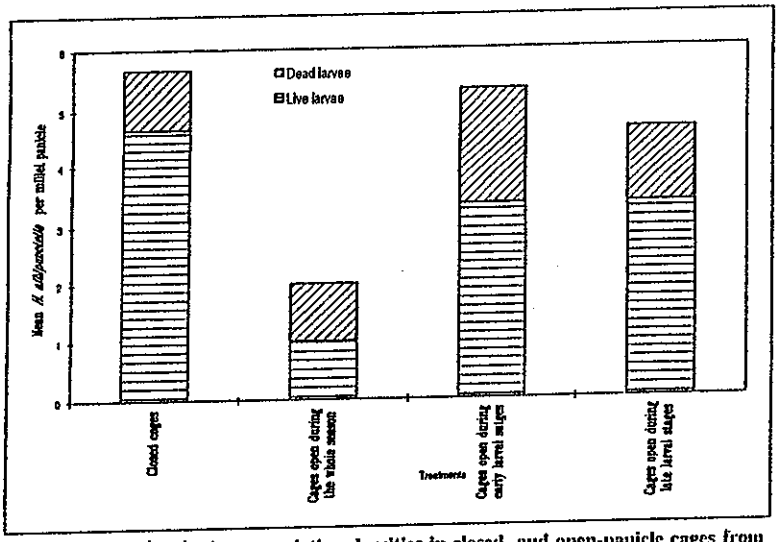

Figure 2. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (second series), 1993 rainy season at ISC, Niger.

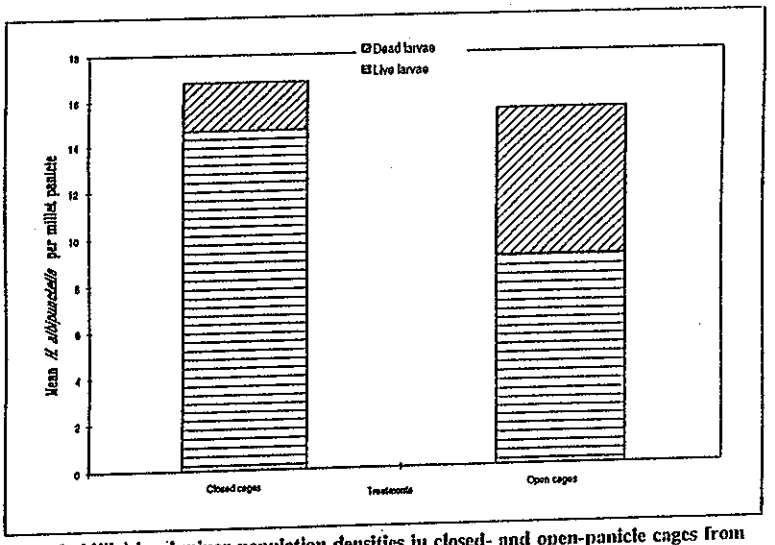

Figure 3. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (third series), 1993 rainy season at ISC, Niger.

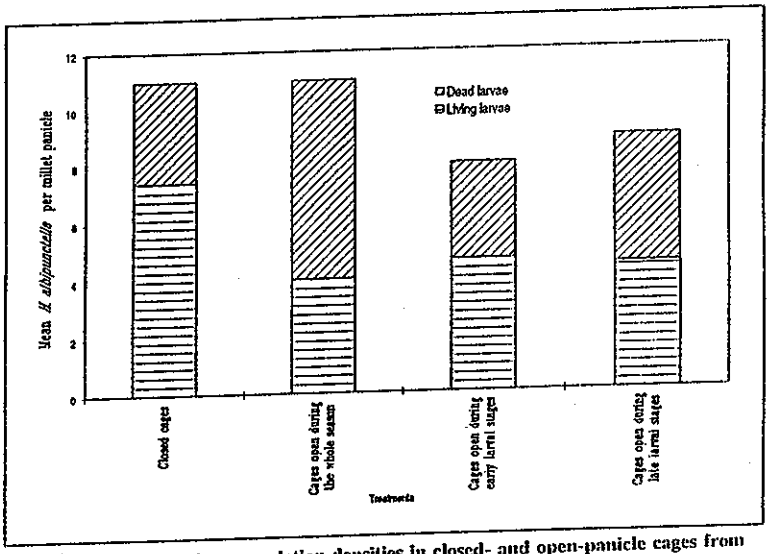

Figure 4. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments, 1994 rainy season at ISC, Niger.

approach. Promising techniques to reduce population carry-over include cutting and laying millet stems on the soil surface soon after harvest. Partial burial of stems also contributes to reduce populations (Youm et al. 1993a, Youm et al. in press).

Another promising tactic which enhances natural resource management is the use of insect pheromones. Research at ICRISAT Sahelian Center, in collaboration with the Natural Resources Institute (Chatham, UK) has contributed to the identification and evaluation of components of the millet stem borer sex pheromone (Youm et al. 1993b). Subsequently, an effective pheromone trap made from local material has been developed (Youm and Beevor 1995). In the case of the millet stem borers, females produce and release sex pheromones to attract males for mating. The advantage of the pheromone technology is that it is specific to the target organism and has no environmental hazards. The technique therefore contributes to reduced pest densities and environmental stability in the context of natural resource management. The female sex pheromone of the millet stem borer is comprised of five components. However, only three are attractive if mixed in an optimum ratio. With pheromone traps baited with the optimum blend, nearly 400 moths have been caught in a single trap in one night. This gives evidence that mass trapping is likely to have good potential to reduce millet stem borer populations. Mating disruption is being used to assess its value for control of the millet stem borer, and early results are encouraging. A regional millet stem borer monitoring network has been established and is being extended to many member countries of ROCAFREMI. Such a regional monitoring network can serve as an early warning system, a key to effective IPM.

Conclusion

In summary, it is clear that IPM is a key to effective natural resource management and enhances crop production such as pearl millet production in marginal areas in West Africa. IPM implementation emphasizes the development and use of biological control, host plant resistance, cultural control, and the use of sex pheromones. In the context of subsistence farming, these techniques are highly desirable, since they contribute to environmental stability. Implementation of IPM also works best with a multi-institutional and a multidisciplinary approach. International Research Centers, Universities such as INTSORMIL institutions, regional organizations, NARS, NGO partners in research and development, coupled with end-users, each plays a role in successful IPM development and implementation. The two examples given demonstrate how effective collaboration and the use of naturally occurring biological control agents and insect sex pheromone can be exploited to enhance natural resource management,

and reduce pest densities for an increased crop yield such as pearl millet in the Sahel.

Acknowledgments

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Figure 1. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (first series), 1993 rainy season at ISC, Niger.

Figure 2. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (second series), 1993 rainy season at ISC, Niger.

Figure 3. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments (third series), 1993 rainy season at ISC, Niger.

Figure 4. Millet head miner population densities in closed- and open-panicle cages from exclusion experiments, 1994 rainy season at ISC, Niger.

INTSORMIL CRSP Utilization Projects

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Objectives

Our collaborations in West Africa now focus mainly on technology-oriented small scale processing of sorghum and millet grains to competitive, commercialized products, and assisting the NARS breeding programs in grain quality evaluation. Other activities include some work with larger scale millers and biscuit manufacturers to demonstrate the feasibility of using composite flours with sorghum or millet in their operations.

Both projects have trained a number of individuals from INRAN and IER, some of whom have obtained M.S. and Ph.D. degrees. Research at the U.S. universities has focused on developing a fundamental understanding of grain properties related to product quality, as well as studies directed towards improving nutritional quality of sorghum grain. These studies have led to the development of superior food grade sorghums and products that we believe can compete with imported commercial wheat or rice-based products.

Summary

Cereal and legume processing in West Africa fits into the overall natural resource management system as the outlet for increased grain production. For example, in Niger the proposed introduction of the sorghum hybrid NAD-1 must be demand driven from the market and consumer side. Other important benefits of simple or more sophisticated processing technologies is that they generate income at the local level, have the potential of reducing time consuming food preparation tasks for women, and may reduce imports of both wheat and rice and products made from them. This sounds like a tall order, but there are many examples of agriculturally-based poor economies developing through agribusiness and food processing.

One of the largest constraints on the success of processing projects involving sorghum and millet is the lack of a constant supply of good food quality, uniform grain. This is one of the main reasons that previous large projects of this sort have failed in the past. We are trying to introduce small-scale processing integrated with the local production of varieties with good food quality traits. Larger scale production of the sorghum hybrid, for example, could additionally supply grain for composite flours for larger cereal industries. Supporting research from the NARS and U.S.-based collaborators has shown that high quality commercial products can be produced from locally grown grains.

In Mali scientists from IER and Texas A&M University have been very successful in producing sorghum products that in trials are well received, including a rice-like product, flour, pregelatinized flour, and a weaning food (now being sold commercially).

In Niger we are in the process of buying small-scale equipment for a couscous processing facility that will be set up at INRAN for purposes of testing and demonstration to entrepreneurs and cooperatives. A Nigerien scientist has shown at Purdue that certain sorghum varieties under special processing conditions can produce a high quality couscous product. We would like to expand this project with rural-based processing units to work with local groups in processing couscous and/or other food products.

The INTSORMIL Utilization Group would welcome the opportunity to expand our efforts and coordinate them with the other CRSPs in Ghana and Burkina Faso, as well as NGOs and other organizations who may be better positioned to transfer technologies to the field. Also, we are in close contact with scientists at the Food Technology Institute (ITA) in Dakar, Senegal. They have a very active group and have developed many impressive food processing technologies that are appropriate for the small entrepreneur or group wanting to start a food processing business.

Food Science and Post Harvest Handling of Peanuts

E. Perez Castell, Alabama A&M University/Peanut CRSP, Normal, AL, USA

The major objective is to improve post harvest handling and storage techniques to increase quality of peanuts and peanut products. Thus, emphasis should be given to post harvest technology as the primary constraint in peanut utilization in the region. There is a strong need for application of food technology principles (drying, storage, processing, packaging, nutrition, etc.) to come up with solutions to the utilization problem.

The major areas of focus will be:

1. Identification of post harvest handling equipment needs (on farm processing facilities). Design and construction of necessary equipment (sheller, storage facility, dryer, etc.) for use at farm level.

2. Identification of needed cottage industry processing equipment to reduce contamination and to increase efficiency. Development of applicable equipment in various locations (grinders, shellers, cleaners, packaging, etc.).

   Emphasis should be given to conversion of locally available equipment for manufacturers to make inexpensive processing technology available to food processors. As an example, use of press for extrusion processing and oil extraction.

3. Recognition that proper storage and packaging will be a critical part of developing good quality products.

4. Assurance of safety of products considering naturally occurring toxicants and added ingredients with particular reference to mycotoxins in raw and finished products.

Peanut CRSP

General Accomplishments:

Increased use of peanut in traditional foods, developed new products, increased awareness of the high energy and protein value of peanut, improved harvesting, storage and processing of peanut to supply adequate quantities of safe and acceptable products to consumers, minimization or total elimination of aflatoxin in food products, and enhanced research capacity of institutions (Burkina Faso).

Available Technology:

1. Surveying procedures to assess problems in handling of peanuts (farmers) and processing of specific products such as peanut paste (manufacturers). Assessment of microbial and aflatoxin contamination of both fresh peanuts and peanut-based products, product shelf-life and quality (moisture content, rancidity, etc.).

2. Process improvement of selected peanut-based food products:
   a. Roasted peanuts
   b. Tô
   c. Peanut paste

3. Use of composite flour technology to develop more nutritious foods such as ready to use for under 5 age children products.

4. Packaging alternatives cost and improve quality. Interaction with private sector (local industry, Burkina Faso).

5. Development of post harvest methods for prevention of aflatoxin contamination such as improved drying and storage conditions as well as chemical methods (*Allium sativum* extracts).

6. Extrusion technology to produce energy dense nutritious foods.

7. Trained personnel in the areas of food technology, food microbiology, food processing and food chemistry

Transfer of technology should be made via regional workshops. The Universite de Ouagadougou in Burkina Faso could be the center of development of regional efforts to benefit other countries.

Challenge:

1. Appropriate Technological advancement of postharvest practices.
   - Equipment (processing) and storage facilities
   - Packaging - investigate economic impact

2. Knowledge of nutritional implications of diet.
   - Supplementation of traditional foods
   - New product development
   - Health - food safety issues.

3. Alternative uses of crops--fuel/feed, etc.

4. Communication--networking?

Food Science and Post Harvest Handling

Peanut CRSP, University of Georgia, Griffin, GA, USA

Peanut CRSP - Ghana and Burkina faso

Development of technology for better utilization of peanuts and peanut-based food products in Burkina Faso and Ghana has improved post-harvest handling operations (on farm and at market level), diversified the options of products available to the consumer, improved the nutritional value of traditional foods, and initiated linkage with the local food processing industries. This technology can be transferred to countries with similar constraints to crop utilization. Training and education are essential components of the technology transfer process.

Some specific examples are as follows:

1. Regional surveys were conducted at farm and local processor levels to assess the level of aflatoxin contamination and to identify critical quality problems related to improper handling practices. Expertise acquired on survey administration and personnel training can be adapted to regions with similar on farm and entrepreneurial needs.

2. Results from research on aflatoxin detoxification strategies using plant extracts as conducted in Ghana and Burkina Faso can be expanded to other regions with emphasis on local, indigenous plants. Methods and procedures for analysis are already in operation.

3. Improvement of traditionally made food items has resulted on expanded availability of nutritious foods to the population. This knowledge can be shared through workshops and training

4. Development of weaning foods using composite flour technology and extrusion cooking. The Food Research Institute will receive a food extruder as part of the Peanut CRSP objectives in food utilization. Training on food extrusion can be conducted via short courses and demonstrations. Once the basic principles and operations of extrusion cooking are learned, the skills can be applied to the development of alternative extrusion processing equipment made by locals.

   Use of locally available crops for manufacture of extruded snacks should also be explored. Development of weaning foods is currently being implemented in Burkina Faso (local products are competing in the market with more expensive products imported from France).

5. Research on quality improvement of products due to proper packaging can be adapted to other needs.

6. Training program can be developed in the Universite de Ouagadougou, Burkina Faso. Students will be able to obtain graduate levels degrees in Food Technology with expertise on Post-Harvest Utilization.

7. InterCRSP collaboration should continue.

Unité de Production de Farine Composée au Mali Fabrique Alimentaire du Sahel (FAS)

Adama Coulibaly, IER/INTSORMIL, Bamako, Mali

Introduction

L'analyse de la situation nutritionelle au Mali montre une prédominance de malnutrition protéino-énergétique. Le problème est très perceptible chez les enfants à l'âge de sevrage qui ont besoin d'une assez grande quantité d'énergie et de matières.

Dans le sens l'amélioration de l'état nutritionnel des enfants, le laboratoire de technologie alimentaire de la Recherche Agronomique de l'Institut d'Economie Rurale (I.E.R) à mis au point plusieurs formulations de farines infantiles dont la formulation originale de Mileg (80% farine de mil et 20% niébé).

Cette formulation originale de Mileg a été testée dans plusieurs localités du Mali (Cinzana, Tinguélé et Kominta) afin de déterminer l' efficacité et l' acceptibilité.

Cette farine composée à intérressée aussi bien les travailleurs de la recherche agronomique que les populations des localités testées; cela à éveillé l'instinct d'entrepreneur d'un travailleur de la Rechereche Agronomique du Laboratoire de Technologie Alimentaire.

Objectifs

Les objectifs du projets sont:

1. Elever le niveau nutritionnel des enfants
2. Valoriser les produits locaux
3. Offrir aux Maliens un produit de qualité moins cher que les produits importés.

Unité de Production

L'étude de faisabilité du projet faite par le BARREP (Bureau d'Assistance pour la Réalisation et la Réhabilitation des Entreprises et des Projets) en 1991 n'a connu un début de concrétisation qu'en novembre 1993 à cause des problèmes liés à la technologie. En fait les bailleurs de fonds représentés par le PAPME Canada (Projet d'Appui aux Petites et Moyennes Entreprises) ont émis le voeu de fabriquer un produit malien avec les machines fabriquées au Mali.

Il fallait alors partir d'un ensemble de résultats de recherche et de consultation menées avec le soutien financier du PRMC International (Programme de Restructuration du Marché Céréalier) pour aboutir à un certain nombre de machines.

- Le crible: pré-nettoyage des grains
- Laveuse désableuse
- Le séchoir à gaz
- Torréfacteur à charbon
- Le mélangeur de farine
- La doseuse.

En plus de ces fabrications locales il faut ajouter deux autres machines importées (Décortiqueur et broyeur SISMAR) complétant ainsi la chaine de production.

Il faut noter que ni la laveuse désableuse, ni le mélangeur, ni la doseuse ne correspondent réellement au besoin de l'unité de production pour les raisons suivantes:

- La laveuse désableuse: Grossiers taux de désablage moyen 75%; matériel grossier, non économique.

- Le séchoir: Capacité trop petite (30kg en 4 heures) pour couvrir les besoins de l'entreprise.

- Mélangeur: Appareil oxydable et ne peut être utilisé pour la finition.

- La doseuse: Totalement défaillante par rapport à la farine et ne peut être utilisée que pour les granules.

Il est important de souligner que seules les machines de prétraitement de grains ont été bien conçues sur place. Les machines de finition ont été défaillantes à cause du manque matériaux de construction adéquats mais aussi à cause du fait que les fabricants représentés par des ateliers de constructions métalliques n'ont pas bien mesuré l'importance et la délicatesse des travaux dont ils avaient la charge.

L'unité de fabrique: La Fabrique Alimentaire du Sahel (FAS) a une capacité de 4 tonnes par mois. Le produit est dénommé Mileg (Mil, Mais, Légumineuse) en annexe face I et II du sachet. Mileg ne contient que pas de protéagineuses. Sa teneur en lipides est de 3.98% ce qui fait que le produit à une bonne conservation. Malheureusement après un contrôle par Ciba Geigy il apparait que la densité energétique est très faible (0.6 Kcal/ml). Il à été recommandé d'élever cette quantité à 1 kcal/ml. La FAS et l'IER sont en train de faire des efforts pour parvenir à ce résultat. Le laboratoire de technologie alimentaire est chargé de mener des recherches pour palier à ce déficit

Toutefois la question reste ouverte au séminaristes pour appréciation d'une technologie applicable et maîtrisable pour l'unité de production.

Commercialisation

Pour le développement de son marché commercial le FAS à eu l'appui financier et technique de CECI Canada (Centre d'Etude et de Coopération Internationale Canada) du CEDI (Centre de Développement Industriel Bruxelles) du Kit (Institut Royal des Tropiques) du Ciba Geigy.

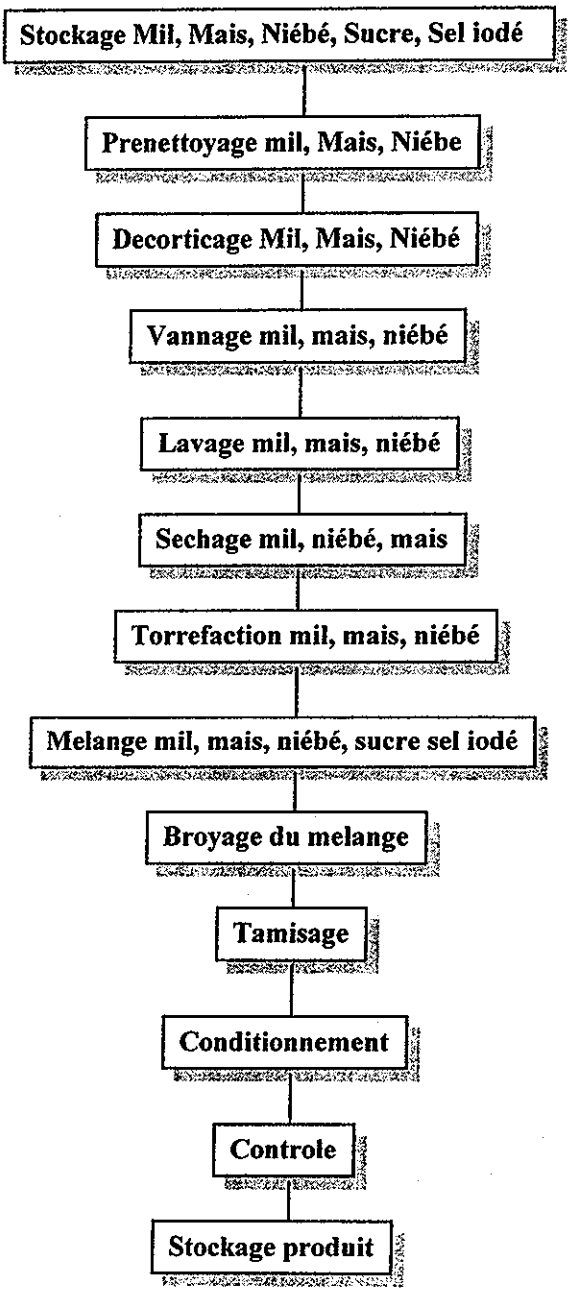
Il à été établi à l'intérieur de Bamako un grand nombre de points de vente (voir annexe). Les ventes sont encore faibles. L'unité de production ne vend que 25 cartons de 13kg/mois.

