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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Interim SCIENCE COUNCIL

Progress Report on Regional Approach to Research

Interim SCIENCE COUNCIL SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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1. Introduction

At AGM 2001, TAC presented to the Group a "*Progress Report on Regional Approach to Research*" (SDR/TAC:IAR/01/32) which recorded progress achieved during 2001 in the implementation of Plank 4[1] of the new CGIAR vision and strategy endorsed at ICW 2000. The progress report highlighted the action taken by GFAR, regional and subregional organizations and CGIAR Centres to facilitate regional consultation processes to establish a regional approach to research priority setting and implementation for the CGIAR and NARS as envisaged by Plank 4.

The progress report also recorded the steps taken by TAC, in collaboration with GFAR, national and regional institutions and CGIAR Centres, to facilitate the implementation of the Group's decision at ICW'00 for piloting an experimental bottom-up, priority setting approach in the Central America sub-region. In support of the regional approach to research, TAC prepared or commissioned several documents during 2001 and shared them with the Group at MTM 2001 and AGM 2001. These are summarized in Section 2.

This progress report (SDR/iSC:IAR/02/27) of the iSC to AGM 2002 records the action taken by TAC/iSC and developments since AGM 2001 in further facilitating the regional approach to research in the CGIAR. This is described in Sections 3 and 4. The report ends with Section 5 which offers some concluding remarks and suggestions about the future.

[1] Plank 4 of the new CGIAR vision and strategy calls for the adoption, in collaboration with national and regional partners, of a regional approach to research planning, priority setting and implementation.

2. Developments since ICW 2000 and up to AGM 2001

Developments in since ICW 2000 and up to AGM 2001 were reported to the Group at AGM 2001 by TAC and included the following:

2.1 Regional Approach to Research for the CGIAR and its Partners
(SDR/TAC:IAR/01/09)

Once the Group approved the new vision and strategy at ICW 2000, there was a need to elaborate on the conceptual basis of the strategic Plank 4. This was done by TAC in the document prepared by Alain de Janvry and Amir Kassam entitled *"Regional Approach to Research for the CGIAR and its Partners"* (SDR/TAC:IAR/01/09). This was presented to the Group at MTM 2001.

The paper provided an elaboration on Plank 4 of the new CGIAR vision and strategy. Given the poverty and impact focus of international public goods research, both NARS and the CGIAR have advantages in pursuing a regional approach as a component of their respective activities to address poverty and food security. For the NARS in the region, this means seeking at the regional level advantages that they could not derive solely from a national-level approach, thus complementing and supplementing the national approach. For the CGIAR, this means seeking complementary gains that it could not achieve exclusively through a global or ecoregional approach. These mutual advantages open the door for partnerships in regional research between NARS and their regional organizations, and the CGIAR.

The paper highlighted the advantages as well as risks and limitations of a regional approach to research, and noted some emerging lessons, and the next steps. Key advantages include: (a) economies of scale in research that can be captured through a regional approach when they could not at the national level; (b) positive externalities that can be better internalized at the regional level than at the national level, creating greater incentives to invest in research; (c) division of labour and specialization among the scientists in the region on a comparative advantage basis; (d) elevating research priorities above national processes and cycles to give greater continuity in research undertakings; (f) giving guidance and coherence to national and international donors and investors by providing an overall framework with well defined research priorities; and (g) opportunities for scientists to exchange information on research issues specific to the region. For the CGIAR, the underlying guiding principles of a regional approach are: coordination with development agents in the region; broad participation of stakeholders involved in the struggle against poverty; and partnerships between CGIAR and NARS in the region on win-win research initiatives. Regions are heterogeneous and, within regions, poverty is itself highly heterogeneous. As a result, a regional approach will differ across regions according to the specificity of the region and, within the region, it will have to deliver instruments of poverty reduction that cater to the heterogeneity of poverty. The information needed for priority setting is highly imperfect, and largely available at the local level. Mobilizing this information, formulating demand driven research priorities and facilitating collaboration and division of labour for research requires participation of stakeholders which a regional approach can greatly facilitate.

A regional approach is beset with risks and limitations arising from several unknowns that need to be addressed. These are: the lack of experience in planning and implementing regional research priorities in the manner and scale envisaged by Plank 4; lack of effective

traditional partners and of the catalytic institution for a particular region; the need for regional ownership of the process and outputs; weakness in the database coverage and quality and in the understanding of the poverty processes and impact pathways; high transaction costs in coordinating with other development partners; and lack of donor and investor support.

2.2 The Pilot Experiment in Central America

To facilitate the implementation of the Group's decision at ICW 2000 for piloting an experimental bottom-up, priority setting approach in the Central America sub-region, TAC worked closely with GFAR, FORAGRO, FONTAGRO and CGIAR Centres active in the region. Subsequent to e-mail interaction with relevant parties in November and December 2000, FORAGRO organized a "brainstorming" meeting at IICA, San Jose, Costa Rica, 8-9 February 2001 to define the regional planning methodology.

The "brainstorming" meeting was held as a preparatory step to the next planned meeting scheduled for 2-4 May 2001 in Mexico. It was envisaged that the results from this May meeting would be reported to the MTM'01. The Mexico meeting was expected to produce an agreed process for moving forward with a reassessment of research priorities, with Central America as a sub-regional pilot case study. It was agreed to proceed with the regional priority-setting process for the Central America sub-region covered by Puebla in Mexico to Panama. A small steering committee led by FORAGRO formed to oversee the process and help organize the first multi-stakeholder meeting in May 2001 in Mexico, and oversee the agenda and documents to be prepared for the meeting. Three studies were commissioned for the Mexico meeting: (i) Poverty in Meso-America, to be contributed by TAC; (ii) Competitiveness and technology in Agriculture in Central America, to be contributed by FONTAGRO; (iii) Annotated inventory of studies on research priorities in Meso-America, to be contributed by GFAR.

This was followed by a multi-stakeholder meeting on Sub-Regional Priority-Setting, 2-4 May 2001, CIMMTY, Mexico. Organized by FORAGRO and cohosted by CIMMYT. The meeting was attended by a cross-section of institutions including representative from FORAGRO and regional NARS, FONTAGRO, PROCICARIBE, PROCISUR, PROCIANDINO, CONDESAN, CGIAR Centres, SICTA, CATIE, INIFAP, IICA, Inter-Agency Group on Rural Development in LAC and other donors, private sector, NGOs, development agencies, and TAC.

TAC made the following contributions to the meeting:

1. An invited paper by Alain de Janvry and Amir Kassam on the "Advantages and Added Value of the Regional Approach to Research for the International Agricultural Research System".
2. The TAC Consultancy Report by Reed Hertford on "Poverty in Meso-America: Tendencies, Causes, and Implications for Agricultural Research (SDR/TAC:IAR/01/16).
3. TAC priorities and strategies datasets for Central America and the Caribbean on population, poverty indicators, agricultural performance indicators, nutrition and other social indicators, commodity prices, share of production sectors and the effect on its relative importance of poverty modifiers, and estimated shares of values of production for CGIAR and non-CGIAR commodities.

The main outcome from the Mexico meeting was a proposal entitled "*Pilot Project for the Study of Research Priorities for Meso-America and to Consolidate Strategic Alliances Around Them"*. The FORAGRO pilot project was submitted to CGIAR donors for partial funding but no donor came forward to support the implementation of the pilot experiment.

2.2.1 Poverty in Meso-America: Tendencies, Causes and Implications for Agricultural Research (SDR/TAC:IAR/01/16)

This study reviewed poverty at the global level and at the level of Latin American and Caribbean (LAC). On one commonly used measure of poverty, LAC is that developing region of the world with the highest incidence of poor people—slightly over one in every two persons. Worldwide, poverty also turns out to be far more persistent than presumed by the G-8 resolution to halve it by 2030. Less surprising, perhaps, is that it is shown to be predominantly a rural problem, even in the rapidly urbanizing LAC region.

In the 1990s, poverty's persistence around the world was due to increased income inequality within countries and patterns of economic growth that widened gaps between rich and poor countries. That poverty is a rural problem is hardly surprising, given its chief determinants: fewer owned assets, lower returns to those assets, greater variability in asset amounts and returns through time, low levels of public sector social spending, and locational factors (e.g., remoteness and accessibility). But within LAC, it is also an agricultural problem. Campaigns to reduce poverty should not only give top priority to rural areas, but within rural areas, agriculture should come in first for attention.

No evidence was found to support three plausible hypotheses concerning recent trends in poverty, including its persistence: that the pervasive "opening" and "globalization" of the world's economies worked against poverty reduction; that natural resources degradation reinforced poverty; or that rising rural non-farm employment led to greater poverty.