Grâce à une subvention accordée par CDI le produit va connaître au mois de septembre une réelle promotion médiatisée.

Le marche social d'une tonne par mois est entretenu par le ravitaillement de sept centres de récupération nutritionnelles siégeant dans les centres de santé communautaires des quartiers périphériques de Bamako.

Ces centres de réccupération nutritionnels ont été créés par le CECI-Canada avec l'appui financier du PRMC Fond Spécial Mali (FSM). Ils ont pour objectif l'accroissement de la consommation d'aliment complémentaire du lait maternel fait avec les produits locaux (produits céréaliers en particulier). Mileg sera vendu bientot dans les centres de santé publiques avec l'appui de la division santé familiale.

SCHEMA DE PRODUCTION DE MILEG



Conclusion

Le produ Mileg largement distribué à Bamako à été beaucoup apprecié par les consommateurs et les médecins. L'extension du réseau de distribution dans les chefs lieux de régions est en cours. À la demande des consommateurs la FAS entend mettre sur le marché la forme instantanée du produit.

Remerciements:

La FAS remercie vivement l'INTSORMIL et l'Institut d'Economie Rurale pour son invitation et pour toute l'importance qu'ils accordent à cette entreprise.

Emerging Technologies for Regional NRM: Information Dissemination, Training & Communication

Ron Grosz, HERNS/USAID, Arlington, VA, USA

With all the talk about the information superhighway, it's hard to sort out whether applications in this field are promoted because they are truly the best tools for the job or simply appealing because people are enticed by all the government support, press coverage and advertising they continue to receive. Development and use of technology is a complex issue. We sometimes have a tendency to throw technology at a problem or worse yet use it simply because it's available. This is as true about NRM as it is of communication and information technology, especially computer-based applications.

Technology is a tool to use in response to a problem, issue or opportunity. When deciding which technology to use, we have to consider whether it is affordable, maintainable and appropriate from perspectives such as culture, politics, and society. Determining whether there's a good match between the problem, the technology and the people or institutions who are the intended "end users" is as critical as the technology itself. We know that it's not technology alone that ever

solves a problem or takes advantage of an opportunity. The whole system must be considered, not just the technology. It is that carefully matched balance of people, process and technology that "works" most effectively and is ultimately sustainable.

So it is with communication, information or training technology. Computer applications are not the high-tech panacea for all that ails us in these areas. The many computers gathering dust in offices in the U.S. and other countries demonstrate they are not always the right tool for the job.

Having said that, it's important to recognize, according to Jake Brunner in a report for the Africa Bureau, that "Electronic networking [via computers] can help African Countries respond to, and participate more effectively in a rapidly changing global economy that is increasingly driven by the free flow of information and ideas. Without the expertise and communications infrastructure to circulate information rapidly, Africa will be further disadvantaged." (1). Looking at cost, only one of several factors that must be considered. Jake states that in Africa, for example, a five-minute phone call can run up to $25, a one-page fax is about $10, but a one-page email costs about $1 to transmit!

There is definitely a place in West Africa for well-planned, implemented and supported efforts to bring the information highway to the region. Without such efforts, already impoverished areas of the world risk cascading even more deeply into poverty. Information is the new "currency". Much of the African continent is dreadfully poor in it. Countries risk not being able to purchase a hold on the global economy without it. Information and communication technology nested in an "enabling" private sector environment, supported by policies, regulations, skilled men and women and capable institutions is a winning combination for Africa. It can help the InterCRSP effort achieve its stated objectives more rapidly and cost-effectively.(2).

Let's consider five types of technology which are relevant to our discussions this week:

1. Lower-end Technologies

Existing technologies are often still appropriate to supporting the human and institutional infrastructure. They should not be forgotten as efforts are undertaken to improve communications and information flow in the region. Phones and faxes are important. But they don't consistently work well in the region. They are often constraints to rather than supporters of effective communication. Motor-scooters or bicycles are still critical to getting around to communicate with a group of farmers or

business women. They are often in short supply or broken down. The need for these low-end communication and information tools doesn't disappear just because there is suddenly an Internet node operating in Niamey or Bamako!

2. E-mail

Rapid and measurable results in solving identified problems can be achieved through reliable applications such as computer-mediated communication and training. This can include electronic mail, electronic conferencing, and on-line in-service training workshops. Many constraints identified by various assessments already done for the region could be greatly mitigated through adequate yet simple "higher-end" technology such as email. Reliable email can help end isolation, obtain information, coordinate, collaborate and learn what's needed when it's needed. The benefits will substantially exceed the costs of establishing email service in Africa as the AFRICALINK report I quoted indicates.

USAID/Washington and several USAID Missions are actively engaged in establishing or expanding internet email capacity in Africa. In Niger, for example, the USAID Mission and the World Bank are involved in establishing an internet node in Niamey. They are working closely with various organization such as INRAN, AGRHYMET, ICRISAT and others.

3. World Net

Periodic, regular training sessions for the region can easily be designed using the United States Information Agency's World Net, a one-way (Washington-to-post) video transmission capacity. For example, farmers, technicians from research or extension institutions and others involved in the technology development and transfer process can gather at the local World Net facility in their capital cities. Expert trainers from collaborating Universities or Government Agencies in the U.S. can be inexpensively brought to the studio in Washington, DC rather than flying them to countries in West Africa. They would present the training module which is sent by satellite and immediately viewed by those gathered at the in-country facilities in West Africa. Two-way audio connection is established using dedicated telephone lines. Dialogue can be carried on among all the connected sites in real time.

World Net can also be used with video taped training for those situations where the trainer can't come to the Washington studio. Such sessions would be less "interactive" unless local resource people were "trained up" to provide on site discussion and answer questions of refer them on to other experts. Email would greatly improve and facilitate

such distance interaction. Meanwhile, a training program that included training of local facilitators could be designed and implemented to take advantage of the World Net facilities in the region.

The World Net System could also help the InterCRSP effort by providing a forum for holding planning and organizing meetings, team-building sessions, or other critical organizational development activities without the expense of so many face-to-face meetings. This can help assure that all voices are heard, all ideas considered and everyone has input.

If arrangement can be worked out with USIA, the World Net system can and should be used immediately since it is already in place throughout the region and doesn't have to wait for the arrival of widespread access to the internet.

4. Kiosks

There are successful examples in the U.S. of computer email stations called "kiosks" that are accessed in public places by individuals and groups who do not own the hardware and software needed. The concept could be piloted at key points in rural areas in West Africa. These kiosks could become training and information centers for farmers, NGO staff, researchers and extension agents. People in the field would be able to ask questions, seek help, and get critical information quickly. Key sites for such installations might be in regional extension or farmer organization offices, NGO field locations and so on. Location, of course, depends on existing supporting infrastructure like electricity and phone lines.

5. National Television

Where they exist, we should investigate whether national television facilities can play a role. Television could be used effectively in distance learning as well as in information dissemination efforts in Niger for example. As with all technologies, there would have to be an appropriate "match" between the medium, the message and the audience or client. Video taped regular programs could be designed for farmers, input suppliers, NGO staff, extension agents, researchers and others. They could be brought to a TV access point more cheaply than to, say, Niamey. Combining TV with capable on-site trainers can make this an effective learning technology.

Conclusion

There is definitely a place in West Africa for well-planned, implemented and supported efforts to bring the information highway to the continent. With it, West African countries can better leverage the huge investments already made in building their human and institutional resource base, their research programs and their technology development and transfer processes. Information is the new "currency". Using it, countries will more effectively purchase a sustainable hold on the global economy. Information and communication technology nested in an "enabling" private sector environment, supported by policies, regulations, skilled men and women and capable institutions is a winning combination for Africa.

ENDNOTES

(1) AFRICALINK Final Report & Recommendations, Draft. Jake Brunner. World Resources Institute, Washington, DC. February 10, 1995. Page 1.

(2) The InterCRSP proposal has two overlapping and interdependent objectives. First is to strengthen the institutional and human capacity to develop and transfer natural resource management technology and information. Second is to increase the availability of and access to profitable and sustainable NRM technology in West Africa.

Rapporteur's Synthesis of Session II: Technologies Available for NRM in West Africa

Chair: Gaousso Traore
Rapporteur: Menwueyellet Moussie

I. Land and Water Conservation and Utilization

Focus: Rainfall harvesting and Erosion Control

Watershed to be considered as a unit of agricultural and NRM technology development transfer at the farm and landscape level.

Challenge: To adopt a holistic watershed management plan with full participation of the farming and non-farming communities that derive their livelihood in/from the watershed.

NRM Research and Technology

Niger: Tropsoils research has been going on since 1989 on different soil structures and landscapes; some have been applied on farmers' fields.

Using the landscape as a unit, a number of research activities have been carried out on plateau and lowland fields, but these have been individually and separately. It was suggested that research on both plateau and lowland be done as a system simultaneously.

Burkina: Research has been conducted to reduce:

Soil and wind erosion
Deforestation
Overgrazing

Some of the technologies developed are hedging, diking, mulching, composting, zays, and rock terracing.

II. Genetic Resources and NRM

Focus: Preservation and conservation of genetic resources to enhance NRM and agricultural technology development and transfer

Challenge: The development of improved, sustainable, and stable genetic resources compatible with NRM and the environment from which West Africans derive their livelihood.

Research and Technology Tranfer Themes:

- Biotechnology: particularly for cash crops such as cowpea
- Hybrid Cultivars: particularly for sorghum and maize for Sahelian agriculture
- Nitrogen Fixation Technology for Food Crops: cultivation of legumes such as peanuts and cowpeas
- Small Ruminant: Multipurpose goats, weed control, manure, and energy

III. Crop and Livestock Production and NRM

Focus: Integrated management of the natural resources for increased and sustainable crop and livestock production in West Africa.

Challenge: Integration of chemical with organic and biological inputs into production systems that will increase and sustain crop productivity, and enhance environmental integrity.

Research and Technology Tranfer Themes and Issues:

- Pros and cons of chemical fertilizers
- Crop residues, such as millet straws
- Green and farmyard manures
- Sorghum: Rotation, intercropping, crop residues, stress tolerance, and production practice packages
- Aquaculture: Develop efficient production system compatible with land and water resources

IV. Crop Protection and NRM

Focus: Integrated Pest Management (IPM) to sustain and enhance agricultural, environmental, and NRM base of West Africa.

Challenge: Promote and use multiple tactics to minimize pest damage and enhance productivity of natural resources.

Research and Technology Tranfer Themes:

- Knowledge of key and damaging pests important regionally in West Africa, synthesis of diagonostic research made to-date
- Crop protection techniques, such as biological, cultural, chemical, and genetic
- Germplasm evaluation and utilization for pest resistance
- Soil Amendment

Future Prospects:

- Focus on adoption and use of IPM technologies
- Regional coordination to benefit from economies of scale, comparative advantage, and minimize duplication
- Control of *Striga* using intercropping with legumes, cowpea, and peanuts, use of fertilizer
- N fertilization with chemical fertilizers and manure
- Cowpea seed storage technologies from Cameroon: Solar heater, ash storage, and sealed container storage

IITA Experience in IPM:

Take advantage of the number of technologies developed by IITA, especially in *Striga* control, starting from constraint identification to manufacturing of materials and linking it with the private sector.

IITA is now focusing on technology transfer through NARSs, NGOs, and the private sector.

V. Crop Utilization and NRM

Focus: Need for market-oriented and demand-driven technologies which are important farmer incentives to increase productivity and production.

Challenge: Production of good nutrient, consumption, processing, and marketing of quality food crops.

Research and Technology Tranfer Themes:

- Methods for evaluating food quality in important crops
- Low cost food technology (sorghum, millet)
- Food storage, conservation, and preservation
- Food safety

VI. NRM Related Emerging Technologies

Communication: Identify, select, and procure information technology that is appropriate, affordable, and maintainable.

- Lower-end technologies (Radio, bikes, etc.)
- Higher-end technologies (Internet, etc.)

AFRICALINK (AFR/SD Project): To connect electronically (African Institutions)

- E-Mail
- Document Exchange
- Mediated Discussion Groups
- Access to International Information

AGRHYMET:

- Early Warning System
- Monitoring & risk prone areas
- Management of Natural Resources
- Training

Rapporteur's Comments:

1. Incorporate inputs from work done in West Africa by ICRAF and ILRI (former ILCA).

2. Broaden stakeholder participation to include ICRAF, ILRI, NGOs, and private sector.

3. As much as possible, link Agricultural TDT with NRM and the environment.

Besoins de la Recherche en Gestion des Ressources Naturelles: Dimension Sous-Régionale au Sahel

Gaoussou Traoré, INSAH, Bamako, Mali

L'Instilul du Sahel: Un Instrument de Coopération Sous - Régionale en Matière de Recherche Agricole.

L'Institut du Sahel (INSAH) est une institution spécialisée du Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) qui regroupe actuellement neuf pays: Burkina Faso, Cape Vert, Gambie, Guinée-Bissau, Mali, Mauritania, Niger, Sénégal et Tchad. Le mandat du CILSS est de: "s'investir dans la recherche de la sécurité alimentaire et dans la lutte contre les effets de la sécheresse et la désertification pour un nouvel équilibre écologique au Sahel".

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

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

Durant les deux dernières années, l'INSAH à subi une profonde mutation qui se situe dans le cadre du redressement et de la relance durable du CILSS. Le cadre d'orientation stratégique à long terme de cette institution ainsi que son plan triennal (1995-1997) ont été adoptés par ses instances de décision au cours de l'année 1994.

Mission et Stratégie d'Intervention de L'INSAH

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

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

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

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

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

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

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

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

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

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

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

Quelques Contraintes Liées à la Gestion des Ressources Naturelles au Sahel

Les principales contraintes à la gestion durable des ressources naturelles au Sahel sont:

Contraintes bio-climatiques

- variabilité inter-annuelle et répartition spatiale et temporelle annuelle de la pluviomérie très fortes
- invasions fréquentes de nuisibles des cultures

Contraintes liées au sol

- sols pauvres surtout en N et P
- sols fragiles, sujets à l'érosion (hydrique et éolienne) et/ou à l'encroûtement
- dégradation des terres

Contraintes socio-économiques

- faible productivité des systèmes d'utilisation des ressources. Consequence: pauvreté de la majorité des populations
- mortalité très élevée (18%) liée à une forte mortalité infantile (122/1000)
- forte fécondité (6-7 enfants/femme)
- fort taux d'accroissement naturel: 3.1% /an
- fort taux d'urbanisation
- problèmes d'éducation, de santé, d'emploi, de migrations, de conflits, etc.
- insecurité alimentaire pour les hommes et les animaux

Contraintes liées à l'environnement mondial

- forte dépendance vis-a-vis de l'extérieur
- environnement économique international très défavorable

Contraintes liées à l'encadrement technique

- lacunes dans les connaissances de base surtout dans la compréhension des relations causes <==> effets entre les facteurs physiques, biologiques et socio-economiques
- faible taux de génération par la recherche des technologies performantes sur le plan écologique, et acceptables sur les plans socio-économiques et culturels
- faible taux de transfert des acquis de la recherche vers le développement
- faible synergie des échanges d'expériences entre les structures de la recherche et entre celles-ci et le développement/vulgarisation

Contraintes liées aux politiques gouvernementales

- lacunes dans le cadre institutionnel et législatif en vue de libérer les initiatives et comportements individuels et collectifs: foncier, politique des prix, décentralisation, démocratisation, etc.
- manque d'environnement incitatif porteur
- succès mitigés des réformes entreprises par les gouvernements

Domaines et Axes Prioritaires de Recherche en Gestion des Ressources Naturelles de Portée Régionale

Les domaines et axes suivants peuvent être considérés comme prioritaires et de portée régionale au Sahel:

Amélioration de la Connaissance sur la Dégradation des Ressources Naturelles

Evaluation de la sensibilité et/ou de la résistance des terres à la dégradation: études et analyses des interactions entre les facteurs bio-climatiques, démo-économiques, culturels et politico-institutionnels

Etudes visant à mieux comprendre le comportement des communautés par rapport à la dégradation des ressources naturelles.

Développement des indicateurs de suivi de la dégradation des ressources naturelles.

Etat des Lieux et Analyse des Pratiques de GRN

Caractérisation des systèmes d'utilisation des ressources naturelles (systèmes de production).

Identification et analyse des obstacles à l'adoption des technologies et pratiques éprouvées de GRN => conseils

Amélioration de la GRN

Gestion conservatoire des eaux et des sols: Gestion intégrée des éléments nutritifs du sol; fixation symbiotique de l'azote; gestion et valorisation des phosphates naturels; amélioration des techniques de récupération des terres dégradées.

Mise au point de méthodologies de gestion des formations naturelles.

Développement de modèles d'aménagement et de gestion durables des terroirs qui sont acceptables par les collectivités locales (sur les plans social, culturel et économique).

Gestion intégrée des pesticides et étude de leur impact sur l'environnement.

Mise au point de technologies post-récolte et de transformation des produits issus des RN.

Etudes sur les possibilités de diversification des revenus par rapport à l'utilisation des RN.

Recherche sur les ressources génétiques: collecte, évaluation, conservation et diffusion.

Recherche sur les parcs agro-forestiers et les arbres à usages multiples pour une gestion durable des terres.

Développement des biotechnologies.

Etudes et Analyses des Stratégies et Politiques en GRN

Développement de méthodologies et de modèles d'évaluation de l'impact des politiques et stratégies des gouvernements en matière de GRN.

Développement de méthodologie d'évaluation de l'impact de l'adoption des technologies et pratiques améliorées de GRN au niveau des exploitations.

Développement d'un système d'analyse et de suivi de l'impact des politiques et stratégies des gouvernements sur les ressources naturelles transfrontalières et conseil aux decideurs pour leur gestion durable.

Les priorités ainsi indiquées ne sont pas exhaustives. Elles doivent être éablies selon un processus itératif et participatif d'identification impliquant l'ensemble des acteurs, en particulier les collectivités locales.

La convention des Nations Unies sur la lutte contre la désertification constitue, pour les pays sahéliens et leurs voisins, un cadre logique pour établir ce processus.

Le Problème de Gestion de Ressources Naturelles en Tchad

Aminou Bouba-Kaou, Laboratoire Farch, D'djamena, Tchad

Introduction

Le Tchad, situé en plein coeur de l'Afrique est un pays à vocation agro-sylvopastorale, dont les ressources naturelles (sol, eau et végétation) constituent la base de l'économie. De par sa position géographique, il fait partie du sahel et est victime des effets de la sécheresse, de l'augmentation démographique et du cheptel. Durant ces dernières décennies ces effets ont accentué la dégradation des terres des cultures de la végétation et du cheptel du pays. La dégradation de ces unités à des multiples conséquences sur la vie de la population. Face à cette dégradation et ses conséquences, le gouvernement à mis en place un plan d'action dont quelques objectifs fondamentaux sont:

Objectifs fondamentaux

- Contribution à la promotion de l'économie rurale
- Erosion des sols
- Conservation de ressources naturelles
- Amélioration de conditions de vie des populations

Les causes de dégradations

Elles sont surtout d'origine climatiques et humaines:

- Sécheresse de 1972 à 1973 et de 1980 à 1984
- Surexploitations des terres par l'homme et le bétail
- Démographie galopante, désertification des espaces et déséquilibre du milieu

Règles de correction et de régénération du sol

- Maîtrise de l'érosion
- Travail profond des sols dégradés (décompactage)
- Apport de stabilisant (Mo, Ca, C, légumineuses)
- Apport d'éléments biogènes (fumiers)
- Mise en place des cultures associées
- Chaulage = correction chimique

À ces corrections il faut ajouter

Axes stratégiques et prioritaires de lutte contre la dégradation

- Protection et régénération des ressources écologiques
- Elaboration d'un schéma national d'aménagement du sol
- Renforcement du cadre institutionnel
- L' amélioration du système de production
- Restauration des potentiels agro-sylvo-pastoraux
- Amélioration de la gestion de ressources végétales et de protection du sol
- Protection et gestion des faunes et ressources halieutiques
- Gestion rationnelle des ressources en eau

Pour atteindre les grands objectifs fondamentaux cités plus haut un certain nombre de recommandations:

Recommandations

- Coopération régionale pour des échanges d'expériences
- Assurer un contrôle commun de l'avancée du phénomène
- Des moyens techniques matériels et financiers importants
- Mobilisation des médias publics et internationaux
- Interdiction formelle de feu de brousse
- Création des aires protégées par la mise en défense systématique des zones vulnérables

Conclusion

Le problème de gestion de ressources naturelles (sol, ressources hydriques, végétales et animales) n'est pas l'affaire d'un individu (exploitant) mais celui de l'humanité en général. Il faut une prise de conscience personnelle et collective pour qu'ensemble la lutte soit efficace même si les résultats attendus ne sont pas immédiats.

National Programme Needs for Natural Resource Management in Ghana

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Ghana is situated in West Africa's Gulf of Guinea, between latitude 4°44'S and 11 ° 11 'N of the Equator and longitude 3 ° 11 'W and 1 ° 11 'E of the Greenwich Meridian. The land area covers approximately 23.9 million hectares including 1.1 million hectares under in land waters. Agricultural land area has been estimated at 57% of the total land. Savanna woodland, bush fallow and range pastures constitute 30%, 25% and 15% respectively of the total land use. The rest are forest reserves (11 %), tree crops (70%) annual crops (5 %) and unreserves forest (2%).

Natural Resources Base

Land, vegetation, water and soil form the main natural resource base of the country. The land resources have been divided into ecological zones on the basis of rainfall distribution and vegetation. Two main zones are the forest which occupies 34% and the savanna forming the remaining 66%. Within the forest are subzones; the rainforest which lies at the southwest portion of the country and where rainfall is about 2500-3000 mm. This is only 3 % of the land area. This subzone is characterized by a well developed organic topsoil with a strongly leached mineral soil below. The moist semi-deciduous forest zone receives the mean annual rainfall of 1500-2000 mm. Topsoil development and leaching are less pronounced than under rainforest. The savanna zone consists of the interior savanna, the northeast or Sudan savanna and the heterogeneous coastal savanna or thicket.

National Program Needs

The main program needs at the national level are the development of technologies to address problems of (i) low degradation (ii) depletion of the forest resources (iii) soil management and water conservation (iv) rangeland development (v) management of the country's water resources. (Vi) livestock-crop integration (vii) bush fire and (viii) technology transfer and adoption through research-extension linkage.
Due to the fact that the existing method of farming is still based on slash and burn or bush fallow the soils are depleted and vegetation destroyed programs of rejuvenating of the degraded soils through appropriate use of organic materials such as manure and crop residues as mulch are

needed and these are being pursued by research organizations such as the Soil Research Institute, Savanna Agricultural Research Institute, Crops Research Institute and Animal Research Institute, all under Council for Scientific and Industrial Research. There is also the need to draw up program to look at the system of farming.

- Forest resources are being depleted as a result of overlogging. Programs on reforestation to replenish depleted species are needed. Already the Forestry Research Institute of Ghana and the Forest Department of the Ministry are pursuing such a program and there is the need to intensify the activities of the program.

- Agroforestry research, though being pursued, needs to be intensified especially in the use of multipurpose trees as sources of manure, fodder and firewood.

- Soil and water conservation is an important program which needs much attention. There are personnel in this area but there is a need to train mere staff for research activities on this program.

- The country's rangeland is virtually undeveloped. There is the need to monitor growth of vegetation and biomass accumulation so as to determine the carrying capacity of the rangeland and to avoid overgrazing and subsequent problem of land and environmental degradation. Research program is needed to introduce appropriate legume species to improve on feed quality of rangeland vegetation. Animal Research Institute and Animal Production Department of the Ministry of Food and Agriculture are collaborating in this issue.

- Livestock-crop integration program needs to be looked at critically since the two aspects complement each other. This program has started already at Animal Research Institute of CSIR and the need to intensify research in this area is essential.

- The need for the management of the country's water resources including fisheries has been recognized. Water Resources Research Institute and Institute for Aquatic Biology of CSIR have programs in this area.

- Bush fire is a major problem and one of the main causes of deforestation and land degradation. So far no program is being pursued to address this problem. The program needs attention of researchers, local communities and NGOs.

- If all technologies developed are to be adopted and to have impact on the community, the technology transfer program should be much

pursued. The extension unit of the Ministry of Food and Agriculture in Ghana is being strengthened to take this issue at a more serious level.

Natural Resource Management in Cameroon

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Introduction

The major natural resources in danger of degradation in Cameroon are:

- **Soil Resources,** which include:
  - Soil fertility enhancement
  - Prevention of soil erosion and soil degradation
  - Appropriate nutrient management practices
  - Soil management through replacement of natural fallows by improved or modified fallow systems
- **Water Resources**
  - Proper water management practices in dry areas
  - Proper irrigation practices
- **Forest Resources,** including,
  - Prevention of over-logging
  - Prevention of deforestation
  - Use of multipurpose trees for fertility enhancement, animal grazing and domestic use
  - Encouragement of reforestation
  - Prevention of over exploitation of wildlife and game
  - Preservation of endangered species
  - Prevention of over exploitation of wild plant species of medicinal importance

The primary objective of natural resource management is to achieve sustainable improvements in agricultural productivity through the conservation and improvement of the natural resource base. This can be achieved by:

- Focusing on and improving production systems of regional significance that are at risk of degrading the resource base and which offer opportunities for enhanced productivity.

- By exploiting the already available technologies that can be applied directly to manage, in a sustainable manner, the natural resources about to be degraded.

Agriculture in Cameroon and in Tropical Africa can be broadly divided into three groups of production systems:

- **Humid Forest Agricultural Systems**, which include:

  - Roots and tuber-based systems
  - Rice-based systems
  - Banana and plantain-based systems.

In this type of agricultural system, the major natural management problems are:

  - Soil fertility
  - Reduced fallows
  - Serious weed infestation
  - Acidity and aluminum toxicity
  - Water management problems in rice based systems
  - Plantation management and decline, especially in banana based systems.

- **Moist Savanna Systems**, which include:

  - Cereals-based production systems
  - Roots and tubers-based systems, the major NRM problems here are
    - Soil fertility
    - Soil erosion
    - Obnoxious weeds such as *Striga*
    - Reduction of natural vegetation.

- **Dry Savanna Production Systems** , which include,

  - Cereal (small grains)-based production systems
  - Legume-based production systems.

Here, the main constraints are:

- Unavailability of moisture for plant establishment
- Persistent drought spells
- Unavailability of improved short-cycle varieties with consumer acceptability.
- Lack of high biomass producing varieties for livestock grazing.

The main approach to natural resource management is by addressing the constraints primarily through field testing, and by using efficient methods for the transfer and adoption of available and developed technologies. To achieve this, we must rely on three main research thrusts,

- Carrying out multi-scale characterization in each participating country
- Initiation of land and water development programs
- Testing of agricultural technologies through farmer participatory approaches.

The procedure for NRM is to have benchmark sites and pilot sites for each production system. These benchmark sites must be few (3 or 4) and representative of the particular production system. They must be large enough to capture all the variability in the production system and land gradient. The bulk of the work will be carried out in the benchmark sites.

The pilot sites may be many and will be located in the other countries where that production system is important. The results obtained from the benchmark sites will now need to be tested in the pilot sites for confirmation and adaptability to local conditions in that particular country.

For natural resource management to have a regional significance, there must be some kind of coordination of research efforts among participating countries. This coordination may include the following components:

- National coordination units to monitor research and development at the national level
- Annual meetings of all participants to discuss results
- Steering committees which review and approve research project proposals.
- Regional coordination units preferably with the participation of international staff in universities and institutions in developed countries, working in partnership with the participating African countries.

NRM must in every aspect try to integrate crop and livestock production, since farmers in African countries and the society as a whole are always practicing, either consciously or unconsciously, this kind of mixed farming. This is important because livestock have both a beneficial and destructive effect on crop cultivation. Therefore, their exact role in the production system must be clearly studied and regulated. NRM must also seek to investigate post-harvest and post-production systems for both crops and livestock with an overall goal to reduce waste.

Natural Resource Management: A Cameroon example

Cameroon, is one of the benchmark sites of the Alternatives to Slash and Burn Agriculture (ASBA) whose broad objectives are:

- To provide sustainable alternatives to the practice of slash and burn

- Study methods and practices to reduce global warming, through discouraging burning in bush fires during slash and burn. This would concentrate carbon from plant residue in the soil instead of letting it disappear in the atmosphere.

- Study ways by which soil degradation in forest margins could be reduced.

- Study methods to reduce deforestation and recommend reforestation

- Recommend improved fallow management practices to improve ground cover, reduce weed infestation and enhance soil fertility.

The Cameroon benchmark area has the following characteristics:

- It covers a fairly representative area of the humid forest
- It is large enough to capture the most important variability characteristic of a humid forest ecosystem.
- It has a good number of pilot sites for field testing of results acquired from the benchmark site.
- It has the philosophy of a multidisciplinary team approach to solving problems in the area.
- It studies soil management, nutrient management and forest management.
- The benchmark also has in its team of scientists, sociologists and socioeconomists for the evaluation of the resource systems and technology needs.
- It has a good coordination structure made up of,
    - Regional coordinator, from an international centre (IITA)
    - National coordinator, from Cameroon's Institute of Agronomic Research (IRA)
    - A technical advisory committee for reviewing proposals
    - a unit of sustainable agricultural research for approving proposals.
- In its first year, it started with diagnostic research to characterize the area. It is now in its second year and is now tackling the researchable issues found from the surveys of the first year.

International Cooperation in Natural Resources Management in Cameroon

1. IITA - ASBA, (through its Humid Forest Station - HFS)
2. ICRAF - ASBA, (concentrating mainly in agroforestry)
3. IBSRAM - Soil management research

Other Players

1. NGOs, e.g. SAILD
2. The Universities

   - University of Dschang
   - University of Yaounde

3. Ministry of Environment and Forestry (MINEF)
4. International Projects - e.g. TROPENBOS.

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Recherches sur la Gestion des Ressources Naturelles au Sénégal: Acquis et Perspectives

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Introduction

Depuis les années 80, l'USAID finance, au niveau du Sénégal, à travers le projet CRSP (Collaborative Research Support Program) les programmes de recherches portant sur le niébé et l'arachide conduits par l'Institut Sénégalais de Recherches Agricoles (ISRA) en collaboration avec d'autres Institutions de recherches de la sous-région ouest-africaine. Les autres volets de ce vaste programme de collaboration concernent le mil/sorgho, la lutte intégrée contre les nuisibles, la gestion des sols et la gestion des ressources naturelles.

L'objectif du présent atelier est de créer un cadre d'exploitation optimale des technologies générées et des synergies ainsi créées à travers l'élaboration d'un projet interCRSP pour le développement et le transfert de technologies visant la gestion durable des ressources naturelles.

Contraintes à la Production Agricole

La production agricole au Sénégal est en butte à des contraintes d'ordre climatique (sécheresses), agronomique (disparition des jachères, faible utilisation des intrants chimiques ou organiques, érosion hydrique et éolienne, salinité, dégradation du couvert végétal et des ressources forestieres) socio-économique et institutionnel (faible maîtrise des circuits de commercialisation des produits agricoles, insuffisance du crédit agricole, faiblesse des relations entre les divers acteurs du monde rural). D'autres contraintes tiennent aux systèmes de production (faible intégration de l'animal dans l'exploitation, manque de concertation et faible responsabilisation des collectivités villageoises dans la gestion communautaire de leurs terroirs).

Technologies Disponibles

Les recherches sur la gestion des ressources naturelles et le transfert des technologies qui en découlent font intervenir plusieurs acteurs: l'ISRA, les structures de formation et de vulgarisation, les projets et ONG ainsi que d'autres structures specialisées. Aussi, est-il malaisé de faire un recensement exhaustif des technologies disponibles. Toutefois, on peut en citer quelques-unes:

- cordons de pierres, bandes enherbées, cultures en courbe de niveau pour lutter contre l'érosion hydrique dans les bassins versants
- compost, fumier, biogaz
- techniques culturales (rotations, cultures associées, engrais vert, sous-produits de poissons, travail du sol à la dent perpendiculairement à la pente)
- introduction de l'arbre dans l'exploitation (*Leucaena, Gliricidia, Acacia albida*) et mise en défense des parcelles
- mycorhizes

Mutations du Cadre d'Evolution de la Recherche Agricole Sénégalaise

L'âpreté de la competition économique mondiale associée à l'émergence de nouveaux acteurs du développement du fait du désengagement de l'Etat et à l'accroissement de la demande urbaine en matière de produits agricoles de haute qualité et en quantité suffisante milite en faveur d'un partage de la charge de recherche entre les divers partenaires et d'une bonne coordination des efforts en vue de réaliser des économies d'échelle et d' exploiter les avantages comparatifs. Cette réorganisation de la recherche en réseaux tant au niveau national qu'au plan sous-regional apparaît comme une exigence incontournable face à la réduction des financements nationaux et extérieurs.

Stratégies en Matière de Gestion des Ressources Naturelles

En vue de développer un programme cohérent et pertinent de recherche basée sur la gestion durable des ressources naturelles, il est indispensable d'élaborer une approche interinstitutionnelle et interdisciplinaire et de mettre en oeuvre des méthodes participatives impliquant chercheurs, vulgarisateurs et producteurs dans les processus de planification, d'identification des priorités, d'exécution et d'évaluation des programmes de recherche. Cette approche rompt avec la planification descendante et implique une bonne connaissance des systèmes de production, de leurs contraintes et des stratégies paysannes.

Axes de Réflexion pour un Renforcement de la Coopération Inter-CRSP dans le Domaine de la Gestion Durable des Ressources Naturelles

La gestion des ressources naturelles concerne plusieurs domaines d'activité: gestion des eaux et des sols, gestion des jachères, agroforesterie, agropastoralisme et gestion des ressources halieutiques. En un mot, il s'agit de la gestion du paysage agricole dans ses diverses composantes.

Dans le cas spécifique des bassins versants, domaine privilegié d'intervention du projet "Sustainable Agriculture & Natural Resource Management" financé par le CRSP, d'importants travaux ont été réalisés par l'ISRA en collaboration avec l'ORSTOM et diverses autres Institutions de recherche de la sous-région, notamment dans le cadre du Réseau R3S/CORAF/ CILSS-INSAH. Ces travaux ont porté sur les bas-fonds, les bassins versants et la parcelle et ont donné lieu à des technologies en cours de valorisation et de diffusion, sous diverses formes.

Par conséquent, une collaboration future dans ce domaine entre les divers projets CRSP devrait s'articuler autour des axes suivants:

- partage des informations sur les technologies disponibles et mise en oeuvre de recherches adaptatives grâce à une exploitation optimale des synergies au niveau national et sous-régional
- définition des grands axes d'un programme régional de recherche sur la gestion durable des ressources naturelles impliquant les Institutions parties prenantes aux projets CRSP
- recensement des propositions nationales et mise en forme définitive du projet
- élaboration de programmes de formation
- développement d'un système de communication et d'échange d'informations entre les divers partenaires (réseaux informatiques)

Participatory Approach: The First Step to Rural Development and Technology Transfer

M. A. Osman and Carol McCormac Wild, Africare, Niamey, Niger

Background

In September of 1992, Africare signed a Cooperative Agreement with the U. S. Agency for International Development (USAID) to implement a four-year natural resource interventions in the Goure Arrondissement of the Zinder Department (south eastern Niger). The main goal of the project is to assist the population of this region to improve their physical quality of life through the integration of environmental conservation and sustainable agricultural developments in a comprehensive natural resource management plan.

The Goure Natural Resources Management (GNRM) project is a follow-on activity to the Goure Rehabilitation Project (GRP: 1989-1992). The GRP, funded by USAID and the Government of

Niger (GON), had as its principal objectives: 1) supporting national self-sufficiency in nutrition 2) combating desertification and 3) increasing small ruminants production. Although the three-year GRP had produced a number of physical infrastructures, target recipients had not successfully exploited the benefits because of several reasons. First, the project was highly centralized and most of the planning and implementation decisions were made by the project staff and collaborating local level GON officials. This kind of development strategy obviously ignored the active participation of beneficiaries in decision making and, probably, prioritization of project investments. Secondly, maintenance of project investments and sustainability of activities, after funds were withdrawn, were assumed to be assured by the GON technical services. Because of lack of funds, these technical services could not provide the support needed. Based on these lessons learned, the GNRM project is designed using the participatory approach in which beneficiaries are major players in decision making, identification of priorities and implementation of activities. Major objectives of the project include:

1. Introduction of interventions to improve agro/sylva/pastoral resource management and environmental protection.

2. Establishment of environmental and socio-economic monitoring systems.

Project Activlties and Implementation Methods

The first step is to select village(s) willing to participate in project activities. The selected village(s) must be, also, willing to invest their labor and financial resources to execute activities. Following acceptance of terms of agreement, steps are taken to assign a village agent (animator) to serve as facilitator and a means of communication with the project, develop engagement contracts between village(s) and the project, create a village management committee, develop village NRM plan and elaborate formal written activity proposals which the village(s) presents to the project for co-finance. These proposals are submitted to the GON technical services for feasibility and approval. Villagers are, also, required to develop land-use sketches of their territory as it is today and must identify what they will like to invest in it for future improvement of their natural resources. The territory claimed by the village(s) must be approved by the GON officials such as the Sous-Prefet and the Chefs de Canton. As of today, over 8,000 beneficiaries in ten sites, with two to three villages/hamlets per site, are participating project activities. Since the project started, over 78 activity proposals have been submitted to the project by collaborating villagers. Of these, 68 proposals have been accepted for co-financing. Major

activities and interventions proposed include soil conservation such as construction of water retention dams, rock-bands, erosion control such as sand dune fixation, water development such as well digging, sheep fattening for women, adult education, reforestation, purchase of improved cook-stoves for efficient use of fuel wood and training and study tours to villages and projects engaged in NRM and related activities.

To ensure successful technology transfer to rural-based producers, several key aspects must be kept in mind. First, the entire process, starting with problem identification, must be truly participative if an honest dialogue is to occur. Africare's NRM project in Goure, Niger has found that Participatory Rural Appraisals (PRAs) are effective ways to solicit a variety of opinions. All information is gathered with three separate groups such as village elders, women, and young men to get different perspectives. Being traditionally polite to outsiders, farmers often tell people what they think they want to hear and not necessarily what they truly believe.

An example of this approach can be seen with a tool we use during PRAs. Farmers are asked to list all types of trees they know and like, as well as all the uses they can think of for those trees. Months later, villagers proposed live fencing as a solution to destruction by domestic animals of vegetable crops in oases. When species were discussed, none of species on the original tree matrix were suggested as species to plant. The mere existence of the matrix however, allowed an opening point for dialogue: why the change of interest in species? Was the suggested species (an exotic which was not originally cited by the villagers as being important), truly what the villagers wanted, or were they suggesting a species that they thought the project would want to plant?

The second important aspect for successful technology transfer is the need to use as many visual aids as possible to transfer information and technologies, including videos, drawings, demonstrations, and technical sheets (in local language if possible). Seeing is believing and risk adverse farmers will not adopt new technologies without having seen the benefit.

For example, zai holes are a well known technology in Burkina Faso, but very rare in eastern Niger. Despite having no harvest for three years in one of his fields, a farmer in eastern Niger recently mentioned that he had put zai holes in one part of his unproductive field and has obtained good harvest. Now, in the middle of the rainy season, he is convinced of zai technology and its advantages, and plans to extend zai holes to the rest of his field.

To disseminate their results, researchers are encouraged to include visual aids, whenever possible, that can be used by extension agents or projects. Resources in the field for doing this are not always adequate and it is always easier for someone intimately familiar with a subject to create appropriate visual materials.

A third important aspect for technology transfer is the need for contact among farmers. Field Days, farmer to farmer visits, demonstrations, and study tours to areas where farmers have already adopted a technology are all examples of effective ways of transferring to farmers through exchange of ideas.

Furthermore, it is important not to give "incentives" to farmers for their participation such as per diem, etc. The interest in acquiring additional knowledge should be sufficient incentive by itself. If not, it becomes difficult to identify who participates because of interest in the technology and who participates for extraneous reasons.

The importance of farmer to farmer contact cannot be overemphasized. In the Goure NRM Project zone, an exotic tree species, *Acacia holosericea*, was planted during another project. While effective as a wind break, the villagers did not have any secondary uses for this species. Four hundred kilometers away, farmers have learned how to transform *Acacia holosericea* seeds into local food stuffs as done by the Australian aborigines. During a study tour comprised of farmers from the Goure area, this knowledge was passed on. Shortly thereafter, one of the Goure participants asked Africare if she could have a demonstration day in her village so women from other villages in the Africare zone could come and learn how to transform *Acacia holosericea* seeds into local foods. While on her study tour to Maradi, this farmer had been imbued with a sense of responsibility by her hosts to pass on new-found knowledge to others who were not selected to participate in the original trip.

Finally, for successful technology transfer, it is important to remember that this is an iterative process: monitoring and evaluation is extremely important to see if modifications in a technology is necessary. For example the Africare NRM project had a highly successful campaign to teach women to build improved mud cookstoves. Based on high adoption rate, it would have been easy to assume this mudstove technology had been successfully transferred. However, an evaluation after the rainy season showed that many women were saving money to buy metal cookstoves because the mud stoves are built in place and women did not like their immobility. The project is currently researching

portable mudstove models to ensure that poor women will not be excluded from this technology.

Numerous appropriate technologies exist already in the Sahel. From a grassroots perspective, a lack of dissemination and examination of why technologies are or are not adopted is more important than striving for yet more new technologies. From our micro-perspective, four aspects, such as participation, visual aids, farmer to farmer contact, and monitoring and evaluation are essential to successful technology transfer. Our role is to incorporate aspects in our efforts to transfer technologies and, if necessary, refine the technologies to reflect different regional needs.

The GNRM project is being executed in close collaboration with the GON Ministry of Water Resources and Environment with whom Africare signed a Protocole d'Accord in January, 1993. The technical services of other ministries, such as Agriculture and Animal Husbandry, are also being utilized as required. The cooperation of the civil authorities at the departmental and sub-departmental level is critical for the successful implementation of project interventions. In this regard, continuing contact is maintained with the Arrondissement and Department-level technical services and the SousPrefet of Goure Arrondissement for their inputs and monitoring project progress.