Against this backdrop, the paper then turns to a characterization of poverty in Meso-America (Puebla to Panama), taking each country as a case study. With 60 percent of this region being poor and 40 percent extremely poor, the incidence of poverty is higher than for the world as a whole and roughly twice as high as for the LAC region. Too, it is observed that the incidence of poverty tends to decline on passing from the north to the south of the region; the incidence of poverty improved in the 1990s, except in the two most northern countries; rural poverty is everywhere more intense than urban poverty; and most of the poor are in rural areas (except in Mexico).

Highlights of the country case studies indicate that poverty could probably be eradicated from Costa Rica and Panama with a small fraction of the government's budget; Mexico's commitment to a pro-rural social development budget may show the way (if not at least one way) for countries of the region to alleviate poverty; the centrality of agriculture to economic upturns and poverty reduction was exemplified by Nicaragua's economic recovery of the 1990s; Honduran poverty is linked to hillside resource degradation and deforestation, even though the linkage is not always present in other developing countries; the El Salvador case most clearly demonstrates that good rural jobs and better rural incomes require complementary capital and investments; and Guatemala, where poverty is severe, widespread, increasing, and ethnic, is the toughest challenge to poverty reduction in Meso-America.

Implications for agricultural research? Repeatedly, multiple factors are shown to cause poverty. This being the case, agricultural research cannot successfully attack poverty alone, but in union with organizations that can support and manage other poverty determinants. Integrating a comprehensive rural poverty reduction campaign, however, will require, first, better data with standard contents, uniform indicators, and statistical confidence and, second, more in depth study of specific agricultural determinants, production systems, and the relationships between socioeconomic variables, on the one hand, and abiotic and biotic variables on the other. The insufficient study of poverty's rural and agricultural determinants has shackled understandings of the causes and remedies of poverty.

The successful design of poverty reduction programs will require that the better data and more thorough analyses be applied to examinations of the occupations of the poor. To be analyzed is the poverty incidence by rural occupational class, and the requirements of exiting poverty within a class, or of exiting poverty from one class to move on to another with higher incomes. The implication is that agricultural research can do much more than merely improve the enterprise returns for poor producers engaged exclusively in farming. For example, in the case of poor farmers also working in higher paying rural non-farm wage jobs, agricultural research might devise means by which on-farm labour time could be conserved so more time might be available to spend in higher paying rural non-farm positions.

2.2.2 Pilot Project for the Study of Research Priorities for Meso-America and to Consolidate Strategic Alliances Around Them

At the Mexico Meeting, the participants agreed that this project should aim to achieve the following development objectives in the region: (a) to contribute towards reducing the high level of rural poverty; (b) to raise the low levels of competitiveness of extended agriculture (namely the agro-industrial chains); (c) to offset the high rate of natural resource degradation, focusing on soil, water and genetic resources, and (d) to foster greater consistency between policies and existing institutions in general, and the demands and urgent challenges facing the agri-food sector.

In order to solve these problems a continual process of consultation and cooperation must be pursued which will achieve short term results (six to eight months) and medium term results. This implies establishing a process for debating and analysing the regional agenda as well as the longer-term priorities, to make it possible not only to formulate priorities but also to monitor the progress that is being made in terms of achieving the objectives being pursued, in a dynamic process.

In order to achieve the above, three *operational objectives* were set for this project:

a) to better define the regional research priorities, in order to develop a regional research agenda;
b) to reach a consensus among the research stakeholders in order to secure their commitment to the objectives being pursued, and to carry out concerted actions around the priorities identified (through strategic projects);
c) to help identify the role of each stakeholder in the regional strategy, including the CGIAR as one of the important actors in the region, and to strengthen the most important sub-regional and regional institutions.

The expected *outputs* of this project can be summarized as follows:

a) The regional research and technological development priorities for Meso-America will be better formulated and more sharply focused. What is new here is the way in which the various stakeholders are integrated. Even more important than drawing up the list of priorities as such, is the fact of achieving a *consensus* among all the stakeholders working in the region and the need for cooperation in order to achieve the objectives that have been set. One very important part in this process will be the strengthening of SICTA and the involvement of CATIE. It is this interaction between the stakeholders in the region around a jointly agreed/shared agenda that makes the whole process more significant.

b) The second output from the project will be the strategic frameworks that are formulated in each of the five priority areas which will make it possible to define the main activities to be implemented in each of them, and facilitate their distribution among the stakeholders involved. These strategic frameworks will also make it possible to follow-up the activities as they move forward in terms of the operational objectives that can be set for each one of these priority areas, and the progress made in attaining these objectives (impact assessment).

c) The third output is particularly important, because it deals with a portfolio of projects of strategic importance to the sub-region in the priority areas mentioned above. These projects will make it possible to convert the regional priorities and the strategic frameworks into specific activities to be implemented by groups or by consortia of research centres and interested stakeholders. The projects will be submitted to different donors and to FONTAGRO for their appraisal. It is here that joint action between FONTAGRO and the donors - bilateral and multilateral - can play a particularly important part in the process under this project, and hence in the later implementation of the research projects.

d) The fourth output has to do with the design of a CGIAR strategy for Meso-America, which is compatible with the broader framework of regional priorities that emerge from this process. The international centres have sole responsibility for drawing up this strategy, because it is a matter for their corporate programmes and policies and the decisions of the Consultative Group as such. But by doing it in coordination with this process of regional prioritization, all the parties involved will benefit. The international centres can contribute their extremely valuable experience and familiarity with the region to this regional prioritization process, as they did at the meetings in San José and in Mexico. And this forms part of a broader issue: the role of each stakeholder in developing and implementing the regional strategy.

The project considers four main *activities* for implementation:

(a) the establishment of a consensus between the stakeholders regarding the research priorities in Meso-America;
(b) the development of strategic frameworks in five priority thematic areas that have already been identified through recent prioritization efforts, which will enable the stakeholders to coordinate their activities;
(c) the preparation of a portfolio of strategic projects for the region in the high priority areas; and

(d) facilitate the development of a CGIAR strategy for Meso-America, working very closely with the CGIAR centres that operate in the region.

2.3 CGIAR Research and Poverty Reduction (SDR/TAC:IAR/01/02 Rev.1)

To implement the new CGIAR vision and strategy and the regional research approach, TAC anticipated the need for: improved understanding of the processes and conditions under which agricultural technology can be an effective instrument for poverty reduction. TAC commissioned IFPRI to take up the challenge. Consequently, a document, "*CGIAR Research and Poverty Reduction"* (SDR/TAC:IAR/01/02 Rev.1), was prepared by IFPRI (Peter Hazell and Lawrence Haddad) in consultation with TAC with the aim of describing the processes and conditions under which agricultural technology can be an effective instrument for poverty reduction. TAC accepted the report in the context of its ongoing work on priorities and strategies and prepared a commentary. The report was distributed to the Group at AGM 2001.

2.3.1 Main conclusions of the report

How can the CGIAR use its very limited resources and its specific field of expertise to attack such a vast and complex problem as world poverty? Since poverty reduction is its main mission, answering this question should be the main focus of attention for the system as a whole. Yet, and somewhat surprisingly, very little is known about this complex problem. Anecdotal evidence exists, but it does not scale up to comprehensive interpretations. A few global studies have been made, but they apply to only some regions of the world, and results need to be confirmed. The current report is consequently based on evidence that is not firmly linked in causal relations, where specific actions are presumed to have specific effects, but these largely remain to be confirmed. Yet, the information presented is state of the arts, and gives us hints of what to expect from particular technologies, in particular contexts, and for specific categories of poor. Conclusions of the report are consequently useful, even if preliminary and suggestive.

The report proceeds in the following logical steps. It:

i) Identifies the various instruments that agricultural research offers for poverty reduction:

Technological change in staple crops (the traditional approach).
Technological change in high value added crops and livestock.
Technological change for low potential areas.
Technological change for employment creation.
Technological change for improved food quality.
Natural resource management.
Participatory research methods to promote empowerment.
Biotechnology.

ii) Characterizes the context in which technology will bear on poverty through a typology of instances. The dimensions used to construct a typology are:

National context:

Low- versus middle-income countries.

Liberalized vs. policy constrained markets.

Regional context:

Quality of infrastructure.

Surplus vs. scarce labour.

Low vs. high agroclimatic potential.

iii) Enumerates the channels of causation through which technology bears on poverty.

Direct benefits on poor adopters.

Creation of agricultural employment and higher wages.

Migration opportunities from other regions.

Development of the non-farm economy.

Reduction in the price of food for consumers.

Improvements in food quality.

Empowerment through participatory research.

iv) Identifies the poverty outcomes:

Reduction in physiological deprivation (income, nutrition, health).

Reduction in social deprivation (empowerment).