Rapporteur's Synthesis of Session IV: Stakeholder Analysis

Chair: Mudiayi Ngandu
Rapporteur: Souleyman Ouedraogo

Objective: Identify all potential stakeholders (dépositaires d'enjeux) and their vested interests and roles in interCRSP NRM project, including direct and indirect beneficiaries, participants, coordinators, donors, and others.

Le thème de cette session a fait l'objet de travaux en commissions. Trois commissions ont été constituées (NARSs, NGOs, 3 CRSPs, IARCs). Chacune des commissions devait traiter les quelques questions suivantes:

1. Qui sont les dépositaires d'enjeux (stakeholders) et rôles dans la gestion des ressources naturelles?
2. Quels sont les enjeux?
3. Quelles sont les attentes et les besoins des partenaires?
4. Quelles sont les stratégies de chaque dépositaire d'enjeux (stakeholders) pour répondre aux besoins et aux attentes dans le cadre de projet interCRSP?

A la fin des travaux en commission, les résultats ont été exposés en séance plénière. Les résultats sont consignés dans les tableaux ci - après.

Les groupes II et III ont au préalable défini le terme partenaires comme étant ceux qui ont un intérêt commun dans l'accomplissement de quelque chose.

La groupe II a examiné les besoins et les attentes sous l'angle des NGO pour réaliser les activités de gestion des ressources naturelles.

La groupe III a traité la question des attentes et services sous l'angle des relatious CRSPs/IARCs.

Suite à l'exposé des différents groupes, un petit débat a été organisé. Les questions ont tourné autour des relations CRSP/NARS. Il s'agissait de savoir s'il y à eu discussions entres les NARS et les CRSP.

La réponse à été négative. Il n'y à pas de discussion approfondie entre les CRSP et les NARS.

La question des organisations sous-régionales dont le rôle ne relève ni des CIRA, ni des CRSP mais qui peuvent servir de relais entre les CRSP et les SNRIA à été soulevée.

Group I - NARSs

Dépositaires d'enjeux	Enjeux	Attentes/ Besoins	Stratégies
Organisme/projets de dévelopment Instituts de recherche Structures d'enseignement Organisations paysannes Communautés villageoises ONG Privés CIRA Organismes régionaux	Economie d'échelle Coordination des efforts Développement durable Transferts interinstitutionels Échanges d'expériences	Nécessité d'une structure de coordination Financement durable Information Formation/Education	*Au niveau national:* Approche participative Inter-disciplinaire Inter-institutionnelle *Au niveau régional:* Exploitation des avantages Comparatifs Partenaires de la sous-région

Group II - NGOs

Dépositaires d'enjeux	Enjeux	Attentes/Besoins	Stratégies
Institut de recherche (National, régional, international) Les petits entrepreneurs (secteur privé) Les paysans Les communautés Les sources de vulgarisation Les ONG (Locales, nationales, internationales) L'administration locale Les personnes ressources coutumières Les projets de développement Les donneurs	Accroître la productivité sans détruire les R.N. Keep abreast of developments Need to have long-term perspective, not to a limited geographic A need for technical skills for multi-disciplinary approach NGOs need to include stakeholders with larger perspective Coordination and collaboration To responsibilize local population Need of link between NARS, NGOs, and CIRA Information flow mechanism between stakeholders Exchanges in field between NGOs and NARS/IARCs	Local empowerment Increased integration of livestock into crops and tree systems Training and extension Decentralization of local administration to allow NGOs to work efficiently	More involvement of NGOs at planning stage of interCRSP to ensure grassroots perspectives are included in research design Involve NGO during field testing Establish or strengthen links with research institute on a regular basis, be it formal or informal Opportunities for dialogue should be quantified in advance

Group III - CRSPs and IARCs

Dépositaires d'enjeux	Enjeux	Attentes/Besoins	Stratégies
Farmers Policy makers CRSPs IARCs RC NGOs NARS Donors Extension Business (private)	Lives of people Food production Environmental quality and sustainability	Funding Cooperation Science International perspective experience Harmonization and coordination of efforts (NARS, NGOs) Contributions to food production and security Contribution to increase farmer income Technology generation and adoption Improvement of IARC and US university linkages Capacity building	Training Work as partner with NGOs and NARS Information exchange Prioritize and use comparative advantage Ensure that most credit goes to NARS Strengthen NARS Strengthen extension Developing sustainable NARS

Summary of Working Group Discussions on Strategic Objectives for NRM in West Africa

Chair: Phillippe Sankara
Rapporteur: Steve Mason

Mr. Phillippe Sankara opened the session on Strategic Objectives for NRM in West Africa. He read the principal constraints from the Burkina Faso National Research Program for Natural resources:

- Lack of water suited for human and animal consumption.
- Degradation and heavy usage of soil.
- Low productivity of current production systems.
- Weak performance of agencies involved in technology transfer.
- Weak producer organization.
- Difficulties in utilization of agricultural products.
- Degradation of range and forest resources.

Their global objective is to "permit a better knowledge among researchers about techniques and methods to sustain soil, water, and vegetative cover, with the goal to contribute to food security, fight desertification and poverty". This provided useful information for the task at hand.

The plan of work was outlined as follows:

1. Identify the strategic objectives.
2. Prioritize the strategic objectives.
3. Assess potential contributions of available technologies to the strategic objectives.

Jeff Hill, USAID Africa Bureau, defined strategic objectives to be vision statements that include the needs and outcomes necessary to meet the objective. He indicated that a strategic objective should identify a broadbase contribution to society.

The workshop participants were divided into groups based on ecological zones: Sahel (Semi-Arid), Sudan and Guinea Savanna (Sub-Humid), and Forest (Humid) zones. The rest of the afternoon was spent working on this task.

The session was re-opened by Phillippe Sankara and divided into groups to continue the work on strategic objectives. Jeff Hill indicated that this effort is leading to a collaborative, regional natural resource management project. National program objectives are needed, so that common objectives can be identified for a regional effort. The different levels of national strategic plans, unequal representation in ecological zone groups, and time constraints were discussed. The session chair recognized the difficulty of the task, and asked the groups to do the best they can.

Group Reports

GROUP III Humid Forest Zone

Overall Goals

Improve quality of livelihood of the population by increasing the productivity of the agricultural and natural resource system in a sustainable manner.

Strategic Objectives

1. To improve the productivity of crops, livestock and trees.
2. To conserve and improve the natural resource base.

To achieve these strategic objectives, we need to:

- Maintain sustainable use of our forest resources, by prevention of overlogging, encouragement of reforestation, prevention of exploitation of wildlife and wild plant species of medicinal importance.
- Improve the water of our water resources by proper management of irrigation schemes.
- Optimize the fertility status of our soils. To do this we need to utilize improved technologies in soil fertility management e.g. the replacement of natural fallows by modified fallow (multipurpose trees) systems.

To maintain sustainable use of our forest resources, improve the use of water resources, and optimize soil fertility status, we need to:

- Identify and promote existing improved technologies.
- Identify gaps and generate new technologies.
- Improve the dissemination and adoption of existing improved technologies.

Prioritization of Constraints

1. Deforestation
   - agroforestry
   - slash and burn

2. Soil Fertility Problems
   - acidity
   - aluminum toxicity
   - degradation, erosion

3. Water Resources
   - irrigation

Summary of Identification and Prioritization of Constraints

1. Identification of strategic objectives

   Three NRM constraints were identified:
   - forest resources,
   - soil resources
   - water resources

2. Prioritization of specific objectives

   The constraints could be ranked as follows in descending order of importance
   - forest resources
   - soil resources
   - water resources

3. Evaluation of the potential contribution of available technologies to reach these strategic goals

   Some improved technologies are available and can be easily used. Among these are results on:

   - reforestation by agroforestry, slash and burn alternatives
   - improved soil management, and soil conservation practices using various cropping methods and species
   - proper methods of irrigation.

   Other available technologies will still need to be identified from an inventory in each country of work that has already been done and which can be either directly used or quickly improved for use by farmers.

Assumptions in Natural Resource Management

1. There must exist a conducive policy
2. Consideration must be given to market function
3. There must be a favorable land tenure system
4. The natural resource and agriculture systems is one.

GROUP II Sub-Humid Zone

Strategy Objectives Identification

1. To integrate crop and livestock production, tree planting for increased sustainable agricultural production and productivity for improved human welfare.

2. Develop an interdisciplinary approach and participatory methods between researcher, producers, and technology transfer agents in the planning, execution and evaluation of natural resource management programs.

3. Permit a better knowledge among researchers for sustainable management of soil, water, vegetation and crop residues to contribute to food security and fight decertification.

4. Evaluate development impacts and production practices on natural resources in view of sustainable management.

5. Identify, develop and transfer technologies on natural resource conservation and rejuvenation using participatory methods.

6. Promote technical and socio-economic options for decision making at national, regional, local and individual levels for resource use.

GROUP I Semi-Arid Zone

Agreed to the constraints read (from Burkina Faso) by the session chair except "inadequate agricultural politics and forest laws" was added.

Strategic Objectives

1. Improve the knowledge-base about natural resources, traditional production systems, and modern systems for the principal agro-ecological zones.

2. Identify, develop and propose new technologies adapted to sustainable natural resource management.

3. Reduce the effects of drought and desertification by promotion of a sustainable agriculture that guarantees food security.

4. Restore the potential productivity of degraded soil.

5. Evaluate the impact of natural resource management technologies and improve their adoption/stabilization by farmers.

6. Develop interdisciplinary approaches and participatory methods involving researchers, producers and extension agents in the planning, execution and evaluation of research on natural resource management.

7. Promote technical, socioeconomic policy and institutional options for decision making at national, regional and individual level for resource use.

Jeff Hill indicated the need for a strategic plan/process on how to implement a regional natural resource management project. Olin Smith raised concern about the lack of emphasis on health and safety issues, especially aflatoxin, and Steve Mason on the lack of attention to genetic (germplasm) resources as a natural resource. Chair Phillippe Sankara summarized the session, and asked the group chairs and reporters of the groups to work with him to reassemble strategic objectives across ecological zones to present to the participants later during the workshop.

Working Group Report on Policy and Socio-economic Constraints to NRM in West Africa

Chair: Laurent Millogo
Rapporteur: Valerie Kelly

Introductory Presentations and Discussion in Full Assembly

In opening the session, it was pointed out that the development and adoption of natural resource management practices is extremely complex given that most of these technologies cut across different commodity sectors and require input from a variety of disciplines at all stages of the development and adoption process.

The first presentation by Makan Fofana concerned an extensive list of institutional, socioeconomic, and political factors that need to be considered when developing agricultural technologies in general.

> Broadly speaking, institutional concerns focused on the capacity and management of agricultural research at the national, program, and extension levels. The specific factors mentioned were: institutional structures and management, human and financial resources, research planning, program design, follow-up and evaluation, and linkages with other institutions (extension services, development agencies, and NGOs in particular).
>
> Among the political factors mentioned were price and tax policies; exchange rate and trade policies (particularly those which influence producer prices of exports and costs of imported inputs); output marketing policies; public investments policies (communications, transportation, market infrastructure, for example); and land tenure laws.
>
> Among the socioeconomic factors listed were traditional systems of social organization, resource management and production; market, credit, and price systems that influence access to inputs; availability of processing technologies and storage capacity that improve demand for agricultural products and producer prices; health and education services that improve human capital.

No attempt was made in this brief presentation to prioritize these factors in terms of their relative importance for NRM technologies.

The second presentation by Souleymane Ouedraogo, addressed three categories of economic constraints to adoption of technologies: level of economic returns (profitability), availability of investment capital, and risk.

> Concerning profitability, it was noted that the income received when a farmer produces and sells a product must exceed both the costs of production and the alternative opportunities that the farmer has for producing income with his given set of resources. It is important that analyses of profitability start ex-ante (while a technology is being developed) rather than ex-post (when the technology is ready for extension).
>
> Access to investment capital is a major economic constraint in African agriculture. It is a particularly important constraint for poor farmers who have much to gain from adopting new technologies but often pay much more for inputs and credit than wealthier farmers.
>
> Concerning risk it was noted that poor farmers are often more risk-averse than others. The implication for technology development is that one must avoid sacrificing stability in yields for increases in average yields when developing technologies for more risk-averse farmers.

Touba Bedingar added a macro dimension to the discussion by noting that factors such as demographic pressure, structural adjustment initiatives, and policies concerning external trade (exchange rates and import duties, in particular) had an important impact on production constraints, the relative profitability of different products, and the relative costs of different technologies.

The need for more attention to social constraints was noted by all the speakers, who suggested that the InterCRSP include sociologists and anthropologists in future activities.

Following the presentations, discussion was opened to all participants. The interventions generally concerned suggestions for other issues that the socioeconomic and policy constraint group should take into account.

> Several participants commented on the fact that land tenure and gender issues posed a major constraint to natural resource management in general and the adoption of NRM technologies in particular.

It was also noted that natural resources belong to the entire nation and, therefore, everyone should pay to maintain them, not just farmers. Some system must be developed where by others who benefit indirectly from the preservation of natural resources also contribute toward the costs of this preservation.

The issue of demand for local cereals and their competition with imports was raised. If farmers are to produce and market local commodities, policies must be in place that encourage consumption of local products.

The importance of examining opportunity costs at the farm-level was stressed. Farmers are unlikely to adopt NRM practices if they can earn more money by investing their labor and capital elsewhere (migration, for example).

The need to harmonize the wide variety of extension efforts currently underway by different institutions (parastatals, NGOs, government services, etc.) was noted.

The need to take labor time into account when developing technologies was also mentioned; researchers must develop technologies that make better use of labor available during slack periods or develop mechanical means of speeding up activities during peak periods.

Two observations from experience in India were offered to the group:

To improve the agricultural credit system, Indian banks employed a large number of graduates from agricultural training schools to work directly with farmers negotiating loans and to reschedule loans after particularly poor harvests.

To improve extension of new technologies among risk-averse farmers, extension programs would concentrate first on getting the wealthier, least risk-averse farmers to adopt the technologies. This provided a demonstration effect; when more risk-averse farmers saw that the technologies were indeed better, they also began to adopt them.

In his synthesis of the presentations and various comments, the chair of the session suggested that the best way to address the wide variety of political and socioeconomic constraints already mentioned would be to have two working groups: one for political and institutional constraints and the other for socioeconomic constraints. Each group would be responsible for (1) identifying the key constraints to environmental

protection and adoption of NRM practices and (2) for proposing solutions that researchers could foster to reduce the negative impact of these key constraints on NRM activities. The reason given for having two large groups was to encourage participants to consider these constraints in a manner that cut across narrow commodity and sectoral interests.

To assist the two groups, the following list of the general categories of constraints to be covered by each group was presented:

Policy and Institutional Constraints
Legal issues (land tenure legislation, decentralization, international conventions)
Coordination of policies across sectors and ministries (agriculture, industry, environment, finance, etc.)
Lack of coherent development and land use plans at national, regional, and local levels
Migration issues (both national and international)
Poor structures for encouraging interinstitutional collaboration between government, private sector, farmers organizations, NGOs, etc.
Lack of accompanying measures in processing, marketing, taxation, training, rural finance, infrastructure, etc.

Socioeconomic Constraints
Profitability of technologies and risk
Philosophical approach to research and extension (participatory or not, for example)
Local knowledge
Social organization
Training
Cultural considerations
Distribution of responsibilities (government, private organizations, individuals)
Land tenure constraints
Scale of interventions (watershed, agroclimatic zone, household)
Physical and human resources available at all levels (household, extension services, research, government)
Top-down organization of extension services

Before breaking into groups, a concern was raised about the danger of not having a third group to deal exclusively with environmental constraints. It was decided to expand the coverage of the first working group to include political, institutional, and environmental constraints.

Reports of the Working Groups

A. Political, Institutional, and Environmental (PIE) Constraints Group

Chair: Jeff Hill
Rapporteur: Nango Dembele

In its deliberations the PIE group treated political, institutional, and environmental constraints as separate topics, identifying key constraints in each area.

Policy Constraints

The key policy constraints addressed can be divided into two categories: the need for clear policy statements and financial commitment, and the need for legislation.

1. Need for clear policy statements and financial commitment:

   - The lack of a national plan and government political commitment to improve management of natural resources is a constraint.

   - Perceptions of natural resources by populations and the government do not foster good management of resources for future generations.

   - Inadequate financing, flexibility, and coordination at the national level for research and extension services is a problem.

2. Need for legislation:

   - Land tenure laws need to provide long-term land security and equitable access for all groups in society (women, farmers, herders, etc.).

   - Clear rules and regulations concerning accountability and responsibility for natural resources are needed.

- There is a need to clarify private and public sector roles and to consider the pros and cons of interventions that are punitive versus promotional.

- There is a need to clarify the roles of traditional customs versus new legislation.

Institutional Constraints

The key institutional constraints discussed concern three different levels: local government and households, research institutions and extension services, and the central government.

1. At local government and household level:

   - Educational systems do not take NRM into account. There is a need to improve the NRM component of education at the primary and secondary level as well as in programs targeted at farmers (literacy training, health and nutrition training, and extension efforts).

   - There is a need to decentralize the administration and control of institutions that deal with NRM.

2. At the level of research and extension institutions:

   - There is a need to improve the planning for and development of human resources required to work on NRM issues (few national researchers are well-trained in NRM issues and there are few professional incentives to do NRM work).

   - Institutional structures need to foster better links between different institutions, particularly between extension and research and between NARS and foreign universities with expertise in NRM.

   - Poor understanding of farmers' realities by both research and extension services is hampering the development and adoption of NRM practices.

3. At the central government level:

   - There is a lack of government commitment to promoting the agricultural sector and NRM.
   - NRM activities are spread across several ministries and often not coordinated
   - There is a lack of public/private interface for planning and implementing NRM activities.
   - There is a need to monitor and control environmental pollution from industrial as well as from agricultural sector.
   - African countries must avoid importing inappropriate foreign legislation

Environmental constraints

In the discussion of environmental issues many of the constraints mentioned in the political and institutional section were raised again (education, coordination between research and extension, and a need for legislation concerning NRM practices). Three new issues were, however, introduced:

1. The problem of the limited resource endowment in most countries, particularly difficult climatic conditions.
2. The long history of resource misuse in many countries.
3. The lack of or poor access to conventional inputs (fertilizer, mechanical equipment, improved seed) that could improve productivity and capital resources for investment in NRM activities.

Time did not permit the PIE group to enter into particular recommendations on solutions to these problems.

B. Socio-economic (SE) Constraints Group

Chair: Souleymane Ouedraogo
Rapporteur: Bengaly Berthe

The group meeting on socioeconomic issues reviewed the constraints mentioned in the opening presentations by Fofana, Ouedraogo, and Bedingar. It was decided that developing an exhaustive list of socioeconomic constraints was not a desirable output for the group; nevertheless, it was agreed that a number of constraints should be given more attention than they had received in the introductory presentations: gender issues, land tenure legislation, organization of marketing channels for agricultural products, and tastes and preferences of national populations (both rural and urban).

It was also noted that one of the major issues in addressing the socioeconomic constraints in NRM activities was that of getting socioeconomic input into the process at the very beginning when technical scientists are developing their research programs on NRM technologies

The group then turned its attention to selecting the constraints -- among all those identified previously -- that were the most problematic for the development and adoption of NRM practices. In the brief time available, the group agreed that four categories of constraints were probably the most important: social and cultural factors that shape the way households allocate resources, availability and access to inputs (both conventional inputs and new ones required for NRM activities), land tenure legislation, and the organization of marketing channels for agricultural products.

Concerning social organization and cultural factors, it was agreed that a good understanding of the sociocultural environment is necessary before technical scientists begin to develop their technologies. Sociologists need to be involved in NRM design activities. Farming systems research is one approach to getting this type of interdisciplinary collaboration.

There was substantial discussion of the input constraint. Among the issues raised were:

- Availability of conventional inputs (fertilizer, seed, mechanical equipment such as carts) that are complementary to NRM inputs. Availability covers a broad range of input related topics such as local production versus importation, price, marketing and distribution systems, and credit.

- Availability of NRM inputs such as organic matter (manure or straw, for example) tools for constructing dikes or hauling rocks, trees and shrubs for building windbreaks, and household labor. Again, availability covers the broad range of factors mentioned above. The importance of assessing the availability and accessibility of locally produced NRM inputs such as manure and straw at an early stage in the technology design process was underscored. For NRM technologies that demand a lot of household labor, it is important to look at the opportunity costs of household labor, particularly in areas where there are many opportunities for local employment or migration.

The group felt that decentralization of input distribution systems was particularly important in the context of NRM activities.

Many in the group considered credit to be the component of input availability that poses the greatest constraint for the adoption of both conventional and NRM technologies. It was pointed out that most agricultural credit systems in Africa are tied to conventional inputs (seed and fertilizer) whose costs are recovered in a single agricultural season. Many NRM practices do not have immediate short-term payoffs; this suggests that credit programs for some NRM activities will have to be designed to provide long-term credit. Many NRM inputs (particularly organic matter) are also not purchased in conventional market situations; this offers those designing credit programs a further challenge. In brief, credit programs need to adapt to the special characteristics of NRM technologies.

Other issues raised regarding credit were (1) how to lower interest rates, and (2) how to make credit more available to poor farmers and women.