At current state of the arts, linkages between these logical blocks in the reasoning are unfortunately still largely missing. As a consequence, we do not yet have a comprehensive model that we can use for predictive purposes, where changes in technological options and in the context where technology is released would, through channels of causation, affect poverty outcomes. Yet, based on current knowledge in the profession and IFPRI's expertise, the authors arrive at the following recommendations for the CGIAR to optimize the poverty reduction impact of its research efforts. These recommendations stand as conclusions for the report:

i) Focus on situations where there are expectations of scaling up for research results.

ii) Focus on geographical areas where the largest numbers of poor people live, namely Sub-Saharan Africa and South Asia.

iii) Seek research partnerships with users to adapt generic technologies to local conditions and empower poor people through participation.

iv) Pay more attention to the research opportunities on cash crops and non-ruminant livestock where the CGIAR may have comparative advantage.

v) Focus research on improving the nutrient, storage, and cooking qualities of foods.

vi) Focus on NRM problems (including socio-economic constraints) where potential for scaling up exists, including through adaptation by local people.

vii) Focus on biotechnological innovations relevant for poor farmers.

viii) Help build the capacity of NARS and Extension Systems to undertake pro-poor research.

ix) Include more explicitly the poverty reduction objective in Centres' research priority setting.

2.3.2 TAC commentary

With a perspective on the needs for further research on the technology-poverty linkage, TAC would like to offer the following comments on the report.

i) Innovative aspects of the research

The approach followed by the authors, and their ability to bring to bear a vast array of supportive information, is quite innovative. In particular, TAC would like to stress the following aspects of the research:

- *Focus on the multidimensionality of poverty: not only the income dimension of poverty, but also nutrition, health, and empowerment.*
- *Efforts to develop a typology to characterize the heterogeneity of contexts, helping to identify what technology would be most effective for which conditions.*
- *Stress the role of indirect effects of technology (i.e., go beyond only analyzing direct effects on adopters) to consider effects on employment, wages, non-farm activities, the quality of food, and the price of food.*
- *Conclusions reflect state of the arts expert knowledge.*

In such a large and complex problem, there remain many gaps which should be addressed by further research. Some important directions for research are the following.

ii) Link poverty outcomes to technology through rigorous causal relations

The conclusions offered are sensible, and in fact altogether not very surprising. The vast expertise accumulated at IFPRI lends confidence in the recommendations. And many would agree with the recommendations made based on common sense. However, to this stage, it must be remembered that conclusions do not formally derive from the analysis because linkages are missing between the building blocks used in the reasoning. Conclusions are, consequently, still speculative, as indicated by the authors themselves.

iii) Make recommendations for the CGIAR conditional on the heterogeneity of poverty and contexts

The report usefully proceeds to identify technological options through a typology that distinguishes between features of the country and of regions within the country. Optimum technological choices for poverty reduction are conditional on categories within this typology. Yet, when time comes for conclusions, recommendations are not conditional on a particular location in the typology. We should not lose sight of the tremendous heterogeneity that characterizes the poor and the conditions under which they live. Hence, in further work, recommendations for the CGIAR should be made conditional on types of poor and types of context. Global recommendations unqualified by context and expected clientele are difficult to use.

iv) Characterize the type of farm operation in establishing technological options for poverty reduction

In agrarian studies, the most commonly used characteristic on the basis of which typologies have been constructed is farm size: small part-time farms where households are strongly vested in off-farm activities, family farms where household labour is the main source of effort, medium commercial farms with a large component of family labour but strong market relations, and large commercial enterprises based on the use of hired labour. In this report, surplus labour in the region is used as a proxy for both extensive presence of landless households and of a multitude of small farms. Correspondence may not hold. African agriculture is largely smallholder, but with little landlessness. Latin American agriculture is highly dual, with both large and numerous small (minifundio) farms, and there are many landless. South Africa has a lot of landless and limited numbers of small farmers. Hence, landlessness (surplus labour) as a proxy for land distribution does not generally hold. In terms of technological priorities, not looking at the distribution of access to land across households makes us lose on the main guidelines for the definition of research priorities.

v) Determine the optimum balance between direct and indirect effects for each particular poverty-context situation

A key decision that CGIAR administrators and donors need to make is when to seek investing in research for poor smallholders to achieve direct effects on poverty, and when to seek investing in research that will benefit principally large farmers but creates indirect effects (through such effects as employment creation, higher wages, growth of the non-agricultural sectors, and a lower price of food for net buyers) that can be powerful for poverty reduction. If technologies are the same for all farms, then the dilemma does not arise. If they are not the same, which will generally be the case, then careful analysis is required. The report poses the question adequately in identifying the channels of causation through which technology can have an impact on poverty, stressing the role of indirect effects. It, however, does not give us an answer about how to set research priorities to optimally balance direct and indirect effects for aggregate poverty reduction in each particular setting. This is a research agenda that urgently needs to be assumed.

vi) Establish a balance in the roles of public and private research as sources of technology for poverty reduction

The report makes a strong pitch for increased budgets for public research as an instrument for poverty reduction. It makes original contributions in stressing the role of civil society contributions through participatory research with farmers and grassroots organizations. Insufficiently explored, however, are the roles of partnerships with the private sector, which is especially important due to:

Complementarity between public and private investments in research in achieving poverty reduction.
Declining public research budgets which are unlikely to display a major turnabout in the near future.
Intellectual property rights that limit CGIAR access to proprietary information needed for research that is held by the private sector.

Advocacy of higher public sector budgets is desirable. However, unless coordinated with private initiatives, public research is unlikely to provide the technology needed to reduce world poverty.

vii) Identify the role of private sector intermediaries in transforming CGIAR research outputs into useful products for the poor

The report gives a lot of attention to the roles of participatory research and grassroots organizations in linking CGIAR scientists to end users, and in helping adapt research outputs to the heterogeneity of poverty and contexts. In addition, the process is, interestingly, part of the product as participation helps reduce poverty through empowerment. This is certainly very important. However, this is not the way most CGIAR research outputs are transformed into useful products that reach the poor. This occurs via private sector intermediaries that make important complementary investments to transform these innovations into useful commercial products with potential to reduce poverty. These intermediaries protect their investments through patents, franchises and trade marks, trade secrets, vertical integration contracts, staying ahead of the competition through a continuing flow of new products, eventual monopoly power, etc. These strategies in turn provide the incentives necessary to induce investments in the development of useful products for the poor. It is this intermediary sector that is too often weakly developed to serve as a bridge between CGIAR scientists and poor farmers. Offices of technology transfer attached to centres could be useful for this purpose. Hence, in addition to the role of participatory research and grassroots organizations, more attention needs to be given to the emergence and performance of these private sector intermediaries in linking technology to poverty.

viii) Go beyond crops towards forests, fisheries, and livestock

The report largely focuses on agricultural research applied to crops. This reflects the fact that much past social science on technology and poverty has focused on crops. Yet, much of world's rural poverty is associated with forests, fisheries, and livestock. The CGIAR is importantly vested in research in these other sources of livelihood. They consequently require full attention in using "agricultural" research for poverty reduction.

ix) Seek better quality nutrition through both fortification and the diversification of diets

The report correctly identifies the important potential of agricultural research in improving nutrition, and IFPRI has done much pioneering work on this aspect of agricultural technology. Various options should be considered and related to the nature of poverty and malnutrition. They include biotechnology and the fortification of food through insertion of new traits, as emphasized in the report. However, more emphasis could be given to achieving better nutrition through the diversification of diets via integrated farming systems, well functioning food systems, and nutrition education. Careful balance between these approaches need to be sought for each particular context.

x) Other research themes in the technology-poverty relation

As we have shown, the paper makes important contributions to a better understanding of the technology-poverty linkage. Fair to say, however, is that we still have a lot of ground work research to do to rigorously establish causal linkages before firm conclusions can be

offered. Current case studies on the technology-poverty relation being developed at IFPRI for TAC-SPIA should go a long way in this direction. In addition, formal modelling efforts may be needed to capture linkages more rigorously. Future research should also stress the following dimensions of the technology-poverty linkage:

a) Focus on a regional approach to research priority setting and to attacking poverty

A regional approach helps coordinate technology with the actions of other development agents in the region to jointly: (1) set regional research priorities to provide new technological options and (2) work on removing the household (control over assets) and contextual deficiencies (policies, public goods, and institutions) that block the adoption of the new technologies. In other words, a regional approach allows to endogenize as policy options the features of the context which are taken as exogenous in typology construction. In so doing, it multiplies the set of instruments available to combat poverty and gives greatly enhanced value to the potential role of agricultural technology in poverty reduction.

b) Focus on the vulnerability dimension of poverty

The report lumps vulnerability with empowerment. Empowerment may be an instrument for reducing vulnerability, but there are many other instruments to do this, and technology has a role to play. For instance, if global warming is to increasingly destabilize weather patterns, management of abiotic stress will be an increasingly important dimension of household strategies. Putting into place farming systems that are more resilient to climatic shocks, and yet sacrifice a minimum of expected income in achieving more stable yields, should be an integral dimension of strategies using technology to reduce poverty.

c) Focus on the technological support to household livelihoods

The report does a good job in shifting the approach to rural poverty reduction from a focus on agriculture and farms, to a focus on households and livelihood strategies. Rural households are typically involved in a multiplicity of activities that help deploy more effectively their labour endowments and protect them from risks. Yet, this holistic vision of livelihood strategies still needs to be translated into pragmatic guidelines in establishing agricultural research priorities. For the moment, there remains a gap between holistic visions and the practice of allocating resources to agriculture research.