Several members of the group underlined the importance of having better organization of marketing channels for agricultural products (floor and ceiling prices, price information reporting systems, etc). It was pointed out that the lack of price stability in some markets, particularly those for local cereals and highly perishable horticultural products, discouraged their production. If farmers are to adopt NRM

technologies, they must have a certain measure of stability in their income so they can invest and repay their credit.

The group closed their discussion by coming back to the all important issue of land tenure legislation. All agreed that it was one of the most important constraints to the adoption of NRM technologies. The failure to discuss it in detail in the SE group was due to the belief that most important aspects of the constraint were legislative issues that the PIE group would deal with.

Presentation of Group Reports and Discussion in the Plenary Session

The reporter for each group presented a brief summary of their group's discussion to the plenary session. Given time constraints, the reports back to the full group were quite short and did not contain much of the detail presented above.

Many of the interventions from participants in the plenary session covered issues that were discussed in the working groups (and reported above) but not reported to the full assembly due to time constraints. We note below, only those interventions which do not duplicate information and ideas reported above.

A. Concerning the PlE group, it was noted that:

> The weakness in organizational structures of individuals using NRM technologies (primarily farmers) needed to be added to the list of constraints.
>
> Many land tenure laws exist, but they are poorly suited to the existing social structure; further adjustments to land tenure laws need to carefully consider existing social organization and traditional land tenure arrangements.
>
> CILSS countries are already working on a program to improve the NRM content of primary and secondary education.
>
> Policies are needed to encourage both new and renewable technologies; the example of using solar energy and biogas were given.

The "culture" of institutions developing and promoting NRM practices needs to change so that rules and regulations encourage creativity and initiative.

B. Concerning the Socio-economic group, it was noted that:

Improving access to credit at the village level was important; many NGOs are currently involved in programs that attempt to increase both savings and credit at the village level.

Traditional banks do not serve the agricultural community well. There is a need to make them more responsive and to consider whether subsidies should be used to encourage their participation in the agricultural sector.

Participants in the plenary session also raised three questions:

Q: Why was there no mention of bio-physical constraints by either group?

A: The groups felt that bio-physical constraints had been dealt with in previous working groups.

Q: Why are tastes and preferences a constraint?

A: Tastes and preferences are a constraint if technologies are developed that do not take into account existing tastes and preference. They can also be a constraint to the extent that they do not conform to basic nutritional needs, causing health problems for a given population.

Q: Why was there no discussion of cultural factors such as taboos and traditional beliefs that might impede the adoption of NRM practices?

A: The socioeconomic group agreed that cultural factors were important and needed to be considered at the very early stages of NRM research when issues of social organization were being examined.

La base institutionnelle:

À ce niveau, il convient d'examiner la capacité institutionnelle du Système National de la Recherche Agricole (SNRA) pour développer et transférer des technologies aux utilisateurs. Tous les aspects du SNRA sont examinés, y compris la structure de gestion, les ressources humaines et financières, le suivi des programmes de recherche, l'évaluation du processus de planification, les liaisons entre les agents de vulgarisation des technologies et les utilisateurs, avec les institutions nationales et internationales de recherche. L'existence d'un plan à long terme pour la recherche dans le plan du développement peut servir de référence.

Au niveau national, nous avons comme facteurs:

- la capacité institutionnelle du SNRA,
- le processus de formulation de la politique et du plan du SNRA,
- la capacité en ressources humaines et financieres du SNRA,
- l'efficacité du processus de suivi,
- l'efficacité des liaisons extérieures du SNRA.

Au niveau programme les facteurs sont les suivants:

- le processus de planification et de gestion,
- les liaisons institutionnelles du programme,
- le suivi et l'évaluation du programme,
- La capacité institutionnelle de l'organisme de développement.
- Nombre de personnes formées par catégorie (formation de courte durée et formation de longue durée).
- La formation par rapport aux besoins du programme.
- Le financement prévu pour la formation.

Interactions entre la recherche et la vulgarisation

- La fréquence d'interaction.
- L'existence d'un agent de liaison.
- Participation dans le suivi de base.
- Réunions de planification au niveau du programme
- Publications
- Ateliers réguliers
- Un système de suivi
- Nombre de programmes modifiés par suite du "feed-back" de la vulgarisation

- Réunions régulières entre les chercheurs, les agents du développement et les decideurs

Les facteurs socio-économiques et politiques

Les facteurs socio-économiques: Il s'agit de facteurs aussi bien endogènes qu'exogènes au milieu, mais tous affectent à des degrés différents le devéloppement et le transfert de technologie. Ces deux activités sont en réalité la résultante des efforts des décideurs, chercheurs, développeurs, producteurs, transformateurs, transporteurs, commerçants, etc.

- Le marché des intrants agricoles (engrais, semences, matériels agricoles, carburant, les produits chimiques de traitement, etc.)
- Le choix des intrants (quantité, toxicité, difficulté d'application etc)
- Périodicité des achats d'intrants
- Accès aux intrants (conditions des routes, la présence d'un centre de distribution)
- Disponibilité du crédit
- Prix des intrants
- Les infrastructures (routes, marchés, centres de santé, écoles, stockage, transformation, etc.)
- Transport du champ au marché (distance du champ au marché, coûts du transport relatif aux coûts totaux)
- Prix au champ contre prix au marché des produits
- La disponibilité des informations sur le marché
- Les pertes et détérioration de qualité
- Capacité de stockage
- Les habitudes de gestion traditionnelles
- Les habitudes alimentaires des populations
- Les structures et organisations sociales
- Les systèmes traditionnels de production

Les facteurs politiques: Ils sont généralement macro-économiques et très déterminants dans le processus de développement et de transfert de technologies Sans être exhaustif, on peut (citer les) suivants:

- Politiques de prix et de taxation,
- Subventions,
- Taux d'échange,
- Politiques sur les intrants (produit localement, importé, implication du secteur privé, etc),
- Politiques de commercialisation des produits,
- Politique de taxation,

- Investissement public,
- Le régime foncier,

Quelques Determinants Socio-Économiques: de l'adoption des technologies

I Rentabilité

La rentabilité d'une technologie déterminera son acceptation ou son rejet par les paysans, qu'il s'agisse de technologies de conservation des eaux et des sols, de production végétale ou animale.

La rentabilité d'une technologie a deux dimensions:

- D'abord la valeur du produit final (pour une seule ou pour plusieurs années) doit excéder le coût de production.

- Deuxièmement, la rentabilité d'une nouvelle technologie doit être comparée aux autres alternatives dont disposent les paysans, puisqu'il s'agit de compétir avec elles pour les mêmes ressources.

La plupart des évaluations de la rentabilité des nouvelles technologies étaient des études ex-post. Les économistes sont habituellement invités à les évaluer après qu'elles furent développées. Ces études expost peuvent permettre de déterminer leur impact potentiel et les conditions nécessaires pour atteindre cet impact.

II Le Capital

a) La Disponibilité

L'une des contraintes sérieuses à l'adoption des nouvelles technologies pour la plupart des paysans est le niveau du capital. L'augmentation du niveau du capital sera donc une condition pour la plupart des paysans à faibles ressources pour investir dans de nouvelles technologies. Le crédit peut contribuer à augmenter la disponibilité du capital et réduire son coût d'opportunité. Néanmoins, il doit être orienté sur un produit particulier comme s'était le cas dans beaucoup de programmes de crédit passés. Avec plus de capital, les paysans à faibles ressources réaliseront rapidement des gains importants, reduiront le coût d'opportunité du capital et accroîtront la rentabilité des investissements de long terme.

Si cette contrainte n'est pas résolue seules les technologies n'exigeant pas ou exigeant très peu d'investissement seront plus largement adoptées.

b) Le Coût d'Opportunite du Capital

Une étude de cas au Niger et Burkina Faso par Lowenberg-Deboer et al., (1994) montre que les paysans font face à des coûts de capital supérieurs à ceux utilisés pour évaluer les technologies (0-300%). Cette étude à fait ressortir des coûts d'opportunité annuels de capital autour de 50% pour les individus relativement aisés et des taux annuels de profit au-dessus de 1,000% pour les individus pauvres. Avec ces niveaux du coût du capital, les riches paysans dépasseront un gain annuel de 50% en investissant dans les engrais chimiques ou dans les techniques de conservation des sols. Pour les paysans pauvres, le coût effectif des fertilisants chimiques sera dix fois le prix actuel.

c) Le Risque

Pour les paysans à faibles ressources, le risque peut être une contrainte importante à l' adoption.

Le risque dans ce sens dessous. La variabilité de sens dessus est considéré comme positive par la plupart des paysans. Les paysans à faibles ressources sont les plus vulnérables à cette variabilité parce qu'ils ont peu de ressources pour être hors de portée des mauvaises années de culture. Les sources de ce risque comprennent les technologies qui accroissent la production moyenne des cultures en sacrifiant la stabilité du rendement et l'incertitude de performance d'une nouvelle technologie sur leur champ.

The West and Central African Millet Research Network (WCAMRN/ROCAFREMI): An Overview

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Introduction

The Regional Pearl Millet Improvement Workshop of 1988, organized by ICRISAT in collaboration with the Institute for Agricultural Research, Ahmadu Bello University, Zaria Nigeria, recommended the establishment of a West and Central African Millet Research Network (WCAMRN) to strengthen NARS research capability in the region. The West and Central African Millet Research Network was established in 1990 during the workshop held at the ICRISAT Sahelian Center, Sadore, 16-21 September 1990. The network includes 14 countries, ICRISAT, INSAH and SAFGRAD.

The Network is currently funded by the Swiss Development Cooperation. Funds are transferred through ICRISAT for which a Memorandum of Understanding was signed between ICRISAT and the Swiss Development Cooperation (SDC). The Coordination office is based at ICRISAT Sahelian Center (ISC), Niamey, Niger. In addition to its logistic support, ICRISAT plays an important role in the accomplishment of the network activities.

Members of the Millet Network

The members of the millet network are: *Benin, Burkina Faso, Cameroon, Chad, Cote d 'lvoire, Gambia, Ghana, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, Togo, ICRISAT, INSAH and SAFGRAD.* In addition, other organization such as INTSORMIL and ORSTOM have been actively associated with the network.

Objectives and Organization

Objectives

The main objectives of the network are to:

- develop and reinforce the cooperation between National Agricultural Research Systems (NARS) and between NARS and regional and international research organizations;
- define a set of common objectives and strategies for interdisciplinary research.
- facilitate the dissemination of scientific information, meetings and workshops
- contribute to a better use and optimization of human and financial resources in the region and to permit a wider diffusion to the farm level of ready-to-use technologies.

Organization

The different bodies of the network include: the Workshop, the Steering Committee and the Coordination Office.

The Workshop comprised of all country members, holds a meeting every two years, elaborates the framework of the network activities and controls their execution.

The Steering Committee meets once a year and supervises the execution of the decisions and recommendations of the workshop.

The Coordination office ensures the dissemination of information, the planning of meetings and workshops and follows up the execution of the network activities.

Current Research Projects and Activities

During the establishment of the network, representatives of the member countries reviewed the constraints to millet production in their respective countries and identified a number of projects. Currently, four projects are funded (Table 1) for implementation. With the development and implementation of project activities, it is expected that projects will be reviewed with provisions for funding new projects. ICRISAT provides technical and administrative back up to these approved network projects, which emphasize transfer of improved technologies to the farmers by NARS. The research activities of the network are planned and carried out within projects.

For each project, a lead scientist and a lead country are elected by the workshop. Each country member has to participate in at least one project. The current four research projects are conducted in the Sahelian, Sudanian and Northern guinean zones.

Project 1: Selection of early and/or drought tolerant varieties

The main activities of this project are on-farm trials where, in each participating country, a local variety and the most promising varieties from the national program are compared. The trials are conducted with the collaboration of rural development agencies, extension services and NGOs. A regional trial conducted on the basis of agro-ecological zones is presently carried out in Burkina Faso, Cameroon, Cote d'Ivoire, Mali, Mauritania, Niger, Nigeria and Senegal. Varieties from the breeding program of these countries and from ICRISAT Sahelian Center are tested in the Sahelian, Sudanian and North guinean zones.

Project 2: Bio-ecology of millet head insects and development of integrated control methods

Countries participating in this project are Benin, Gambia, Ghana, Guinea Bissau, Nigeria and Togo. Research focuses on establishing the distribution and importance of the main millet head pests and developing and testing integrated methods for controlling these pests.

Project 3: Control of pearl millet downy mildew

This project is conducted in Burkina Faso, Ghana, Mali, Niger, Nigeria and Senegal. Inventory and evaluation of control methods used by farmers and a regional trial on screening varieties for resistance to downy mildew are the main focus of this project.

Table 1. Summary of projects of the West and Central African Millet Research Network (WCAMRN/ROCAFREMI)

Project	Participating countries	Expected result
Project P1 Selection of early and/or drought tolerant varieties for farmers	Burkina Faso, Cameroon, Cote d'Ivoire, Mauritania, Niger(*), Nigeria	* Adapted and improved drought-resistant varieties * Availability of seed of improved varieties * Increased millet production * Skills in improved millet production techniques by farmers
Project P2 Bio-ecology of pearl millet head insects and development of integrated control techniques	Benin, Gambia, Ghana, Guinea-Bissau, Mali(*), Nigeria, Togo	* Understanding bio-ecology * Development of productive and resistant varieties * Improvement of existing control methods * Development of new and adapted control techniques * Information exchange between NARS, regional and international programs * Improvement in the level of training * Information exchange between farmers, extension workers, and scientists
Project P3 Control of pearl millet downy mildew	Burkina Faso, Ghana, Mali, Niger, Nigeria, Senegal(*)	* Obtain sources of downy mildew resistance * Extension of cultural and chemical control methods accessible to farmers * Heritability of resistance * Increased participation of scientists in regional trials
Project P4 Improvement of millet-based production systems	Burkina Faso(*), Cote d'Ivoire, Chad, Mali, Niger, Senegal	* Maintenance and improvement of soil fertility * Improved management of resources *Improved technical competence of extension agents and farmers

(*) = Lead Country for the Project

Project 4: Improving millet-based production systems

Six countries including Burkina Faso, Chad, Cote d'Ivoire, Mali, Niger and Senegal participate in this project, initiated in 1993. Surveys using questionnaires are conducted to collect data on the socio-economic environment in which millet is produced. On-farm and on-station trials on intercropping, use of organic matter and cultural techniques for increasing millet yield are conducted in this project.

For each project, activities linked to project implementation include monitoring tours, and annual project meetings to discuss results and activity planning including projected budgets. The millet network also publishes a quarterly Newsletter.

Perspectives

Activities already planned and carried out in the network projects will continue and significant efforts will be made to enhance relationships between the network and extension services, rural organizations, NGOs and agricultural projects, and all partners. Though well focused, training activities are conducted within each project, the millet network plans to develop a specific training project. Potential donors will be approached to obtain funding for this training project.

A recent meeting in Senegal provided a review of network accomplishments based on the past five years and made recommendations for modifications and/or development of new projects. Such recommended new projects include activities on high-yield potential varieties and seed production, *Striga,* IPM, and post-harvest technologies.

Members of the Steering Committee as of September 1995

Dr M. Beninga, Chairman, Director, IDESSA/Ferkessedougou, Cote d'Ivoire

Mr Richard Kenga, IRA/Maroua, Cameroon

Mr Mahaman Nouri, INRAN/Kollo, Niger

Mr Sidi R'Chid, CNRADA/Kaedi, Mauritanie

Dr S. M. Misari, Director, NCRI-Badeggi, Bida, Niger Sate, Nigeria

Dr Ibrahim Atokple, SARI, Tamale, Ghana

Dr Jean A. Nyemba, ROCAFREMI, Coordinator, ICRISAT Sahelian Center, Niamey, Niger

SANREM CRSP Experience in Participatory Research and the Role of Non-Governmental Organizations in Burkina Faso, 1992-1995

Mudiayi Ngandu, Tuskegee University, Tuskegee, AL, USA

The SANREM CRSP has been working in Burkina Faso for about three years. It is early to evaluate its full impact, especially the extent to which specific appropriate technologies for the sustainable management of natural resources have been developed. However, significant markers already exist and they lay the conceptual framework and, thus, provide the fertile ground for long-term institutional building and successful implementation of the SANREM program. It is precisely in this context that suitable sustainable technologies stand the best chance of emerging. What has been achieved to date?

A High Degree of Inter-Institutional Cooperation and Interdisciplinary Collaboration Between National Partner Agricultural Research Agencies.

The difficult task of working collaboratively across sectors and disciplines is a real challenge at each one of our own U.S. Land-Grant institutions represented in the Inter-CRSP family at this Regional Workshop. This challenge is no less daunting in Burkina Faso. Fortunately, the national agricultural research agencies in Burkina Faso were already, but slowly, moving in this direction. By 1994, they resolved to adopt inter-sectoral cooperation and interdisciplinary collaboration as critical elements in their long-range research strategy. To quote the 1995 master plan document entitled The CNRST Strategic Plan For Agricultural Research "---there is a lack of integration and coordination in the approach of the national agricultural research institutions. An important objective of the Strategic Plan is to systematically plan, integrate, and coordinate all agricultural research activities undertaken in Burkina Faso by various research institutions,

line ministries, technical project departments, and non-governmental organizations " (CNRST Strategic Plan For Agricultural Research, April 1995, pp. 1-3, Executive Summary). The Strategic Plan document emphasizes two other elements of the national research strategy: regionalization and participation. Participation is needed to ensure the contribution of each partner institution to providing suitable solutions to identified constraints from a variety of disciplines and experiences. Regionalization is useful in that it reflects the realities of Burkina Faso agroecological zones. It also captures the relevant context faced by the direct consumers of research results, the final users in the Strategic Plan language. Conceptually, the research strategy in the Strategic Plan document closely parallels the SANREM cornerstones. At minimum, SANREM CRSP has been a catalyst and, at best, an outside partner in the debate on participatory, interinstitutional, and interdisciplinary research.

Emphasis on Ecological Approach Integrating the Landscape and Lifescape Through Training.

An important accomplishment of the SANREM CRSP is the continuous and joint training of SANREM partners in participatory research methodology. The training is in the form of hands-on workshops that are systematically built into the SANREM research process at critical junctures e.g., the pre-Participatory Landscape / the Lifescape Appraisal (PLLA), post-PLLA Workshop to agree on priority research areas based on the PLLA, the Research Work Plan Coordination and Integration Workshop. The training consists of short-term workshops held mostly in Burkina Faso for farmers, NGOs development staff, and Burkinabé and U.S. research scientists. An example of a cornerstone which has taken roots among SANREM partners is the landscape/lifescape ecological approach. This cornerstone builds on the well-known rapid rural appraisal technique. Its strength lies in the focus on the interaction between the physical and natural systems/(landscape) on one hand and human activities/(lifescape) on the other hand. As one Donsin farmer ably observed at a SANREM workshop in Ouagadougou "the challenge is to understand how nature impacts man and how in turn man impacts nature". SANREM CRSP in Burkina Faso has planted a seed and that seed is a conceptual model on how end users and researchers can together analyze ecological interrelationships to alleviate constraints to sustainable agriculture and natural resource management.

Emphasis on Participation, Social, and Economic Stratification.

As indicated above, the SANREM concept of full partnership with farmers implies their participation and involvement at every step in the SANREM research process, for example, from the identification of constraints to sustainability to the formulation and implementation of strategies to alleviate the above constraints. It is in this sense that the participatory research method starts with the farmer and ends with the farmer or " Farmer First and Farmer Last". At the Burkina Faso research site, Donsin farmers in fact prioritized the major research areas for the Framework Plan and the Invitation to Work. At the May 1994 workshop in Ouagadougou, when a participant from an NGO suggested a regrouping of the forty plus research themes from the PLLA and the draft Framework Plan into a small and manageable number of research areas, one of the two women in the Donsin farmers' delegation vehemently objected. The lesson from this episode is that the participatory research method and the SANREM process have provided mechanisms for farmers to influence, shape, and negotiate over the research agenda. Similarly, in March 1995, the Donsin community actively participated in the evaluation of individual research work plans submitted for financing by inter-institutional and interdisciplinary research teams through the Community Advisory Council local facilitator.

Gender analysis is broadly understood as the role of primary resource owners and/or managers of key natural resources (women, elders, youth, other socio-economic strata) and how they may benefit from sustainable resource management. SANREM partners at the Burkina Faso research site prefer the term social and economic stratification on grounds that it is more inclusive of all social classes. There is agreement on both sides of the Atlantic Ocean about the important role of gender analysis/ stratification in sustainable resource management. Furthering analysis and command of research tools on this SANREM cornerstone is a worthwhile objective for which we are laying the groundwork for the implementation of research work plans. Again, joint short-term training in participatory research methodologies with a focus on stratification has proven helpful.

The Role of the Non-Governmental Organizations

One of the criteria for the research site selection was the presence of an NGO in the watershed community. Plan Parenthood International (PPI and most recently simply referred to as Plan International) had been working in the Donsin village for over ten years, prior to entering a partnership with SANREM CRSP. There is a genuine field collaboration between the Village Committee, PPI, INERA, and SANREM CRSP facilitator at Donsin. Plan International is a member of the Board of Directors of SANREM CRSP. An increasing number of NGO development staff took part during the past three years in all SANREM CRSP workshops on participatory research methodologies. As a result of this collaboration, several NGOs staff are team members of research work plans approved in March 1995. This is an opportunity for partner NGOs to bring to bear their longtime, rich, and field-tested experience in participatory development and research.

In conclusion, the SANREM CRSP has built an effective network of institutional ties with Donsin farmers, their village committee, the village leadership hierarchy, the provincial authorities, the Plan International at Donsin, Boulsa, and Ouagadougou, and the national agricultural research agencies. Together, farmers, Burkinabé and US research scientists, and NGOs staff have identified constraints to sustainable natural resource management and formulated priority research areas. In this process, several participatory research tools have been used and extensive hands-on training of Burkinabé and U.S. scientists has taken place. A cadre of trainers has emerged. The considerable investment in networking and in training is paying off as evidenced by the high quality and the number of research work plans submitted for financing to the SANREM CRSP. The SANREM CRSP has earned a measure of trust among Donsin farmers, the NGO community, and researchers in Burkinabé national agricultural research institutions.

Rapporteur's Synthesis of Session X: Structural Model for InterCRSP NRM Project

Chair: David Cummins
Rapporteur: Makan Fofana

Objectives of Session

- Discuss Niger watershed model for Research-Technology Transfer in the West Africa region.
- Consider other alternative models exam.

Issues for Discussion

1. Agreement on an acceptable and valid model for a multicountry (regional) and multisite, landscape approach to improve NRM and Technology Transfer to the end user.

2. Discuss how to make the watershed model sustainable.
   a. Traveling workshops
   b. Establish e-mail communication among participants
   c. Share information, summarize ona regional, landscape, multilocal basis
   d. Well connected to farmers, NGOs, extension, etc. for technology transfer
   e. Impact

3. Extent of Program
   - Financial support important
   - A visionary, well-planned, impact-oriented program to improve West Africa NRM will receive highest possible attention from CRSPs and USAID.

Prior to the initiation of the discussion groups, Dr. Ouendeba reminded the participants of the need for the groups to be aware of the objectives and expected results of the workshop. From then, Dr. Brhane presented a complete summary on those two points as follows:

Main Objectives of the Workshop

- Assess and catalogue available technologies developed by the CRSPs in and/or for West Africa.
- Identify needed technologies as well as related issues bearing on technology relevant to West Africa.
- Assess the applicability of the watershed management model for TDT and interCRSPing.
- Assess the needs and priorities for training and institutional development for NRM in West Africa.
- Evaluate the policy and socio-economic frameworks and constraints influencing NRM TDT in the region.
- Examine alternative organizational and structural models for implementing NRM focused InterCRSP in West Africa.
- Lay the groundwork for coordination among the participating CRSPs, NARSs, NGOs, and IARCs.
- Utilize the workshop as a forum for future planning of the NRM InterCRSP West Africa activities.

The outcome of the workshop is to conclude with a plan for the future, or the initiation of the process for future planning, of NRM InterCRSPing in West Africa.

The results of the working groups can be summarized as follows:

The fundamental question was the applicability or adaptability of the watershed model NRM on a regional scale. There were two schools of thought on the subject.

1. A school of thought favorable to the watershed concept presented the following supportive arguments:

   a. Components of watershed model are scientifically identifiable
   b. Model is good for characterization
   c. Model allows effective linkage of NRM and agriculture
   d. Model could be used as a tool to develop common principles and relationships that can be transferred to similar ecological zones

2. The following issues were raised against the model

   a. The "watershed" is too restrictive
   b. It does not implicate multi-social structures
   c. While the model is good for carrying out basic research, it is not the most ideal tool for technology transfer

3. Alternative models (concepts) were proposed and include:

   a. Land management (Gestion de Tenoir)
   b. Site specific models, data layers from initial characterization of site should be superimposed using GIS to identify land management units.
   c. The "Landscape and Lifescape" approach (Ecologie du Paysage et Humaine)

   After lengthy discussion, the watershed model was adopted, but the concession was that any model chosen should explore the tenuous interrelationships that exist among physical, ecological, and socio-economic factors. It was agreed that the attributes of any good model should:

   1. Allow for integration of Natural Resource conservation and agriculture
   2. Provide framework for multi-faceted research development and demonstration activities, i.e. integrated nutrient management
   3. Provide guidance for land-use planning
   4. Be applicable to support services in different communities
   5. Provide system for sharing and collective sharing of data
   6. Have training and capacity building component

4. Organizational structure, the following issues were raised:

   a. Roles of IARCs, NGOs, and private enterprises were not sufficiently defined. It was pointed out that collaboration between CRSPs, IARCs, NARSs, and some NGOs already exist and this should be strengthened.
   b. Since INSAH is too specific to the Sahel, an alternative organization with regional mandate would be appropriate.

      Following this assertion, explanations were give by Dr. Gaoussou Traoré that INSAH indeed covers coastal countries which are affected by regional NRM situations. Participants questioned about the capability of INSAH to play that role. Both INSAH and CILSS representatives emphasized that INSAH has the capability and its activities are not restricted only to member countries. CILSS also supports activities of non-member countries as well.

   c. At one point it was suggested that the InterCRSP should be changed to NRM, but the consensus was that "InterCRSP" be maintained because it serves as a common link for several organizations.

d. Improving communication by use of the following was agreed upon:
   - E-mail through AFRICALINK
   - Meetings
   - Publications

Constraints and Needs for Institutional Development: Technology Generation and Transfer to Improve Natural Resource Management in West Africa

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The presence of strong, well supported institutions designed to serve the needs of the rural sector is one of the conditions for "take offs" in the development process. Essential institutions include those devoted to research, extension, and educational efforts that are focused on rural needs. However, the institutions themselves, though necessary, are not sufficient for the development process. Institutions function only as well as the people who staff them. These individuals must be both competent professionals and also deeply committed to the institutional mission. Thus, the problem of institutional development is really a problem of human capacity development. Human capacity development braining) and institutional development cannot be separated.

In the rural sector, human capacity development to serve the needs of the essential rural institutions must center on acquiring the skills of the scientific method. At a minimum, institutional staff should know how to recognize essential research needs and must be able to design research protocols that will provide meaningful answers to significant questions. They must be able to interpret research results and must be committed to taking these results to the end-user community. Additionally, the development of human capacity must include a recognition of the importance of acquiring a multidisciplinary perspective. Complex problems require this perspective. Well trained people must then be strategically positioned in appropriate institutions, and provided with the necessary and sustained support to do their jobs effectively.

It is informative to consider the factors that contributed to the successes realized during the early years of the Green Revolution in South and East Asia. In those countries where early and rapid successes were realized in the 1960's and 1970's, several pre-conditions to success were present right from the start. These preconditions included: national research institutions that functioned fairly well; an effective extension system linked to the research programs with duties clearly assigned to the extension agents to communicate knowledge and skills to rural people; a functional national university with skilled faculty. These preconditions for "take off" are present to varying degrees in many parts of West Africa today, just as they were in the early years of the Green Revolution in Asia.

One must, then, ask the question: If the conditions for "take off" in West Africa are present, what are the constraints that are impeding the process? Why is institutional development seemingly so slow a process in this part of the world? There are several parts to the answer to this question: resources that are the life blood of institutions are minimal and sometimes erratically provided; there are chronic problems with staff turnover; the national policy environment does not consistently place rural development needs in a position of high priority; institutions tend to be reactive rather than proactive in seeing much of their research/extension agenda.

Given the constraints outlined above, what are the needs to increase the pace of institutional development? Again, there are several parts to the answer to this question. Clearly, one major need is a reordering of national priorities in those nations where development of institutions that serve the rural sector is not near the top of the government list. Linked to this is the need to increase the pool of trained people to staff the high priority institutions. Staff tenure within institutions must be based on individuals' contributions to the mission of the institutions to solve the problems of the rural poor. In addition, the research mission must be intentionally linked to extension so that technology generation is linked to technology transfer. None of this is possible without a consistent and sustained commitment of national resources. Finally, the process of development will be accelerated by institutional leadership guided by the philosophy that they are partners with the rural poor.

Purdue University has a lengthy history of involvement in the process of institutional development. Two examples of this involvement are the recently completed USAID-funded Agricultural Research and Training Support (ARTS) Project in Burkina Faso (1990-1994) in which we were joined by Winrock International, and a major institutional development project in Brazil that dates to the early 1950's. There are

lessons from each project that may be helpful to the InterCRSP activity of interest to this meeting. In each case, project accomplishments are linked to specific factors that may be replicated to some extent in West Africa.

The success of the ARTS project can be traced to its strong emphasis on collaborative research and its significant focus on a multidisciplinary systems approach to problem solving. There was also a major training component to the ARTS Project. Project personnel were heavily oriented towards village level participation in research design, conduct, and evaluation. Village people were true partners with the Burkinabé and American scientists. The ARTS project also attempted to link technology generation to technology transfer, and benefited from a national commitment to institution building, human capacity development, and sustainability relative to the agriculturally related issues that contribute to environmental degradation.

The Purdue-Vicosa Project, also supported by USAID and its predecessor agency, was devoted to the development of a major new agricultural university in Brazil. Over a 20+ year period, Purdue faculty, working hand-in-hand with Brazilian counterparts, participated in the development of what is now one of the finest institutions of higher learning devoted to the agricultural and related disciplines in all of Latin America. Factors that contributed to the success of this project included the existence of an initial critical mass of indigenous capacity and a level of physical infrastructure sufficient to serve as a foundation for the further development of the university. The project evolved with a strong collaborative partnership that featured a shared vision and mutual goals. The commitment of resources from both parties to the project underscored the shared nature of the institutional development process. Finally, the project has continued to benefit from commitment and momentum that maintained the institutional relationship long after Purdue departed from Brazil. To this day, there are still faculty going both directions, collaborating as partners in a variety of activities of shared interest.

To summarize, the success of institutional development projects is dependent on a focused mission to serve the needs of the rural poor, a sustained flow of resources to provide for the fundamental needs of the institutions, a cadre of trained people with job security to staff the institution, a linkage between technology generation and technology transfer, and a national policy environment that gives prominence to the rural sector of society.

Contraintes et Besoins du Développement Institutionnel: Mise au Point et Transfert de Technologies pour l'Amélioration de la Gestion des Ressources Naturelles en Afrique de l'Ouest

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L'existence d'institutions solides et convenablement subventionnées destinées à satisfaire les besoins du secteur rural est une des conditions du "decollage" d'un pays dans le processus du développement. Les institutions de recherche, de vulgalisation et d'enseignement specialisées dans les besoins des populations rurales sont essentielles à ce processus. Cependant les institutions elles-mêmes bien que necessaires ne suffisent pas. Le fonctionnement des institutions est à la mesule des personnes qui les composent. Ces personnes doivent être à la fois compétentes et profondément impliquées dans la mission de l' institution. C'est pourquoi le problème du développement institutionnel est en fait une question de développement des ressources humaines. Le développement des ressources humaines (formation) et le développement institutionnel sont inséparables.

Dans le secteur rural le développement des ressources humaines destiné à satisfaire les besoins des institutions rurales essentielles doit consister à l'acquisition des aptitudes à la démarche scientitique. Le personnel d'une institution doit au moins pouvoir identifier les besoins de recherche essentiels et doit être capable de concevoir les protocoles de recherche qui permettront de répondre à ces questions importantes. Il doit être capable d'interpréter les résultats de la recherche et doit s'engager à communiquer ces résultats aux communautés d'utilisateurs. De plus le développement des ressources humaines doit prendre en compte l'importance de l'acquisition d'une perspective multidisciplinaire. Les problèmes complexes exigent une telle vision. Les personnes correctement formées doivent ensuite être placées de manière stratégique dans les institutions appropriées et équipées du financement nécessaire et durable pour conduire leurs travaux efficacement.

Il est intéressant de considérer les facteurs qui ont contribué aux succès réalisés pendant les premières années de la Révolution Verte en Asie du Sud et de l'Est. Dans ces pays qui ont connu des progrès rapides dans les années 1960 et 1970, plusieurs préconditions étaient présentes

depuis le tout début. Parmi ces conditions, on peut citer les éléments suivants:

- Les institutions de recherches nationales fonctionnaient convenablement.
- Le système de vulgarisation était lié aux programmes de recherche et comportait une claire attribution des tâches aux agents de vulgarisation, à savoir la communication des connaissances et du savoir-faire aux populations rurales.
- Un système d'université national fonctionnait bien avec du personnel apte.

Ces pré-conditions pour le "décollage" du développement sont présentes en Afrique de l'Ouest selon différents degrés en fonction des endroits, tout comme elles étaient présentes au début de la Révolution Verte en Asie.

On peut donc se poser la question: Si les conditions pour le développement en Afrique de l'Ouest sont présentes, quelles sont les contraintes qui ralentissent le processus? Pourquoi le développement institutionnel semble-t-il si lent dans cette partie du monde? Il existe plusieurs réponses à cette question. Les ressources, qui permettent à ces institutions d'exister, sont minimes et leur flux parfois erratique. Il y a des problèmes chroniques dans le roulement du personnel. Les besoins de développement rural ne constituent pas toujours une priorité constante du milieu politique national. Les institutions ont tendance à être réactives plutôt que proactives dans l'élaboration de leur agenda de recherche et de vulgarisation.

Etant données les contraintes citées précédemment, comment peut-on accélérer l'allure du développement des institutions? De nouveau, la réponse à cette question comporte plusieurs volets. Tout d'abord, il est clair que les priorités nationales doivent être réordonnées, de manière à placer le développement des institutions qui desservent le secteur rural en tête de liste dans ces pays. Parallèlement, les institutions prioritaires doivent accueillir un nombre croissant de personnes d'un niveau de formation élevé. La promotion professionnelle du personnel au sein des institutions doit être basée sur les contributions des personnes à la mission des institutions à résoudre les problèmes de pauvreté en milieu rural. Par ailleurs, la mission de recherche doit être intentionnellement liée à la vulgarisation, de façon à ce que la mise au point des technologies soit liée à leur transfert. Tout ceci n'est possible qu'avec un engagement des ressources nationales régulier et durable. Enfin, le processus de développement peut être accéléré par des qualités de direction institutionnelle guidées par une philosophie de partenariat avec la communauté rurale défavorisée.

L'université Purdue possède une longue histoire de participation au processus de développement institutionnel. Le Projet d'Appui à la Recherche et à la Formation Agricoles (ARTS) au Burkina Faso (1990-94), financé par l'USAID et géré avec Winrock International, et un important projet de développement institutionnel au Brésil qui date des années 1950, constituent deux exemples de cette participation. Chaque projet a apporté des leçons qui peuvent être utiles aux activités de l'INTERCRSP et à cette rencontre. Dans chaque cas, les réalisations des projets sont liés à des éléments specifiques qui peuvent dans une certaine mesure être répliqués en Afrique de l'Ouest.

Le succès du projet ARTS tient à l'accent porté sur la recherche en collaboration et sur une démarche systémique et multidisciplinaire de la résolution des problèmes. Le projet ARTS comportait également une forte composante de formation. Le personnel du projet a cherché à promouvoir la participation villageoise dans la conception, l'exécution et l'évaluation de la recherche. Les villageois étaient de véritables partenaires des chercheurs burkinabes et américains. Le projet ARTS a également renforcé le lien entre la mise au point et le transfert des technologies, et a bénéficié d'une volonté nationale à appuyer le renforcement institutionnel, le développement des ressources humaines et la durabilité des systèmes de production agricoles par rapport à la dégradation des ressources naturelles.

Le projet Purdue-Viçosa, également financé par l'USAID et par l'agence qui l'a précédé, était consacré au développement d'une grosse université d'agriculture du Brésil. Pendant une période de plus de 20 ans, le corps professoral de Purdue, travaillant étroitement avec leurs homologues brésiliens, ont participé au développement de ce qui est de nos jours une des institutions d'enseignement superieur spécialisées dans les disciplines agricoles et para-agricoles les plus performantes de toute l'Amérique Latine. L'existence d'une masse critique initiale de ressources locales et un niveau d'infrastructures matérielles suffisant pouvant servir de fondation au développement de l'université ont contribué au succès de ce projèt. Le projèt a porté ses fruits grâce au travail effectué en partenariat à travers une vision et des buts communs. L'allocation de ressources du projèt par les deux partis souligne la nature mutuelle du processus de développement institutionnel. Enfin, le projèt a bénéficié de l'engagement el du dynamisme des participants qui ont conservé un lien institutionnel longtemps après le départ de Purdue du Brésil. Aujourd'hui encore, des professeurs de ces deux universités vont et viennent, et collaborent comme des partenaires dans le cadre de multiples activités d'intérêt commun.

En résumé, les projèts de développement institutionnel atteignent leurs objectifs lorsqu'ils possèdent la mission de servir les interêts des

populations rurales défavorisées, et lorsqu'il existe un flux de ressources permettant de satisfaire les besoins fondamentaux des institutions, un ensemble de personnes bien formés possédant une sécurité d'emploi pour faire fonctionner cette institution, un lien entre la mise au point des technologies et leur transfert, et un milieu politique national qui cherche à promouvoir le secteur rural de la société.

Problems and Opportunities for Seed Production and Distribution in Developing Countries: A Breeder's Experience

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I had the opportunity of joining The Rockefeller Foundation's Indian Agricultural Program in 1959. I was involved with predictions of double cross maize hybrids from which four were released (1969) and the release of the first sorghum hybrid in 1964. The yields of these hybrids exceeded locals by at least 40%, often doubling yield, raising farmer enthusiasm and encouraging the government to establish a seed industry. Over the years, the industry has grown substantially contributing good quality seed but also valuable contributions from research.

I had the chance to participate in the development of a breeding program in the Sudan first with the ALAD program of the Ford Foundation and then with ICRISAT in collaboration with the Agricultural Research Corporation (ARC), being involved until the release of Hageen Dura-1 - their first sorghum hybrid. Dr. Ejeta, whom most of you know, worked with the relevant agencies in the Sudan leading to the development and wide scale use of the hybrid

After diversifying the germplasm base in Zambia, the breeder (Dr Bhola Nath Verma) contributed to the release of both hybrids and varieties and has contributed substantially to both seed availability and market opportunities

Important throughout has been the follow up of the organization (The Rockefeller Foundation in India) and/or the involved breeder to get new cultivars sufficiently spread through the farming community to generate interest in stabilizing seed availability There is now a rising pressure from the donor community to demonstrate accomplishment increasing pressure on the research scientists and their parent organizations to address development components of their research. Failure to respond to the gap between research and the farmer all too frequently retards development.

In this paper, I will comment on my experiences and those of a number of my colleagues as they relate to the development aspects growing out of research. It is hoped that these comments will be helpful to those interested in moving research accomplishments to the farmer.

India

At the time that the first hybrids of maize, sorghum, and pearl millet were released (1961-65) the country was short of food. There was no seed industry and attempts to move seed of varieties released up to that time made little contribution to increasing production. Staff of The Rockefeller Program participated in the development of these hybrids and expanded their program to include three scientists (in a total staff of 14) to concentrate on three aspects of a seed industry; seed production and processing, seed law and certification (quality control),and processing plant design and fabrication of seed processing equipment. The Foundation also brought in consultants and supported a study tour of Indian officials and private seed producers. For a period of about 8 years there was a shared experience between concerned Indians and expatriates familiar with aspects of the seed industry. It was a learning process and some of the original concepts changed. In India there is both a private and public sector. The initial idea was to stabilize the production and marketing aspects in the private sector with quality control (seed law and certification) and maintenance of breeder and foundation seed in the public sector. This was modified including substantial production and marketing of seed by the public sector leading to vested interests which tended to retard the rate of investment by the private sector. The growth of the industry has had problems but the direction has remained positive. Increasingly, hybrid seed of many crops is being produced and marketed by the private sector. For sorghum, approximately 5.6 million hectares is now sown to hybrids (about 40% of the total hectarage). By 1988, the total seed production capacity in the country was 667,853 tons in 504 processing plants. Of this, 217,770 tons were produced by the private sector in 212 processing plants. Since 1988, the percentage in the private sector has

increased including more than 90% for sorghum. By 1990, private companies had developed 122 varieties/hybrids of different crops, about 70% of these being hybrids. At this time, about 500 companies emerged of which 35 are large, most of them including research. During the last five years, the input into research by the private sector has greatly increased (Singh et al 1990).

For three years following the release of the first hybrid, CSH-1, the breeder with the Rockefeller Foundation interacted with new seed producers on technical problems. Generally, during the first year of production about 900 kg of seed was produced, the second year this increased to 1500 and in the third year to 2200. After this, the breeder could learn from the seed producer.

To support the spread of high yielding cultivars, the Government of India developed a high yielding varieties program in which, for two years, scientists were responsible for demonstrations and participated in training extension trainers.

By 1968, a seed law was implemented, seed certification became a state responsibility leading to quality control. Many privately developed hybrids are not certified but quality is maintained in the companies brand name.

The All-India Coordinated Sorghum Improvement Program strengthened during this period modifying research objective to meet new problems (caused by new cultivars and management practices) and changing opportunities (for example, a research thrust into sorghum for feed).

It has now been a little over 30 years since the first sorghum hybrid was released in India. Several things have happened that relate to the environment. The area sown to sorghum in the period 1962 to 1965 averaged 11,272,000 hectares, with average yield of 546 kg/ha and production of 6,156,000 tons. Comparing this with average figures for the period 1988 to 1991 area sown decreased to 8,867,00 ha, average yield increased to 942 kg/ha, and production averaged 8,335,000 tons. This represents an increase in production of 2,179,000 tons on 2,405,000 fewer hectares (ICAR, 1992).