In conclusion, TAC thanks IFPRI for taking on this difficult task and praises the authors for the comprehensiveness of their report and the innovations they have made in researching the theme. TAC stresses the urgent need to proceed with further research on the technology-poverty linkage to help better allocate scarce resources for maximum impact of the CGIAR on world poverty reduction.

2.4 A Regional Approach to Setting Research Priorities and Implementation: Towards Satisfying National, Regional and International Concerns? (SDR/TAC:IAR/01/21)

TAC also anticipated the need for a set of guidelines for setting regional research priorities and their integration with global research priorities. TAC requested ISNAR to take up the challenge.

Consequently, a document, *"A Regional Approach to Setting Research Priorities and Implementation: Towards Satisfying National, Regional and International Concerns?"* (SDR/TAC:IAR/01/21) was prepared jointly with ISNAR by Willem Janssen, Amir Kassam and Alain de Janvry with the aim of formulating a set of guidelines for setting regional research priorities, taking into account challenges and concerns highlighted at national, regional and international levels. The report was also distributed to the Group at AGM 2001.

The paper outlines an approach to sub-regional priority setting from the bottom up. It is based on earlier experiences with regional priority setting and research planning in general. Establishing priorities is by itself not an easy activity (though some of the available methodologies have not contributed to making it easier). The process would be complex enough if it were done for one organization, which controls the resources that it wishes to allocate through the priority setting exercise.

The process is complicated by the fact that it is not about allocating resources but about attracting resources and by the fact that it is not for one organization but for many, very different organizations. The implicit challenge in regional priority setting is to arrive at an outcome or a compromise acceptable to all participants and through which most or all participants can be better off. In addition, if the outcome is attractive new organizations may be interested to contribute to the regional agenda. If the outcome is not attractive, a lot of time, credibility and willingness to collaborate will have been wasted.

One of the major risks in setting regional priorities is that the level of detail is such that possible regional partners could be excluded. The regional agenda that comes out of the priority setting exercise must be like a painting made with a large brush, in a simple composition with attractive colours. Otherwise it will not draw the attention of research institutes, funding agencies, and development organizations and will not contribute to sustainable and equitable development.

The CGIAR can benefit from the regional priority setting exercises in the following ways:

1. The outcomes of the different priority setting exercises can be integrated in the CGIAR efforts to identify Challenge Programmes.
2. The CGIAR Centres may analyse how their priorities relate with the priorities of the region.
3. The CGIAR might use the regional priorities to define its strategy for each of the regions.

A central issue in the interaction between sub-regional priorities and the CGIAR Centres is poverty alleviation through raising real incomes of producers and consumers, and generating rural employment leading to improvement in sustainable food security and resource management.

Through the regional approach to research envisaged in Plank 4 of its new vision and strategy, the CGIAR aims to make its research priorities demand and impact driven and to improve the international division of labour in planning and implementing international public goods research. That subset of regional priorities that can meet CGIAR strategic criteria will be of potential interest to the CGIAR for inclusion in its agenda. Because there are large areas of coincidence in objectives and modus operandi, there is ample scope for

collaboration between NARS, regional organizations and the CGIAR in the definition and implementation of research agendas. Each group of organization is, however, pursuing objectives that are not the same. In addition to regional objectives, the CGIAR is pursuing objectives at the global level which are not simply the aggregation of regional research needs. Within a region, the CGIAR will be pursuing objectives that are partly, and potentially largely, coincidental with national and regional objectives, but also partly distinct.

The integration of CGIAR regional and global priorities and making adjustments and balancing at the inter-regional and global level will most likely occur over time as an ongoing process. It will be that subset of regional priorities that are consistent with CGIAR goals that will be of interest to the CGIAR. The subset of regional priorities would have gone through an appropriate joint evaluation by the CGIAR Centres at the regional level for incorporation into Centres' joint and individual programme portfolios. The further sorting of these priorities at the next level (inter-regional and global) would not be possible as a one time exercise for all the regions together because each sub-region will have its own planning cycle. This is the so called Phase II of the bottom-up exercise, the integration of regional priorities into the CGIAR global research agenda, Phase I dealing with the identification of the comprehensive set of regional priorities by the regional stakeholders and the identification of a subset by CGIAR Centres and their NARS partners. TAC has highlighted this as an area where there is little experience in the System. The challenge for the CGIAR is to determine how to maintain a global focus in its agenda while promoting a coordinated regional approach to research planning and implementation.

2.5 Some Challenges as Reported by TAC to the Group at AGM 2001

Since the report at MTM, additional challenges came to light with regards to establishing a multi-stakeholder regional approach to research planning focussed on poverty alleviation. These were presented as follows to the Group at AGM 2001 in the *"Progress Report on Regional Approach to Research"* (SDR/TAC:IAR/01/32).

The regional approach to research planning and priority setting was meant to complement the global commodity/thematic approach which has hitherto characterized research planning in the CGIAR. With the new focus on poverty alleviation, a regional approach was thought to be more likely to capture the complexity and heterogeneity of poverty and thereby help the CGIAR Centres and their NARS partners better target their technology generation and policy formulation activities to the needs of the poor. By bringing the NGOs, farmers, the private sector and the national and regional development agencies around the planning table, the research priorities and strategies can be better articulated and aligned with the needs of the farmers, with the strategy of extension agencies and investment decisions of the national and regional development agencies as well as the private sector.

The NARS and their regional organizations and the Centres have taken up the challenge and simultaneous consultations are now underway in the different regions. Experiences so far highlighted the following problems and opportunities:

- How best to introduce the perspectives of NGOs, farmers' associations, and the private sector into the planning process?
- How to align major investment decisions in agricultural and rural development with research activities and/or structure research to support investment decisions?

- How to integrate agriculture planning with fisheries and forestry whose research organizations conventionally are independent of agricultural institutions?
- How to tackle the methodological issues of linking technology with poverty; of poverty mapping and synthesizing global priorities out of the identified regional priorities?
- How the regional exercises should feed into and influence the heartland agenda of the CGIAR Centres and the articulation and development of Challenge Programmes?
- Given the high transaction costs of establishing and sustaining multi-stakeholder processes, how should these be supported to maintain momentum, effectiveness and cost-efficiency?

The enthusiasm with which the NARS and the CGIAR Centres have approached joint research planning is an essential first step. But the full benefit of the regional approach can be attained only with participation of the farmers themselves, of the private sector and the development and investment agencies. There are enormous process and methodological hurdles to be overcome which are enumerated further in the ISNAR-TAC discussion working document "*A Regional Approach to Setting Research Priorities and Implementation: Towards Satisfying National, Regional and International Concerns?"* (SDR/TAC:IAR/01/21). The support of the donors is crucial in the days ahead.

3. Developments During 2002

Since AGM 2001, TAC and then the iSC focussed its efforts in facilitating the regional consultation process in sub-Saharan Africa region, while keeping a watching brief on regional consultation activities in the other regions. In particular, as a contribution to the consultation process in the West and Central Africa subregion, and in collaboration with GFAR and CORAF, the iSC commissioned two studies to examine the causes of low impact of agricultural research in the subregion and possible solutions leading to improved future performance, from two perspectives – national and international. Two consultants were hired to work with the iSC Standing Committee on Priorities and Strategies (SCOPAS) to conduct the studies. SCOPAS provided the terms of reference for the studies. Dr. Willem Stoop examined the agricultural research performance from a national perspective and Dr. Lukas Brader from an international perspective. Syngenta Foundation provided support to the Mali portion of Dr. Stoop's work.

Dr. Stoop's report is given in Annex I, entitled *"A study and comprehensive analysis of the causes for low adoption rates of agricultural research results in West and Central Africa: possible solutions leading to greater future impacts: The Mali and Guinea case studies"* (SDR/iSC:IAR/02/21).

Dr. Brader's report is given in Annex II, entitled *"A Study about the Causes for Low Adoption Rates of Agriculture Research Results in West and Central Africa: Possible Solutions Leading to Greater Future Impacts"* (SDR/iSC:IAR/02/22)

The iSC at its August 2002 meeting discussed the two reports. The iSC believes that these studies should be given maximum visibility as they bring new ideas to a problem still in great need of good diagnostics and new approaches. They will also be useful in providing guidelines in defining CPs for sub-Saharan Africa. Therefore, the iSC requested SCOPAS to prepare a commentary on the two reports, which is presented in Section 4 below.