Average yields in some of the major sorghum districts in the state of Maharashtra have exceeded two tons per hectare. This has not only reduced pressure on the land but has encouraged better crop husbandry. The increase of yield from 546 to 942 kg/ha indicates that both new hybrids and better management practices have continued to take place. The indication is that mining of the environment has not occurred.

Before the release of CSH-1, scientists indicated that farmers would not use fertilizer on sorghum. Following the release, many farmers were using 30 kg/ha of nitrogen or more on sorghum. Their traditional varieties were not responsive.

Seeds from the first production in 1964 sold for as much as Rs 75.00 per kg. when grain was selling for around Rs 1.00 per kg. This cost rapidly dropped to stabilize at Rs 5.5 to 6.5. This does indicate farmer willingness to pay for seeds of high yielding hybrids. Bank loans became available and increased use of irrigation including sorghum became available.

Since 1964, 14 hybrids and 13 varieties have been released of which hybrids and 4 varieties have been grown significantly. This has offered farmers a selection and avoided genetic vulnerability problems to pests when large areas are sown to the same cultivar year after year. About 55% of the sorghum area is sown to high yielding sorghum cultivars and 95% of this is sown to hybrids. Clearly, this has been a successful endeavor.

Sudan

In 1972, as part of the Ford Foundation's Arid Lands Agricultural Development Program, I had the opportunity to participate in initiating a program to develop hybrid sorghum in the Sudan. Initially, the germplasm base was expanded including a substantial collection of yellow endosperm lines from the program of the late Dr. Karper in Texas. This program became associated with ICRISAT and Dr. Gebisa Ejeta was stationed there. By the early 1980's several hybrids were identified with proven yield superiority (50% above checks). Three of them were evaluated in seed production plots of about one acre to demonstrate produceability. For two of them, the two parents flowered at the same time, considered important for new seed producers. The first hybrid was released as Hageen Dura-1 in 1983 raising the issue of seed production.

The Sudan has a Plant Propagation Administration, but there was no authorization or mechanism to deal with hybrids. Beside working with producers of hybrid seed, particularly the Gezira Board (400,000 hectares of irrigated land) and the Mechanized Farming Corporation, the breeder cooperated with Sudanese Authorities in developing a pilot project to phase in the production of breeder, foundation, and certified seed, and was an organizer of a seed meeting involving Sudanese

authorities, interested seed producers, and individuals involved with seeds in other countries.

In 1985, two years after the release, Hageen Dura-1 was planted on 29,000 ha; and seed available for the 1986 season was sufficient for 250,000 hectares. Yields on farmers fields far surpassed the 50% increase over locals indicated in yield trials. During the drought year of 1984, the hybrid had an 85% increase over locals on dry land and a 300-400 % increase in irrigated conditions.

Of concern was that the large harvests of 1985 and 1986 resulted in a drastic drop in sorghum grain price hampering further development of the seed industry. The area under seed production dropped from 1080 hectares in 1985 to under 400 in 1986. Such an experience as this highlights the need to consider how the crop can be utilized and marketed to avoid this problem. However, production continued and by 1988-1989 reached 5,850 hectares

During this period, seed was produced by the Sudan Gezira Board, the Mechanized Farming Corporation, the National Seeds Administration, several international companies and several Sudanese entrepreneurs. In addition, USAID sent out bids to US companies to produce seed and they delivered 1,100 tons by May 1986.

Over the years since the released of Hageen Dura-1, the National Seed Administration and the Agricultural Research Corporation have been concerned about the difference between production of hybrids compared to varietal seed and the importance of seed quality to attract farmers. There is on going debate in the Sudan on the role of the private and public sectors. "However, it is indeed positive that in a country where no private seed business existed before the advent of Hageen Dura-1, there is a significant private sector seed sales and operation today" (Ejeta 1993)

With the existing infrastructure it is significant that a *Striga* resistant variety, SRN39, was released in 1992 and in that year grown on 7,600 hectares. Dr Ejeta spent a significant amount of time working with the seeds issue for a four to five year period. I was able to share my experience from India with him for a two year period. The idea of a pilot project and a seed meeting were unique to the situation in the Sudan.

Zambia

The sorghum improvement program in Zambia was strengthened in 1984 by employing a sorghum breeder from ICRISAT. To strengthen the program over 5000 introductions were evaluated at two locations. Based on testing during the period 1987/88 to 1990/91, two varieties and two hybrids were released creating a concern for the production and distribution of seed.

A seed company, Zamseed, was established years before based on the production and marketing of hybrid maize. This company and the utilization industry were situated in the maize growing area of the country distant from the sorghum areas. This raised questions about costs related to selling seed in the more remote areas and ability to reliably supply good quality grain in adequate quantity to the utilization industry. There was reluctance on the part of Zamseed and the utilization industry to become involved with sorghum.

Interestingly, the variety Kuyuma, while not exceptionally high yielding has been the most popular in rural areas. This variety is very stable and particularly yields well in moisture stress situations. The breeder, as part of his activity with seed, carried seed in a pickup truck to farmer meetings in the areas of adaptation for the variety. The farmers purchased the seeds cash out of pocket. This began to generate interest among farmers. Zamseed was marketing seed only through cooperatives with reports of no farmer interest. As a consequence of this activity Zamseed reduced its market share through cooperatives to 30% and moved 70% of it through local shops. Following the severe drought of 1991-92, the breeder participated in an off-season emergency production of Kuyuma on 158 hectares and of two hybrids, each on 40 hectares. Two hundred and ten tons of seeds were produced and distributed, the variety to small scale farmers and the hybrids to commercial farmers. Production in the 1993-94 season nearly doubled to 60,000 tons compared to 35,000. Small scale farmers were realizing yields of 3.5 tons/ hectare and commercial farmers up to 5.7 tons/hectare on 40 hectare fields, equal to maize. There was impact on the community and Zamseed increased its interest in being involved to sustain, even increase the spread. During the 1994 off season the breeder again produced 596 tons of seed on 300 hectares and the seeds spread through the farming community. During the 1995 off season he is again producing on 150 hectares.

The concern of the utilization industry was recognized, also the awareness that a substantial increase in production could lead to a fall in price and loss of interest. In anticipation of the problem, the breeder diversified his objectives, grain types for food, grain (of the hybrids)

with good diastatic power for malting, and sorghum x Sudan grass crosses for feed. He also participated in organizing a meeting of seed producers and people from the utilization industry. The industry brewing traditional beer has shifted from malting with commercial enzyme to the use of sorghum with high diastatic power. Some 5000 tons annually are exported to a private company Foods Botswana, some 300-500 tons of seed of Kuyuma are annually exported to Mozambique, and seeds of hybrids for malting are being exported to Zimbabwe. While there is still concern, there appears to be a rising demand for seed and without the build up of grain stocks that are incentive destroying.

While much has been done with varieties, yield trial results clearly show the higher yield of hybrids. Hopefully, in the future with Zamseed, the production and marketing of seed of hybrids will expand.

Evaluating the situation, the breeder estimates that he should spend 60% of his time on development and 40% on breeding. This is more time on development than ordinarily expected, but much has been done to surmount concerns of the seed and utilization industry and in spreading seeds of high yielding cultivars in both small scale and commercial farming areas.

Namibia

Pearl millet is the major crop in northern Namibia where rainfall varies from 150mm to 600 mm. In the 1986/87 season 50 varieties were provided by the SADC/ICRISAT program and evaluated at Okashana where rainfall ranges from 350 to 450 mm. At this time, there was no research structure for the improvement of pearl millet but there were stations where testing could be done. The first farmers field day was held in March 1987 and ICTP 8203 was most impressive; particularly with a seasonal rainfall of 170mm.

Two hundred kilograms of seed of this variety was requested from the SADC/ICRISAT program for multiplication, and on farm demonstrations. A field day was held in March of 1988 with 250 farmers attending from the northern provinces. A seed day was organized in November of 1988 and 500 farmers came to buy seed - about four tons was sold.

Based on limited testing and primarily on farmer response ICTP 8203 was renamed Okashana-1 and released (1988/89) for cultivation in northern Namibia. In 1990, the Ministry of Agriculture requested SADC/ICRISAT to multiply seed and 10.6 tons was produced in the offseason station in Zimbabwe, sent to Namibia, and distributed to 2130

farms. In 1991, 32 tons of seed was multiplied by the department in Namibia, packed in two kgs lots and sold to approximately 1600 farmers (Monyo 1991). During the 1992 off season production by the SADC/ICRISAT program 38 tons of seed of Okashana-1 was produced, sent to Namibia and distributed. It is estimated that by the 1992-93 season 50% of the pearl millet farmers in northern Namibia had tried Okashana-1 (Friis-Hansen and Rohrback 1993).

Farmers appreciated several attributes of Okashana-1. It is earlier than the locals and provides a source of food earlier in the season than from their locals, it has good drought resistance and bold seed. This is an interesting situation in which release was based largely on farmer demand - there were no routine formal procedures applied.

Pearl millet is grown on about 92,000 hectares in Namibia. The active input of Government to produce seed and conduct demonstrations has been very successful in the spread of this variety.

Breeders from the SADC/ICRISAT program were closely involved in the production of seed from 1987 to 1992.

Zimbabwe

In response to a severe drought in the 1991-92 season, an off season emergency production of seeds of sorghum and pearl millet was undertaken by the SADC/ICRISAT Program. Four hundred and eighty tons of the sorghum variety SV-2 and 121 tons of the pearl millet variety PMV-2 was produced and distributed. This seed was sufficient to sow 37% of the sorghum and 22% of the pearl millet areas in the country (Friis Hansen and Rohrback 1993). There is an on going concern in Zimbabwe to stabilize seed availability to small farmers who are isolated from the maize seed and utilization industries.

Suggestions

1. The successful introduction of a cultivar into the farming community depends on high yield or the expression of an important trait. The area of adaptation needs identification.

2. To initiate a seed industry high yielding hybrid(s) are required. High yielding varieties have spread but likely can be replaced in time with hybrids. Following the introduction of the first hybrid/variety, the breeding program should continue to develop

new ones improving on the previous ones and expanding the range of adaptation.

3. A seed industry is probably the best way to provide adequate quantities of quality seed on a timely basis. Seed production and marketing is best done in the private sector while quality control is best conducted by government. Definition of functions should be adhered to Government involvement in production, particularly of commercial seed, results in vested interests and reduces private sector confidence to invest.

4. Diversification of the germplasm base is a valuable way to rapidly enhance the opportunity for high yielding cultivars.

5. While developing new cultivars, the use (commercial use) of produced grain is a valuable objective.

6. Seed as a component of development needs appropriate recognition.

7. There are unique situations in each country that should be addressed while establishing a seed industry. It is a learning experience and flexibility is important. The opportunity to interact with outside experienced people over a four to eight year period has been and can be very helpful. It is also valuable for nationals to visit other countries with established seed industries.

8. Effective uptake of new high yielding hybrids and varieties requires the involvement of the research scientists, particularly breeders over a three to six year period. This involvement includes production of seed, working with extension, getting seeds to farmers, and an active concern for utilization of grain produced. It also gives the breeder a good idea of farmer acceptance of a new cultivar and helps identify problems that can be corrected in subsequent cultivars.

9. The spread of new cultivars and changes in management practices can result in changes in the pest complex. Research scientists need to remain alert to these changes and take action before they become severe.

10. Generally, the seed law is compulsory for all seed, regardless of source. It has been found best to have a voluntary certification system. As new cultivars come from private research there may be reluctance to certify (particularly if it is necessary to divulge pedigree and/or there are time consuming requirements for

eligibility for certification or in timely carrying out the functions or certification). Companies with their own research programs will generally market by brand name. Keeping certification voluntary facilitates this.

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Rapporteur's Synthesis of Session XI: Needs and Priorities for Training and Institutional Development in NRM

Chair: David Sammons
Rapporteur: Botorou Ouendeba

Institutions require trained people to be effective. Both private and public sector institutions are important in accelerating the development process.

Among the important industries for Agricultural Development are:

Seed industry, Fertilizer industry, Equipment manufactures, Food processors, and Pesticide manufactures

Effectively functioning industries can:

- Assist consistent and good quality of processed products
- Provide channels for distribution
- Provide funding to support applied research
- Assist with demonstration/extension service
- Improve flow of information between research, producers, and consumers

But, industry needs training and technical support from educational and research systems

Some Constraints of the Seed Industry in West Africa

- Limited availability of varieties with significant contributions
- Actual availability of seed of improved cultivars
- Seed dissemination not effectively done
- Continuous funding for the seed industry is not available
- Qualified people to manage the seed industry in the region are not available sufficiently
- Little effective legislation on seed quality exists in the region

Some Suggestions to Strengthen the Seed Industry

- As a regional example, a hybrid seed industry exists in Nigeria.
- The breeder must be involved in the promotion and strengthening of the seed industry.
- Involve the farmer in production and dissemination of improved seed in their own area.
- Regional programs must assist national seed interests (eg. the IITA program) can assist in regional seed training.

Training

- Training is needed for seed producers, processors, inspectors, lab technicians, and farmers involved in seed production and dissemination

Training and Communication

- Short-term training of entrepreneurs, women's groups, and farmers are needed.
- Diversified long-term training at high level are essential.
- Necessity to share information should be emphasized.
- Scientific reinforcement of professionals through available modern technologies of communication are important
- Researchers must listen to the consumers regularly

Notes on Developing a Collaborative Regional NRM Program

Jeff Hill, USAID, AFR/SD/RSGE, Arlington, VA, USA

I would first of all like to acknowledge the effort and commitment that has been made to engage in a joint effort to support NRM TDT. The CRSPs, including US and national organizations, in a short period of time have mobilized this community of experts. I would also like to note that on the USAID side there has been real interest in this initiative. At present funding is provided by

- Global Bureau Economic Growth Center, Office of Agriculture
- USAID Niger has provided initial funding for assessments and this workshop
- Africa Bureau has provided funding
- West Africa Regional Program Office provides funding for INSAH
- Global Field Support Office has provided funding

By themselves these sources of funds are not large. However, they do demonstrate the interest in the concern for NRM TDT in West Africa and the willingness to work together within the Agency to support this effort.

It is important to establish the context of the group I work with. I am with the Africa Bureau, Office of Sustainable Development. I work in the Technology Development and Transfer Unit.

While it is late in this meeting, it seems to me to be important to establish some background. And, to provide some clarity to some next steps.

This presentation will take me about 30 minutes. So please bear with me. I have a lot of material to cover before I provide some comments for review on prospective next steps.

USAID Africa Bureau Activities

Beginning in September, 1994 the Africa Bureau undertook assessments and analysis to formulate a regional support effort for technology development and transfer. This design effort was completed under the heading of Sustainable African Agricultural Technology Systems (SAATS). This was originally intended to be a stand alone project, but was later integrated into the ongoing Africa Bureau PARTS project.

The PARTS Project is an umbrella Project that provides support for a number of activities, including activities in

- Technology Development and Transfer
- Natural Resources Management
- Food Security and Productivity
- Agribusiness and Marketing, and
- Environment

The SAATS design effort provided input into the reformulation of the portfolio of technology development and transfer activities. The activities in Technology Development and Transfer have a common concern to:

Induce and support agricultural transformation through sustainable increases in productivity.

The TDT activities are organized around three themes or categories. They include:

- Policy and Institutional Environment for TDT
- Demand and Supply of Technology
- Performance Monitoring and Impact Assessment

Through the numerous processes that included, stakeholder meetings that were held, discussions with policy makers, producers, researchers, NGOs, CRSPs, IARCs, etc... several priorities were arrived at to support the concern for accelerating the contribution of technology systems to agricultural transformation. The priorities include:

- Institutional and policy reform of technology institutions,
- Technology transfer to build on recent improvements in the policy environment and past investments in technology development, such as through the NARS, CRSPs, IARCs.
- Maintenance and support of ongoing technical programs that would likely need redirection based on the formulation of strategies and prioritized programs of work.

In West Africa there was an expressed concern for increased attention, in particular, to natural resource management technology development and transfer. The heads of national research systems, Field Missions, NGOs, international centers and other stakeholders had agreement on the priority for NRM TDT.

The Africa Bureau's response to this design effort was the provision of support for several new priority issues. In line with the priorities, the preponderance of new financing is being directed at addressing policy and institutional constraints of technology systems in East and West Africa. At the same time, funding for ongoing regional programs is being maintained while some strategic planning can be completed by West Africans to identify priorities.

In regard to technology transfer several new activities were initiated, including increased attention to technology transfer in ongoing programs. New activities include: IARC technology transfer grants program, biotechnology technology transfer, commercialization and transfer of technology.

In response to the concern for NRM TDT in West Africa an agreement was established with the CRSP council to support NRM TDT in West Africa. The NRM TDT activity for West Africa is the only new technical research activity and includes concerns for technology transfer as well as research. A brief summary of TDT activities is being copied for circulation to the participants.

Regional Coordination

Let me briefly turn to the approach that is being promoted by USAID in concert with leaders of national systems and donors to support regional collaboration and coordination in West Africa.

This is important because the NRM program, from our point of view, will need to fit within this context.

First, it clear that there are a number of collaborative regional research activities that are already operating in West Africa. USAID is providing support for 3 networks being coordinated by IARCs. CORAF is providing support for a number of networks.

The experience with these networks has provided solid evidence of the value of collaboration, both in terms of professional development and the increased flow and use of technology through sharing of effort and spillover. However, there are also several concerns about networks, that include:

- national ownership
- links between national priorities and regional action
- competition for time of researchers
- too many regional meetings
- lack of harmony in organizational structures and procedures among regional programs

To address these concerns and to improve the framework for regional collaboration, efforts are being made by Directors of west African NARSs to create a consortia among existing regional organizations to broaden participation, improve governance and harmonize approaches to coordination of regional research programs.

It is my understanding that the Directors will establish a forum to review and coordinate programs. With regard to NRM, the Directors have established it as a high priority and would like to see it as their first major effort to formulate their regional program. It was the intent of USAID to support the efforts of the Directors, not to create a conflicting or competing process.

At the same time, INSAH has initiated several activities of specific relevance to the regional processes and the NRM activity. These include assessments of capacity and inventory of technology. One purpose of this effort, as I understand it, is to make available information to support planning of national and regional activities. Another activity is support for strategic planning to assist national and regional organizations.

At present a lot of ground work has been laid to support new ways of collaboration among countries. What this group and specific effort have to offer is real action to operationalize the discussions.

NRM Regional Program and InterCRSP

The Africa Bureau of USAID has received and agreed to fund a proposal from the CRSP Council. In the proposal that we have agreed to support, we have a three year time horizon, subject to the availability of funds. The objectives outlined in the proposal are:

- **To strengthen the institutional and human capacity to develop and transfer NRM technology and information.**

- **To increase the availability of and access to profitable and sustainable natural resource management technology in West Africa.**

The proposal describes important conditions and programmatic issues. I will not go into those details. However, I will note that the proposal does describe several key areas for action. They include:

1. Strengthen African Institutional capacity by

   a. Supporting the design of a consolidated strategy and work plan for NRM TDT in West Africa.
   b. Establishing a mechanism for West African researchers to collaboratively implement NRM TDT.
   c. Strengthen existing national and regional human capacity.

2. Increase the availability of known techniques among NARSs; and increase access to NRM innovations.

3. InterCRSP collaboration in priority research topics to be designated in the strategy, with indicative areas of collaboration in: soil, water and vegetation conservation; IPM; socioeconomic and policy areas; germplasm improvement; processing and product development; and integrated production system improvement.

It is important to note that from our point of view that the CRSPs offer several unique strengths and opportunities to support and promote collaboration among nontraditional partners that need to work together.

For example, the participation of universities in regional research efforts has been limited, yet universities offer a wide range of technical capacity that is not always found in NARIs. Furthermore, there has been significant interest among the West African policy makers to find mechanisms to strengthen the linkages that have been previously developed through graduate training and professional associations.

This Brings Us to the Workshop

This workshop has proven to be successful from the point of view of demonstrating the value of bringing together colleagues across countries. Aside from any formal agenda it has enabled peers to share experience, findings and ideas.

The workshop has facilitated discussion on approaches, such as the watershed, to organizing technical research across commodity lines. It has also highlighted selected technologies, such as:

- new cowpea varieties,
- biotech methods,
- hybrid sorghum,
- green manuring and integrated nutrient management,
- new peanut germplasm,
- *Striga* control methods,
- fish and crop production systems,
- pest control in storage systems,
- post harvest technologies for roasting, mixing and packaging
- electronic communication

These innovations provide a rich set of opportunities that need to be more carefully reviewed to select some "low apples" for some immediate attention.

> A next step from the workshop might be not only a cataloguing of the innovations, but a specific follow-up with researchers that developed them and transfer agencies to determine what nonresearch activities could be completed to promote them.

A portion of the workshop has been devoted to the concern of how to formulate and support a regional strategy and program; and, a portion has focused on the operational concerns of how to create a network to facilitate collaboration. These should not be in conflict, but rather are complimentary. Both are necessary. The concern that needs to be addressed is the sequence of actions.