4. The iSC-SCOPAS Commentary on the Stoop-Brader Reports

Two studies about the causes of low impact of agricultural research in West and Central Africa: Possible solutions leading to improved future performance

The iSC asked Drs. Willem Stoop and Lukas Brader to propose independent interpretations as to why the past products of agricultural research in West and Central Africa have had limited impacts on the performance of agriculture and on poverty reduction, and to suggest ways ahead to remedy this situation. The two separate reports that were submitted provide deeply provocative statements about what went wrong with the way (1) agricultural research has been conducted and (2) the results of agricultural research have been used by farmers. They propose well reasoned alternative approaches to remedy the current situation. The reports were jointly sponsored by iSC and the Syngenta Foundation. Drs. Stoop and Brader are some of the very best experts on agricultural research in Africa to address these issues, having worked for many years on the subject. Their two documents offer sharply contrasted yet complementary interpretations. They should help make fundamental contributions to reconsidering approaches to agricultural research in Africa at a time when new approaches are being sought by CORAF, GFAR, and the CGIAR, particularly in the context of the definition of Challenge Programs for the region. The documents should be widely debated by NARS in the region, the CGIAR, and among people and institutions interested in agricultural research and poverty in Africa.

(i) The Stoop report

a. The proposed interpretation

The main thesis advanced by Stoop is that low impact is due to low adoption. Limited adoption is in turn due to the fact that the wrong model was used for the generation and diffusion of technological innovations. According to Stoop, the model that was applied to Africa is an uncritical transposition of the standardized improved varieties cum chemicals blueprint that was successful in achieving the Green Revolution in Asia. In that case, the release of new varieties in a sufficiently homogenous agro-ecological context and with generally adequate markets, supportive institutions, and policies led to rapid adoption, initially by the more commercial farmers, but eventually by the mass of smallholders as well. Improved technology was the missing element needed to make a quantum jump in yield and income levels. These conditions do not, however, hold in Africa. There, the huge diversity and variability of local ecological, socio-economic, cultural, and policy contexts and conditions invalidates a standardized approach. In addition, there is general weakness of NARES and significant deficiencies in markets, institutions, public goods, and policies, with the implication that innovations need be robust to these deficiencies. What is needed for Africa is consequently a different research-extension paradigm. Without this different approach, tailored to the specificity of African conditions, technologies released will not be of the right type and will consequently not be extensively adopted.

What is this alternative paradigm? What Stoop proposes is a participatory learning process, where research is conducted in partnership with producers' organizations and

through extensive on-farm experimentation. Local participation would help mobilize information about the huge heterogeneity and complexity of conditions and constraints under which farmers operate, continuously adapt innovations to these diverse and variable conditions, and create ownership of the innovations thus facilitating diffusion. The process would also help increase local capabilities and develop entrepreneurship. A participatory approach to research is of course not new. However, Stoop is critical of the way the approach has been used in Africa and in other parts of the world, with insufficient experimentation and analysis to determine best practice under different conditions. Given weakness of national-level research systems and existence of economies of scale in many research undertakings, a regional approach to research coordinated by CORAF and with a division of labour between autonomous NARES and CGIAR centres is deemed highly desirable.

b. Comments on the proposal

The proposed alternative approach to research and extension in West Africa is quite appealing and certainly deserves consideration and further analysis. A problem, however, in the way the argument is developed is that it tends to create a sharp opposition between two paradigms, the bad and the good. Since there is no systematic use of empirical evidence in this brief report, the relative merits of alternative paradigms may not be sufficiently nuanced, with in particular the risk of creating a negative construct called the "Green Revolution paradigm" that does not recognize localized success stories and heterogeneity in impacts. Are there positive lessons that could be derived from the Green Revolution approach? Could this approach work better for some countries (e.g., where fertilizer prices are competitive with international market prices and where transactions costs in bringing modern inputs to the farm are low), regions (e.g., more homogenous irrigated areas; areas with a higher density of institutions and public goods in support of competitiveness), types of farmers (e.g., more commercial farmers), and classes of commodities (e.g., major grains) than the alternative approach would? While the report stresses the great heterogeneity of farmers' circumstances across Africa, it may also need recognize a continuum of applicability between two extremes, the "Green Revolution paradigm" and the "participatory learning paradigm", instead of wholesale displacement of one by the other. In fact, the core of the issue may be to precisely identify the conditions under which one approach is more effective than the other.

Constraints to adoption may indeed come not from the research-extension system used that delivers inadequate technologies, but from deficiencies in the context where technologies are released. This includes such factors as extensive market failures (high transactions costs, missing institutions for credit and insurance), low educational and health levels of farmers, inadequate land tenure systems, lack of investment in public goods such as infrastructure, policies biased against agriculture, etc. As a consequence, there may be insufficient balance in the argumentation between what comes from the supply side of technologies (inadequate research and extension systems) and what comes from constraints on demand (low quality assets, market failures, institutional gaps, under-investment in public goods, and biased policies). Is the greatest payoff to be obtained from fixing the research-extension paradigm to adapt it to an adverse context, or from fixing the context where it is being applied? If fixing the context is important, then coordination of investments in research with other development interventions at the national and regional scales are fundamental. This means that it is not only agricultural research that needs to be coordinated at a regional scale (role of CORAF), but also the potential contributions made by research and by other investments such as education, infrastructure, etc. If this is the case, then the set of participants involved in

coordinating the effective use of agricultural innovations for development needs go beyond the traditional agricultural interests.

The report proposes a vision of evolving agricultural systems in Africa to be assisted by agricultural research. The vision is that agriculture needs to undergo a classical transformation from subsistence agriculture to large scale, mechanized, modern, commercial agriculture. However, one can doubt whether this vision can apply to the vast majority of African farmers. Implementation of the vision would lead to massive displacement of rural inhabitants toward urban environments where they would work in manufacture and services. Land could then concentrate into a few large mechanized farms. For the bulk of other farms, however, the needed transformation may well be quite different. One can envisage a large number of small family farms, competitive on agricultural markets, but also involved in a multiplicity of other activities, thus helping households out of poverty. As Thomas Reardon from Michigan State University has evidenced, even in Africa at a low level of industrial development, some 40% of farm households incomes are earned in non-agricultural activities. These small farms may use modern technology, and hence be good clients for agricultural innovations. They may well focus on high value crops, non-traditional exports, quality goods, niche markets, etc. Hence, there is another vision for the transformation of African agriculture that may be more consistent with current trends and with better prospects for poverty reduction. Implications for agricultural technology are important, in particular focusing on labour intensive farming systems as opposed to mechanized farming. There are also important implications for the management of rural development programs from a regional perspective, with an important role for local organizations. In any case, the two visions are not mutually exclusive. But, in this cohabitation, the latter is likely to be quantitatively more important than the former in a poverty reduction perspective. If CGIAR research is targeted at poverty, the technological needs of these small, pluri-active farmers cannot be neglected.

The report gives interesting data contrasting adoption rates between favoured areas (irrigated) and marginal environments (rain fed). The observed difference would deserve careful analysis. Does low adoption in rain fed environments come from unfit technologies for the more heterogeneous conditions that characterize them (corresponding to the thesis advanced by Stoop, i.e., the supply side of technology) or does it come from low profitability in adverse environments and binding other constraints (such as insurance and credit market failures, high transactions costs, low education), and hence low demand? Identifying the relative roles of these two causes of low adoption is key. If the first dominates (the author's thesis), then a new research-extension paradigm is indeed necessary. If the second dominates, then a more comprehensive approach to investment in research that coordinates research with investments and reforms aimed at relaxing these other constraints is necessary.

Stoop concludes his analysis of past impacts of agricultural technology (conclusion 4) by saying that: "The major international trade policies and the proposed yield increasing technologies have had mostly adverse effects on alleviating poverty". This is a strong statement, not founded on supporting evidence. Have yield increasing technologies been a <u>cause</u> of poverty? That they have been ineffective in reducing poverty may be easier to admit. But that they have had adverse effects on alleviating poverty would need to be evidenced if maintained. In addition, surely there is heterogeneity in impact. Can yield increasing technology be universally blamed for increasing poverty?

Stoop further concludes that: "The richer segments of the population will always be better positioned to profit, and therefore the gap between rich and poor is widened". This also is a strong statement. Is yield increasing technology necessarily regressive? One of the progressive effects of yield increasing technology is through reduction in the prices of staple foods. This is particularly important in Africa, where most staples have low tradability. Most poor people spend a high share of their budgets purchasing staple foods, and this includes many rural poor. In addition, while there typically is a lag in adoption between rich and poor (that should be of serious concern), the expectation for the CGIAR is that yield increasing technology can indeed be effective for poverty reduction. Again, heterogeneity of impacts needs to be carefully considered.