It should be noted that the formulation of a regional NRM TDT strategy will need to involve a broader set of individuals and groups than are represented here. The issue at hand as a follow-up action is to (a) become more familiar with the processes already initiated, (b) advise them that support is available to assist them, and (c) engage them in a process of identifying what assistance they will need.

Several concrete actions that might be considered include:

1. Focus on the assessment process now underway. A meeting will be held in late November or early December. In addition to the agenda it has, it might be used as a forum to deliberate some of the technical issues, review capacity and needs.

2. The Directors might be approached to see if they have a working group to develop the strategy, and determine whether additional assistance might be needed. It will be important for this group, regardless of who constitutes it, to be familiar with the interest here in formulating an operational mechanism for collaboration, and to ensure that the operational mechanism conforms to the approach endorsed and developed by the Directors.

   A key issue is to ensure that the strategy contains the definition of one or more operational mechanisms to support collaboration.

3. There are tentative plans for Directors to meet in January. The issue might be raised to provide input to the Directors to enable them to have a draft strategy ready for review at that time.

4. Critical input to the Directors and the process of formulating a strategy and program will be the description of activities (e.g., a work plan) that this group believes can and should be implemented. A follow-up action of this workshop would then be to define activities that are in support of the national NRM Programs and National Research Strategies.

Consistent with the terms in the proposal that we have supported, it is anticipated that by the close of January 1996 there would be

1. Support provided to formulate a regional strategy that in turn provides guidance for a prioritized set of activities.

2. A workplan that lays out the technical activities to be completed over the next 12 to 18 months.

Where Do We Go From Here?

Brhane Gebrekidan, IPM CRSP, Virginia Tech, Blacksburg, VA, USA

Over 70 registered workshop participants representing NARSs of seven West African countries (Burkina Faso, Cameroon, Cape Verde, Chad, Ghana, Mali, and Niger), all eight CRSPs (Bean/Cowpea, IPM, INTSORMIL, Peanut, Pond Dynamics, SANREM, Small Ruminant, and Soil Management), USAID (Africa Bureau, Global, Niger Mission), IARCs (ICRISAT, IITA, IFPRI), Regional Organizations (INSAH, AGRHYMET), and NGOs (Africare) have actively participated in the workshop. This has been the first time for the CRSPs to be jointly involved and taking the lead, with INRAN, in organizing and implementing such a workshop. The workshop was planned to serve as a forum for launching the "NRM InterCRSP in West Africa" regional initiative expected to be supported under the USAID Africa Bureau funding. Based on the presentations, active participations, and discussions of the participants of this workshop, the stage is set for moving forward with the InterCRSP NRM West Africa initiative. I am pleased to realize that most of the objectives of the workshop have been met satisfactorily. As planned, a wide range of papers, on important NRM-related topics, have been presented and discussed, a number of spirited panel discussions, as well as active working group discussions, were completed, and an interesting and appropriate field visit has been made. In the course of the workshop, a number of conclusions and recommendations have been made and these will appear in the appropriate places of the Workshop Proceedings which will be published by the IPM CRSP.

Some of the main recommendations and conclusions which are relevant to the continuation of the future planning and activities of the InterCRSP NRM West Africa initiative are:

- It has been agreed that INSAH will be the West Africa Regional Coordinating Center for the InterCRSP NRM initiative.
- INSAH should identify and appoint the regional NRM/InterCRSP coordinator and also form the regional InterCRSP Committee.
- The CRSPs operating in a country should form a National InterCRSP Committee and select a national coordinator.

- INSAH should find a mechanism and facilitate the participation in the InterCRSP NRM regional activities of the NARSs where there is no CRSP presence.

- It has been agreed that the watershed management model is appropriate for NRM technology development and demonstration, however, it was also emphasized that it should be modified to suit local situations and to accommodate socio-economic issues relevant to a region.

- It has been recommended that the CRSPs should give more attention to NRM technology transfer concerns of West Africa.

- As soon as the IPM CRSP receives the funds for the USAID Africa Bureau Grant for the InterCRSP NRM West Africa initiative, the CRSP Council, INSAH, and the collaborating NARSs should develop a workplan for the implementation of Year 1 of the initiative.

- The InterCRSP should not be a superstructure nor a new project, but a coordinating mechanism for complementing and strengthening national and regional efforts in NRM in West Africa.

- The InterCRSP and the CRSP Council should be represented in the forthcoming regional workshop on NRM in West Africa to be organized by INSAH in Bamako.

The IPM CRSP will continue to play the lead role in implementing the recommendations and concepts developed in this workshop. Many of the recommendations made in this workshop are also covered in the Conclusions and Recommendations of the InterCRSP NRM West Africa Strategy Assessment Team Report (Available with the IPM CRSP) which covered Niger, Mali, and Burkina Faso from July 8-22, 1995. Since those recommendations are relevant for the future implementation of the InterCRSP NRM West Africa initiative, they are given below:

1. There is a broad regional and institutional support for the InterCRSP NRM Initiative.

2. Institutional and human resource capacity in NRM and related areas available in West Africa is substantial.

3. Strong financial support from donors is essential to coordinate and implement the InterCRSP NRM Initiative in West Africa.

4. It is recommended that the watershed management model underway as an InterCRSP NRM activity in Niger be extended to the other participating West African countries.

5. In addition to the watershed approach, the InterCRSP should employ supplementary Technology Development and Transfer methods to reach a wider range of farmers.

6. As the InterCRSP NRM regional activity continues, it is recommended that Niger be taken as the lead and model country.

7. Of the three countries visited by the team, only the USAID/Niger Mission had a prepared and well articulated strategic plan in which NRM was identified as a high priority strategic objective.

8. Both Technology Development and Technology Transfer are important in the regional InterCRSP initiative.

9. The CRSPs should begin to give high priority to Technology Transfer.

10. The CRSPs can help lower information costs to farmers and extension agencies through demonstrations, field days, workshops, and publications. In this context, extension agencies would include both government extension services and NGOs.

11. The stakeholders in NRM TDT are many and diverse - GOs, NGOs, PVOs, ROs, IARCs, CRSPs, etc. - highlighting the importance of having a strong national and regional coordination mechanism.

12. The highest priority issues in human resource capacity are related to: end-user (customer) involvement throughout the TDT process and creating an institutional system that encourages and allows true interdependence among research and extension staff.

13. A typical NGO involved in NRM work, Africare Niger, has a broad-based rural rehabilitation and development approach addressing such issues as water development, reforestation, and revegetation of degraded lands, leading to sustainable rural development.

14. NRM TDT means different things to different stakeholders, emphasizing that the InterCRSP NRM Initiative should identify and concentrate on NRM aspects where the CRSPs and their collaborating NARSs have comparative advantage.

15. It is recommended that INSAH serve as the regional coordinating institute and designate the coordinator.

16. A MOU should be signed between INSAH and the CRSP Council to formalize the InterCRSP coordination.

17. AGRHYMET can be an important collaborator in this regional NRM interCRSPing effort and the management has expressed interest to be a partner. Within the framework of the CILSS Early Warning System, it develops and distributes satellite products and geo-referenced analyses obtained through the use of a geographic information system (GIS).

18. Where multiple CRSPs are present in a country, these CRSPs should designate a lead CRSP and its host country coordinator as the interCRSP country coordinator.

19. The group of CRSP host country coordinators, especially those operating in Mali, emphasized that real operational and financial authorities in interCRSPing should reside in the hands of the cooperating NARSs.

20. A lead CRSP, the IPM CRSP, should be responsible for the overall coordination of this InterCRSP NRM initiative.

21. ICRISAT has expressed that the proposed InterCRSP natural resource management effort fits well with the objectives and activities of the integrated systems projects of the institute.

22. Among the major themes suggested for interCRSPing are integrated NRM, Integrated Crop Production Technology, Nutrient Management, Watershed Management, Pest Management, Technology Transfer, and Institutional Strengthening, etc.

23 Access to effective and timely communications and information among the various key stakeholders in the TDT process is important. Communication and information technology can play a critical role in the InterCRSP NRM West Africa effort.

24. If we initiate distance learning using World Net, USIS/Niger urged us to bring the World Net sessions to more than one West African site so we can demonstrate the linking power of the facilities and model their use for distance learning conference and

meeting. This could be a powerful communication mechanism for strengthening regional cooperation in NRM and interCRSPing.

25. Follow-up Assessment

- This assessment, covering only three West African countries, was only a first step. It is recommended that similar assessments be done in the future in additional West African countries.

Discours de Clôture du Directeur Général de l'INRAN

Abdoulaye Gouro, INRAN, Niamey, Niger

Messieurs les Responsables des SNRA,
Messieurs les Responsables des CRSP,
Messieurs les Chercheurs,
Mesdames et Monsieurs,

L'organisation et la tenue de l'atelier ont été faites en un temps très court. Ceci explique probablement l'incompréhension qui a régné les deux premiers jours au niveau des participants.

La mise à niveau de l'information a permis aux uns et aux autres de mieux comprendre l'opportunité de cette réunion.

Malgré donc les piétinements, l'atelier a atteint ses objectifs parce qu'il a permis:

- D'avoir une masse critique d'information sur les Recherches en matière de Gestion des Ressources Naturelles et les Technologies Generées à partir de ces Recherches.

- De nous rendre compte que les CRSP ont obtenu des résultats positifs non seulement au Niger mais aussi dans plusieurs pays de l'Afrique de l'Ouest.

- De coordonner nos efforts au niveau national et régional pour assurer un développement durable à travers les activites des CRSP.

La mise en commun de nos efforts et la coordination de ces efforts, suppose la mise en place d'un mécanisme opérationnel qui permettra une meilleure collaboration entre les différents partenaires.

Cet atelier n'aura un impact que s'il y a un suivi des recommandations qui sont faites ici. Je voudrais parler ici du développement d'un plan d'action avec les activités bien définies.

Des rencontres périodiques de ce niveau devraient alors être organisées, par exemple tous les ans ou tous les deux (2) ans pour faire le point.

Permettez-moi avant de terminer, de remercier l'AID Washington pour l'intérêt qu'il porte à l'amélioration de la Gestion des Ressources Naturelles en Afrique de l'Ouest.

Je tiens à remercier tout particulièrement la Mission de l'AID/Niger pour son appui financier pour organiser l'atelier qui a permis de réunir en un temps aussi court, des compétences venant de toutes les régions.

Sur ce, Messieurs les Participants, je vous souhaite un bon retour dans vos pays respectifs .

JE VOUS REMERCIE

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APPENDIX 2

WORKSHOP PROGRAM

TECHNOLOGY DEVELOPMENT and TRANSFER to IMPROVE NATURAL RESOURCE MANAGEMENT

A Regional Workshop to Plan Collaborative Activities for West Africa

18-22 September 1995, Niamey, Niger

Background

Through several Collaborative Research Support Programs (CRSPs), USAID has promoted agricultural research and development for West Africa since the early 1980s. There are currently six CRSPs with independent activities in West Africa -- Bean-Cowpea; Integrated Pest Management; Peanut; Soil Management; Sorghum-Millet; and Sustainable Agriculture & Natural Resource Management. These CRSPs have contributed significantly to technology development and human capital for West African agricultural research.

In July 1995, three CRSPs began an InterCRSP project on natural resource management with support from the USAID Mission in Niger. In addition to this project, USAID has identified a need for a regional approach to natural resource management that would draw on available technologies developed by all CRSPs active in Africa. The USAID Mission in Niger is partially supporting this workshop.

Objectives

- Create a common base of understanding across CRSPs, including technologies that have been developed and the current and potential impacts of those technologies in the region.
- Identify priority constraints to natural resource management.
- Plan technology transfer to apply available technologies and research activities to develop new or to adapt existing technologies for priority constraints.

- Establish linkages among research, extension, and NGO/PVO organizations active in West Africa.

Monday, 18 September 1995

0800 - 0930 REGISTRATION -- Palais de Congrés

I. OPENING SESSION

Chair: Botorou Ouendeba
Rapporteur: Curt Nissly

0900 - 0910 Welcome address - Abdoulaye Gouro, Director General, INRAN

0910 - 0920 Workshop Background and Objectives - Brhane Gebrekidan

0920 - 0930 Regional Collaboration for NRM - Keint Simmons, AID/Niger

0930 - 1000 Opening Address - Minister of Agriculture & Livestock, Niger

1000 - 1030 BREAK

II. TECHNOLOGIES AVAILABLE FOR NRM IN WEST AFRICA

Chair: Gaousso Traore
Rapporeur: M. Moussie

Objective: *Identify technologies available from research and existing production systems to meet strategic objectives for improving NRM in West Africa*

PANEL DISCUSSIONS

1030 - 1120 A. Land & Water Management
Panelists: Tony Juo, Solibo Some, Andrew Manu, Ibrahim Zanguina

1120 - 1210 B. Genetic Resources

Panelists: Russ Freed, Will Getz, Issofou Kapran, Ousmane Ndoye, Moussa Sanogo, Olin Smith

1210 - 1300 C. Crop & Animal Production Technologies
Panelists: Issaka Mahaman, Andrew Manu, Jim Bowman, Steve Mason

1300 - 1430 LUNCH

1430 - 1520 D. Crop Protection
Panelists: Ousman Youm, Issofou Kolo, Kadi Kadi, Philippe Sankara

1520 - 1610 E. Crop Utilization
Panelists: Sam Sefa-Deda, Richard Awuah, Bruce Hamaker, Elena Perez

1610 - 1640 BREAK

1610 - 1700 F. Emerging Technologies for Regional NRM

Panelists: R.L. da Costa dos R. Silva, AGRHYMET (GIS), Ron Grosz, HERNS (Communication and Learning Systems), Dan Dworkin, AID/AFR (AfricaLink)

1700 - 1730 General Discussion

Tuesday, 19 September 1995

III. ASSESSING WEST AFRICA'S NEEDS FOR NRM

Chair: Botorou Ouendeba
Rapporteur: Andrew Manu

Objective: *Review the percieved needs for natural resource management from a broad range of InterCRSP stakeholders.*

0830 - 0845 From the perspective of a regional organization - Gaoussou Traore, INSAH

0845 - 0900 From the perspective of a national program - Abdoulaye Gouro, INRAN

PANEL DISCUSSION

0900 - 0945 National program needs for natural resource management
Panelists: Aminou Bouba-Kaou, LRVZ, Chad; Kwasi Adu, CSIR, Ghana; Amadou Ba, ISRA, Senegal; Makan Fofana, IER, Mali; Victor Hien, CNRST/INERA, Burkina Faso; Mbua Ngeve, IRA, Cameroon; Jose Gabriel Levy, INIDA, Cape Verde

0945 - 1015 From the perspective of technology transfer NGO - Mohamoud Osman, Africare

1015 - 1030 From the perspective of an IARC - Kenton Dashiell, IITA

1030 - 1045 From a donor perspective - Curt Nissly, USAID

1045 - 1115 BREAK

IV. STAKEHOLDER ANALYSIS

Chair: Mudiayi Ngandu
Rapporteur: Soeluyman Ouedraogo

Objectives: *Identify all potential stakeholders and their respective roles in InterCRSP NRM project, including direct and indirect beneficiaries, participants, coordinators, donors, and others.*

Working Group 1: NARS
Working Group 2: NGOs
Working Group 3: CRSPs and IARCs

1115 - 1125 Session objectives and charge to working groups - plenary

1125 - 1230 Stakeholder analysis

1230 - 1300 Working group reports and discussion -- plenary

1300 - 1430 LUNCH

V. STRATEGIC OBJECTIVES FOR NRM IN WEST AFRICA

Chair: Philippe Sankara
Rapporteur: Steve Mason

Objective: *Identify & prioritize strategic objectives for NRM in West Africa. Assess potential contribution of available technologies with strategic objectives.*

Working Group 1: Semi-arid zone; Sahel
Working Group 2: Sub-humid zone; Sudan & Guinnea Savanna
Working Group 3: Humid zone; Forest

1430 - 1440 Session objectives and charge to working groups - plenary

1440 - 1545 Formulating and prioritizing strategic objectives

1545 - 1615 BREAK

1615 - 1730 Linking available technologies with strategic objectives

1900 - 2100 RECEPTION / BANQUET

Training and Visitors Center - ICRISAT Sahelian Center

Wednesday, 20 September 1995

0800 - 1300 VI. FIELD TRIP TO HAMDALLAYE WATERSHED

Chair: Issaka Mahaman
Rapporteur: Andrew Manu

Objectives: *Visit a watershed in which InterCRSP NRM technology interventions are underway. Observe field activities of three CRSPs and evaluate the applicability of this model to other sites and countries.*

1300 - 1430 LUNCH

(Cont.) V. STRATEGIC OBJECTIVES FOR NRM IN WEST AFRICA

Chair: Philippe Sankara
Rapporteur: Steve Mason

1430 - 1515 Working group reports and discussion - plenary

VII. POLICY AND SOCIO-ECONOMIC CONSTRAINTS TO NRM

Chair: Laurent Millogo
Rapporteur: Vallerie Kelly

Objectives: *Identify critical policies and socioeconomic factors that affect adoption of NRM technologies.*

PANEL DISCUSSION

1515 - 1600 Socio-economic and policy issues that affect technology development and transfer - Souleymane Ouedraogo, Makan Fofana, Touba Bedingar

1600 - 1630 BREAK

WORKING GROUPS SESSION

Working Group 1: Political and institutional constraints
Working Group 2: Socio-economic constraints

1630 - 1640 Objectives and charge to working groups

1640 - 1730 Analysis of policy and socioeconomic constraints

Thursday, 21 September 1995

(Cont.) VIII. POLICY AND SOCIOECONOMIC CONSTRAINTS TO NRM

Chair: Laurent Millogo
Rapporteur: Vallerie Kelly

0830 - 0915 Working group reports and discussion -- plenary

IX. MODELS OF SUCCESS FOR COLLABORATIVE RESEARCH & TECHNOLOGY TRANSFER

Chair: Amadou Ba
Rapporteur: Charles Sloger

Objectives: *Review organizational structures and modes of operation for organizations involved in collaborative research and technology transfer in West Africa*

0900 - 0915 Africare technology transfer programs in West Africa
- Mohamoud Osman

0915 - 0930 Extending agricultural technologies in Niger
- Malam Ari Kori

0930 - 0945 Regional networks
- Ousman Youm

1030 - 1045 Linking participatory research with end-users and NGOs
- Mudiayi Ngandu

1045 - 1115 BREAK

X. STRUCTURAL MODEL FOR InterCRSP NRM PROJECT

Chair: David Cummins
Rapporteur: Makan Fofana

Objective: *Develop a structural model that can be used in the InterCRSP NRM project.*

Working Group 1: Administrators, managers, donors
Working Group 2: Active researchers
Working Group 3: Extension and training specialists

1115 - 1125 Workshop objectives and charge to working groups -- plenary

1125 - 1300 Identification, analysis, and ranking of models and institutional relationships

1300 - 1430 LUNCH

1430 - 1515 Plenary reports and discussion

1515 - 1600 Organizational charts and MOUs

1600 - 1630 BREAK

1630 - 1730 Organizational charts and MOUs (Continued)

Friday, 22 September 1995

(Cont.) **X. STRUCTURAL MODEL FOR InterCRSP NRM PROJECT**

Chair: David Cummins
Rapporteur: Makan Fofana

0830 - 0915 Working group reports and discussion -- plenary

XI. TRAINING & INSTITUTIONAL DEVELOPMENT

Chair: David Sammons
Rapporteur: Botorou Ouendeba

Objectives: *Identify agricultural inputs and agribusiness issues that affect NRM technology adoption. Establish training and institutional development plans that address agricultural inputs and industry needs for NRM.*

PANEL DISCUSSION

0915 - 0930 Constraints and needs for institutional development
- David Sammons

0930 - 0945 Developing a viable seed industry for West Africa
- Lee House

0945 - 1000 Fertilizer availability as a constraint to agriculture
- Vallerie Kelly

1000 - 1015 Industrial linkages and their impacts on technology adoption - Alfred Traore

WORKING GROUPS SESSION

Working Group 1: Seed production and availability
Working Group 2: Factors affecting fertilizer availability
Working Group 3: Industrial development and support to research

1015 - 1025 Workshop objectives and charge to working groups -- plenary

1025 - 1100 Training needs and priorities

1100 - 1130 BREAK

1130 - 1215 Needs for institutional development

1215 - 1300 Working group reports and discussion -- plenary

1300 - 1430 LUNCH

XII. CLOSING SESSION

Chair: Mamadou Ouattera
Rapporteur: Jeff Hill

WORKING GROUP SESSION CHAIR REPORTS

1430 - 1440 Stakeholder Analysis - M. Ngandu

1440 - 1450 Strategic Objectives for NRM in West Africa - Philippe Sankara

1450 - 1500 Policy and Socioeconomic Constraints to NRM - Laurent Millogo

1500 - 1510 Structural model for InterCRSP NRM Project - David Cummins

1510 - 1520 Needs & Priorities for Training & Institutional Development - David Sammons

1520 - 1530 BREAK

PLANNING FOR THE FUTURE

1530 - 1545	Where do we go from here? - Brhane Gebrekidan
1545 - 1600	Response from USAID - Curt Nissly
1600 - 1615	Closing Remarks - DG of INRAN
1615	ADJOURN