As the author indicates, the modernization of agriculture will need more than technology and subsidized inputs. Call is made for improved transportation, effective national research and extension services, higher investments in education, etc. This is precisely why a coordinated approach to rural development is needed. Not clear is how this would be done. CORAF coordination of regional research efforts is necessary, but may be insufficient to reach into these other dimensions. Yet, it is true that high payoffs from investments in research depend on these other investments. It would be useful to explore how investments in agricultural research can thus be coordinated at national and regional scales with these complementary investments without which adoption rates will remain low. Since much emphasis is placed on the coordinating role of CORAF, this may be a good opportunity to stress the need for CORAF to open its doors to broader partnerships in coordinating regional development efforts.

The critical review of participatory approaches in development-oriented research is welcome. Yes, the participatory approach has much promise and has been heralded in the CGIAR as an fundamental innovation to make research more effective for small farmers, but there has been insufficient experimentation with identification of best practices. Making the most of the approach will require more than improving the interviewing techniques of senior scientists, giving them training in the social sciences, and improving logistics so they can spend more time in the field. The whole approach needs to be treated as a research topic in itself, experimenting systematically with features of the approach so it be optimally adapted to various contexts and needs. In addition, the participatory approach should not be just an appendix of research, but should be fully integrated into the definition of research strategies (comprehensive development frameworks) and the allocation of Centre budgets to research areas (see the recent discussion by Byerlee and Alex on pro-poor R&D).

(ii) The Brader report

This also is a very important paper that provides a well informed interpretation of the reasons why agricultural research in West and Central Africa did not have more impact on aggregate yields. In writing this paper, Brader not only makes use of his considerable personal experience with agricultural research in Central and West Africa, but also engages in a systematic review of research done by others in the region. Results reveal that new technologies were in fact widely adopted. The proposition is made, however, that inability for farmers to access the modern inputs (principally fertilizers and chemicals) complementary to high yielding seeds prevented them from deriving full benefits from research. Low impact of adopted technologies places central responsibility on the role of the state, calling on better policy-making for agriculture, more investment in public goods, more support for national public research systems, and more promotion of producers' organizations and the private

sector. For the CGIAR, recommendation is made for more downstream and participatory research given weakness of NARES and the private sector in the region. This rejoins the recommendations made by Stoop.

(i) Criteria to assess research contributions

A central observation in Brader's argument is that high adoption did not translate correspondingly into large yield gains. Most of the output gains during the last forty years have been due to area expansion, not to yield increases. Data presented are quite telling in support of this observation. Results are summarized in the following table, decomposing observed output growth between what is due to yield gains and what is due to area expansion. Most of the growth, even in the 1980s and 1990s, was due to area expansion. Only for maize in Central Africa did a third of observed output growth in the recent period originate in yield increases. According to these data, contributions of yield to output growth have been insignificant for maize in Nigeria and for cowpeas in all regions. Clearly, if the main outcome of successful research is to be growth in yields, much of the research in the region was indeed ineffective. As possibilities of area expansion are more and more compromised by exhaustion of uncultivated land, seeking greater yield impacts from research will be increasingly important.

	Average annual growth rates (%)			% contributions to production growth		
	Area	**Yield**	**Production**	**Area**	**Yield**	**Production**
Maize Central Africa						
1962-1980	5.2	-0.9	4.3	121	-20	100
1980-1998	6.7	4.1	11.0	61	37	100
Maize, West Africa						
1962-1980	-3.5	3.2	-0.3	1016	-946	100
1980-1998	23.0	5.9	30.2	76	19	100
Maize, Nigeria						
1962-1980	-15.3	7.6	-8.9	173	-86	100
1980-1998	47.0	0.1	47.2	100	0	100
Cowpea, West Africa						
1962-1980	-0.9	6.4	5.5	-16	117	100
1980-1998	23.9	-0.8	22.9	104	-4	100
Cowpea, Nigeria						
1962-1980	-6.2	7.3	0.6	-976	1150	100
1980-1998	25.6	1.8	27.8	92	6	100
Cowpea, Niger						
1962-1980	13.5	13.6	28.9	47	47	100
1980-1998	23.0	-10.2	10.5	220	-98	100

The contradiction observed by Brader between "high adoption and low yield impacts" suggests, however, that yield gains may not have been the main objective of research. Indeed, if most output gains were due to area expansion into new lands, it may well be that expansion could not have happened without research helping adapt new varieties to environments where traditional varieties would have had poor performance. This is suggested for instance in the results reported from Aedsina et al. (1997) who observe that "the availability of early maturing varieties has allowed maize production in the semi-arid zones of Burkina-Faso, Mali, Niger, Senegal, and Guinea to grow phenomenally... Most of the growth has been due to area expansion."

There consequently is a need to take a broader look at what agricultural research has been offering, in particular, beyond potential yield gains that would only materialize if matched with access to modern inputs. Other gains from research in the region include:

i) Adaptation of maize and cowpea varieties to new environments, enabling area expansion.

ii) Hidden yield gains: Area expansion of a particular crop may occur in substitution for cultivation of other crops in good lands (e.g., maize displacing sorghum), but it may also occur by incorporating increasingly marginal areas into production. In this latter case, area expansion would have resulted in declining yields had it not been for research. Hence, the observed stagnant yields need to be compared not against previous average yield levels but against the counterfactual of yields that would have been observed with expansion into marginal areas without research. Alternatively, yields need to be compared over time on the same, not an expanding, land area. This counterfactual is still to be established.

iii) As recognized by Brader, gains in pest resistance, helping stabilize yields and reduce risks, are very important for poor farmers with high risk aversion and with little access to chemical pesticides due to credit constraints, high transactions costs on markets, and bad policies.

iv) Yield stabilization through higher drought resistance.

v) Cost reduction through improved farming systems, with in particular nitrogen fixation by leguminous species of crops or trees benefiting cereals.

vi) Fodder production as a by-product of improved varieties (e.g., dual-purpose cowpeas).

v) Quality improvements in cereals.

Many of the interesting stories told in the report suggest that a broader assessment needs to be made of the contributions made by research in the region. Low gains in yields do not imply that research has not made valuable contributions. These contributions, however, remain in need of systematic evidence against the counterfactual of what would have happened without this research, following good impact analysis methodologies. Measuring yield impact is the easiest to do through official statistics. These other dimensions are harder to evidence, yet they may have been the main contribution of agricultural research and explain widespread adoption in spite of low observed changes in yields. Doing this analysis is in itself an important research undertaking.

(ii) Fixing the policy context and relaxing constraints on efficient use

The central thesis for the interpretation of the observed "high adoption-low impact" dilemma is that the policy, public investment, and institutional framework did not provide farmers with access to the complementary goods and services needed for them to take full advantage of the yield potential of the adopted new varieties. Macroeconomic policies (in particular appreciation of the real exchange rate and trade liberalization in distorted international markets) were detrimental to agriculture, investments in national research and

extension services were woefully inadequate, transactions costs on markets were very high due to poor infrastructure, modern inputs were excessively priced (often due to import tariffs to protect national industries and to raise fiscal revenues) or not available, the private sector was not present to replace declining public sector services, and farmers' educational and health levels are insufficient to sustain a productive agriculture. This is indeed the heart of the matter. There are two alternative responses to this dilemma in making the contributions of agricultural research to poverty reduction more effective.

One is to admit that these conditions are, in the short-medium run at least, largely structural and hence here to stay, and to adapt research to these conditions, making yield impact robust to these adverse conditions. This is what is suggested in the last part of the report: to direct the CGIAR to work more downstream in Africa as opposed to other regions, to rely more on the role of producers' organizations and participatory research, to give a more prominent role to NGOs, and to develop farming systems less demanding in purchased inputs, where technology substitutes for these inputs for as long as they are out of reach for farmers. Since both hunger and bad policy are here today, there may indeed be short run impacts that could be obtained through this strategic redefinition of how research is done and what products it aims at obtaining.

The alternative response, also present in Brader's paper, is to seek a broader regional approach to research that coordinates what agricultural research can do for poverty reduction with what other development agents in the region can contribute. This requires better coordination between research priorities and donor and government interventions on other fronts: macroeconomic and trade policy scrutinized through a "rural lens" (as in Canada) for their expected impacts on rural interests, investments in infrastructure to reduce transactions costs, development of institutions (credit, insurance, extension, market intelligence) in support of the competitiveness of small farmers, investments in the health and education of rural populations, coordination of investments in NARS and CGIAR research projects, etc. There is no deficit of foreign aid in support of poverty reduction, and more could be obtained if it were used more efficiently. However, there still is a clear lack of coordination between investments in agricultural research and investments in the determinants of greater impacts from the adoption of improved agricultural technology. This is beautifully clear in Brader's report. The implication is the urgent need to reconsider the way these investments are made and coordinated. Questioning which regional and national institutions could provide this coordination is at the forefront of a solution in overcoming the dilemma of "high adoption and low impacts". Perhaps it is this response to the dilemma so clearly identified in Brader's report that needs much further elaboration. A plan of action as to how to get started on this is badly needed.

Both responses are of course complementary, would it only be of necessity in a time dimension. Yet, again, an explicit strategy for the CGIAR and for the region is urgently needed to establish the relative weights of the two lines of action.

(ii) The road ahead: lessons derived from the two reports

The Stoop and Brader reports give us perceptive diagnostics on what went wrong with agricultural research in Central and West Africa, and give us important recommendations for the road ahead. Both question the uncritical transposition to Africa of the Green Revolution model that was effective in other parts of the world. This model offered new HYVs that could apply over larges expanses of relatively homogenous lands in contexts that were readily

favourable to adoption (adequate markets, policies, public goods, and institutions). Delivery of passepartout technologies, intensive in purchased inputs, did not work for Africa.

According to Stoop, this is because the vastly heterogeneous farming conditions encountered in Africa required a different approach to research, anchored in strong producers' organizations and based on participation. Only in this fashion could information about the specificity of local needs and constraints be revealed. While the CGIAR has pioneered participatory research, this has not been pursued sufficiently systematically: experimentation with best practice has not been pushed far enough, and demands for innovations deriving from participatory approaches have not been sufficiently internalized into overall centre research priorities and budget allocations. Promotion of strong producers' organizations and decentralized research done in partnership with these organizations and with NARS are thus necessary.

According to Brader, research on new varieties and new farming systems has delivered technological innovations that have been widely adopted. Yet, impact on yields has been modest due to the adverse contexts in which African farmers operate. Economic policies are biased against agriculture, markets are atrophied and burdened with high transactions costs, investments in rural public goods are lacking, and fundamental institutions, both public and private, in support of farmer competitiveness are missing. As a result, new seeds were adopted without the use of complementary inputs. Key is consequently to seek interventions complementary to agricultural research that will construct a context more germane in helping farmers derive yield benefits from the technologies they have so widely adopted. National policy and institutional reforms that support the competitiveness of African agriculture are urgently needed. It is also the rationale for a regional approach to agricultural research that coordinates investments in research with other investments that will complement research in making it effective to help reduce poverty.

The two perspectives offered by Stoop and Barder are complementary. For the CGIAR, NARS-GFAR, and regional organizations, the research agenda that derives from these two perspectives should be clear. On the one hand, reconsider the current research strategy to develop a new approach, better tailored to the diversity and variability of conditions, the weakness of institutions in Africa, and capitalizing on the potential for a regional approach. On the other hand, approach agricultural research from a broader perspective that coordinates what agricultural research can do for poverty reduction with the complementary interventions in the fields of policy reforms, public goods, and institutional innovations needed to make it more effective. Both approaches are complementary for two reasons. One is that the dominant limiting factor to success can be one or the other in particular places and times according to circumstances. The other is that neither approach can be sufficient alone. Reforming the way research is done can help make it more adequate to the conditions under which research results are ultimately made available for adoption. Reforming contexts can make adoption more profitable and more yield-increasing. For many farmers, constraints on adoption will remain severe because of market failures that uniquely and differentially apply to them. As a result, an approach to research that can accommodate the specificity of these conditions will always remain important, even after successful policy and institutional reforms have been implemented.

The two reports give us fresh perspectives in defining a new approach for agricultural research in Africa. They should be carefully taken into account by the CGIAR, regional organizations, and NARES in the region in pursuing this important task.

5. Concluding Remarks

The lack of CGIAR support to the pilot experiment in Central America has led to a loss in momentum and enthusiasm from the regional and sub-regional organizations in organizing and engaging in multi-stakeholder consultation processes for research priority setting. However, planning activities of the various Challenge Programmes have provided some impetus to the process of integrating regional priorities with CGIAR priorities. This integration process could be strengthened and sustained if one regionally driven Challenge Programme initiative from the current batch of CPs in the regular process is supported by the CGIAR. There is evidence that some CGIAR donors would be willing to provide support to competitive research with a regional perspective which would facilitate the implementation of Plank 4.

In this regard, continuing effort will be required by the CGIAR Centres, GFAR, and the regional and subregional organizations to strengthen and sustain multi-stakeholder planning and priority setting processes at subregional levels. Regional research priorities for international public goods research should be of interest to CGIAR and its regional partners for collaborative research. It would be important for the CGIAR to provide support to such collaborative research, particularly where regional partners are willing to contribute resources and willing to develop multi-stakeholder planning activities involving the farmers, the private sector and the development and investment agencies. Systemwide and Challenge Programmes are effective mechanisms to promote the integration of regional priorities with CGIAR priorities for international public goods research.

Studies such as those by Drs. Stoop and Brader should prove to be very useful for regional priority setting, and have indeed already been discussed by CORAF. They provide a sound basis for improving agricultural research planning and implementation. The iSC suggests that such studies need to be conducted by the Centres in collaboration with their regional and subregional partners in all subregions so as to improve the relevance, quality and impact of agricultural research.

The future Science Council should continue to commission such studies for other subregions, particularly for Eastern and Southern Africa, South Asia and the Andean sub-region. In each case, these studies should be prepared by people with considerable knowledge of the subregion/region and also great familiarity with the way the CGIAR works. The Stoop-Brader studies have shown clearly that there is a need for better ways of assessing impact of agricultural research. Centres and their NARS partners are in a unique position to be able to monitor the impact process in a disaggregated fashion so that the CGIAR is able to obtain a more accurate picture of what is working and what is not. The future Science Council should facilitate the development and implementation of such methods.

Annex 1

***"A study and comprehensive analysis of the causes for low adoption rates of agricultural research results in West and Central Africa: possible solutions leading to greater future impacts: The Mali and Guinea case studies"* (SDR/iSC:IAR/02/21)**

Willem Stoop

SDR/ISC:IAR/02/21
iSC Working Document

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Interim SCIENCE COUNCIL

A Study and Comprehensive Analysis of the Causes for Low Adoption Rates of Agricultural Research Results in West and Central Africa: Possible Solutions Leading to Greater Future Impacts

The Mali and Guinea Case Studies

iSC SECRETARIAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Preface and Acknowledgements

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The author has considered this study as a unique opportunity after having worked much of his professional career in close association with the West African region. Having graduated in 1969 as soil scientist from the Wageningen University (The Netherlands), he started as rubber agronomist in Liberia, with subsequent assignments as agronomist for ICRISAT in Burkina Faso and later for ISNAR and for KIT (Royal Tropical Institute – Amsterdam) as senior research officer on regular support missions to the NARS of Burkina Faso, Mali, Niger, Guinea and Ivory Coast. During the last few years he became involved with WARDA as an interim Director of Programs and with the National agricultural research institute (IRAG) of Guinea in designing a link between the national research and development/extension interventions through an on-farm/systems research program.

So all together, many institutions and many people have contributed in one way or another to this report.

Willem A. Stoop

Driebergen, 20 March 2002

List of Acronyms

CGIAR	Consultative Group on International Agricultural Research
CMDT	Compagnie Malienne de Développement Textiles
CNRA	Comité National de la Recherche Agronomique
CORAF	Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles
CRA	Centre de Recherche Agronomique (Guinée)
CRRA	Centre Regional de Recherche Agronomique (Mali)
CRRD	Comité Régional de Recherche – Développement (Guinée)
CNU	Comité National des Utilisateurs (Mali)
CRU	Comité Régional des Utilisateurs (Mali)
DGIS	Directoraat Generaal Internationale Samenwerking
DNAMR	Direction Nationale de l'Appui au Monde Rural (Mali)
DNRA	Direction Nationale de la Recherche Agronomique (Guinée)
DRAMR	Direction Régionale de l'Appui au Monde Rural (Mali)
FIDA	Fond International pour le Développement Agricole
FRAO	Fondation Rurale de l'Afrique de l'Ouest
FFS	Farmer Field School
FPFD	Fédération des Producteurs de Fouta Djallon (Guinée)
GDRN	Gestion et Développement des Ressources Naturelles (Mali)
GTZ	Gesellschaft für Technische Zusammenarbeit
IARC	International Agricultural Research Center
ICRAF	International Center for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-arid Tropics
IER	Institut d'Economie Rurale
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IRAG	Institut de Recherche Agronomique de Guinée
ISNAR	International Service for National Agricultural Research
ISRA	Institut Sénégalais de Recherches Agricoles
ISRIC	International Soil Reference and Information Centre (Wageningen)
IVC	Inland Valley Consortium (WARDA)
KIT	Royal Tropical Institute
MDR	Ministère du Développement Rural (Mali)
NARS	National Agricultural Research System
NARES	National Agricultural Research and Extension System
NGO	Non-Governmental Organizations
OdN	Office de Niger (Mali)
PASAOP	Programme d'appui aux Services Agricoles et Organisations Paysannes
PNRA	Projet National de Recherches Agronomiques (Mali)
PNSA	Projet National de Services Agricoles (Guinée)
PNSR	Projet Nationales des Services Ruraux (Guinée)
PNVA	Projet National de Vulgarisation Agricole (Mali)
POP	Promotion Organisation Paysannes
PSA	Projet Services Agricoles (Guinee)
R and D	Research and Development
RYMV	Rice yellow mottle virus
SG 2000	Sasakawa Global 2000

SLACAER	Service Locale Aménagement Equipement Rural
SNPRV	Service National de Promotion Rurale et de Vulgarisation (Guinee)
SSA	Sub-Saharan Africa
TAC	Technical Advisory Committee
T + V	Training and Visit extension system
URDOC	Unité de Recherche Développement Observatoire du Changement
WARDA	West African Rice Development Association
WTO	World Trade Organization

Executive Summary

The study was conducted at the request of TAC and in the context of the new Vision and Strategy of the CGIAR. A major element of this strategy is an increased emphasis on a regional orientation in research planning and implementation. This report aims at providing elements of a coordinated regional research approach for the West and Central African Region. The study has been financed jointly by TAC and the Syngenta Foundation for Sustainable Development.

The terms of reference for the study specified the following aspects:

- the appropriateness of currently available improved technologies given the agro-ecological and socio-economic conditions in the region,
- the efficiency of the present technology transfer mechanisms in widely reaching the producers,
- the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies, and
- the implications of the above issues for the new CGIAR regionalisation strategy, leading into recommendations towards an increased impact of its future research efforts.

The study is being implemented in two parts:

- at the level of *international centers*, active in the West and Central African Region (IITA, WARDA, ICRISAT, ICRAF and ILRI), and
- at the level of *individual countries* of the region in the form of case studies for Mali and Guinea.

This report deals with the latter. The field study started on 10th January 2002 in Bamako (Mali), which was followed by a stop-over in Dakar on the way to Conakry (Guinea) for the second part of the study. The fieldwork was concluded on 16th of February.

In organizing the "country" part of the study, the author has taken a comprehensive and qualitative view by considering the impact of agricultural research results in the wider context of *agricultural development.* Agricultural development depends on contributions by many different actors that together cover a complex range of interdependent issues. The actors have been grouped according to their respective (major) level of intervention:

- *international*: donor, research and development agencies
- *national*: government, national research and extension agencies; the private sector,
- *provincial*: decentralised, local government and national (regionalised) research and development agencies, NGOs, and producer unions
- *local:* producer organizations.

It is postulated that the impact of research results cannot be divorced from the *overall development context,* as created jointly by international and national policymakers, and involving educational, medical/health, infrastructural, commercial/trade, supply (input,

credit) and other agricultural services facilities. Each of these facilities will affect the relevance of research results, whether these can be adopted by farmers, and ultimately what the impact will be on the national economy.

For the sub-region in general, the *agricultural development context* must be viewed simultaneously in terms of the progressive transformation from traditional, subsistence systems towards more permanent and intensified, commercial agricultural systems. Necessarily the latter will be more "knowledge-intensive", and therefore the successfulness and speed of this transformation will obviously depend on the availability of the facilities mentioned above.

The considerable differences in *development contexts* between the individual countries of the region provide an additional and complicating factor. This is illustrated by the Mali and Guinea case studies. Moreover these studies show important differences in research impact for the major agricultural sectors being:

- the traditional staple crop – livestock systems
- the cash crop-based systems (cotton, coffee, irrigated rice)
- the non-traditional crop systems (vegetables)

Research impacts have been **least** for the traditional staple crops (by far the dominant system) and for the marginal agro-ecologies. Highly positive impacts have been achieved also, but these have been limited mostly to the introduction of new varieties in particular for the more favorable environments. Improved cultural practices have evolved naturally as the population pressures increased, but can generally not be attributed to the efforts by formal research. For the cash crop systems the situation is somewhat better, although again many recommendations for improved cultural practices were not, or only partly, adopted. As illustrated by the Guinea case, potentially large research impacts are possible in the non-traditional sector, provided the producers are well organized, as is the case in the Fouta Djallon (Moyenne Guinée).

This study concludes that the international donors and national policymakers, as well as the scientific community grossly underestimate the complexity of the progressive transformation of a predominantly subsistence into more commercially-oriented farming operations. This involves the development of an agricultural services and supply structure, as well as simultaneously raising the educational levels of (mostly illiterate) farmers to cope with the technical and financial/administrative demands of a commercial agriculture. This requires favourable enabling, international and national policy environments. The former has been relatively unfavourable for the agricultural sector of the various countries in the sub-region. With respect to the actual national policy environment, the conditions in Mali are obviously more favourable than in Guinea.

The international donor, research and development agencies have tried to bypass the above constraints and complexities by resorting to "blue-print" approaches and "magic bullet" type solutions. A notorious example of the former is the T+V extension system in the past, and presently the "Farmer Field School" and "demand/contract research" concepts; standardized technological packages based largely on improved varieties and agricultural chemicals are an example of the latter.

In view of the complexity of existing local farming systems in relation to the huge variability and diversity in agro-ecological and socio-economic/cultural conditions, it should not be surprising that many of these project-based interventions have failed. Then what should be the appropriate response?

The study concludes that to resolve these issues, research (international and national) and development/extension must be prepared to face paradigm shifts in strategic and operational (governance system) terms. Most importantly all of the major actors must face up to the implications of the diversity and variability for their respective intervention strategies:

1) the introduction of an intensified, sustainable agriculture cannot be resolved *from "the top"*, except for the creation of an "enabling policy environment" by international and national policymakers, that would enhance the development of professional research and extension services, as well as a competitive private sector,
2) the complexities, partly due to location-specific variations, are such that *no single actor*, operating by himself, can hope to resolve the situation in a sustainable way,
3) development/extension services (but also research) can only cope with this situation through *flexibility* in their approaches, e.g. by following a "process approach", that emphasize facilitation and participatory learning (rather than instruction and the mechanical transfer of blue-print solutions), thereby strengthening the "self-help" and local organizational capacity of farming communities.

In this part of the study, the national agricultural research and development/extension system (NARES) takes "center stage". In that context a very first requirement is that **the African governments recognize that the *agricultural sector* constitutes the main pillar of their respective national economies,** directly impacting on the well-being of a large majority of the population, and therefore deserving **active policy support**. The present study concludes that the creation of an enabling policy environment for the agricultural sector is crucial for at least three aspects:

- stimulation of the private sector for trade and transport, enhancing the creation of efficient and equitable markets for both inputs and outputs,
- an allocation from the national budget to the agricultural research and extension institutions to achieve a minimal degree of continuity in their field operations, and
- institutional changes at local levels, stimulating the creation of effective farmer organizations.

In view of the limited resources of all parties involved, the creation of a coordinated, regional research approach is fully justified. Such coordinated approach and collaborative program between the participating institutions needs to be based on the following principles:

- capitalizing on the *comparative advantages* that flow from the major intervention level of the respective institutions,
- capitalizing on the *complementarities*, that exist between intervention levels and between their respective mandates (international versus national research mandates; research versus extension mandates),

- being realistic about the *opportunities* for impact and the *limitations* associated with their respective mandates and the major intervention level at which they operate.

Both the Mali and Guinea case studies illustrate that these conditions are often not met adequately, leading to wasteful overlaps between actors. Thus a coordinated, regional research effort, applying a "bottom-up" perspective, would need to be based on three major components:

- **autonomous and sustainable NARES**, that are appropriately structured to cover a country's major agro-ecological environments and the agricultural systems of major significance to the national economy and national food security. Such NARES would be ideally positioned to intervene at local levels and to cope with local demands through participatory approaches with farming communities and through coalitions with the other development actors (projects, NGOs, and private sector),
- **autonomous, regional coordinating institution: CORAF,** having the credibility and authority to represent the NARES of the 21 member countries in identifying major research issues that go beyond national capabilities. The issues would be of a common interest to at least several countries, whereas individual countries would lack the required professionalism, facilities and/or financial resources to resolve it. CORAF would have the responsibility for sub-contracting such research to International Centers, to other specialized institutions, or to a consortium of national institutes.
- **International Agricultural Research Centers (IARCs),** would be working increasingly in direct response to concrete demands expressed through the NARES of the sub-region and coordinated through CORAF. Moreover, the IARCs should increasingly employ their *core funds* in conducting more fundamental research into the *processes* and *mechanisms* (ecological, technical as well as socio-economic) operating in agricultural production systems. As a result the IARCs research agendas could be adjusted to address strategic issues related to:

    - **efficiency of (external) input use**, thereby meeting environmental and production concerns as related to a more "knowledge-intensive" agriculture, and
    - **quality of agricultural outputs** as demanded increasingly by consumers.

    These adjustments would enhance the complementarity between NARS and IARC's research programs, while providing at the same time, the basic inputs to support the modified approaches to extension/development ("participatory learning" and a "*knowledge-intensive*, integrated agriculture"), as well as to the national policies for "education" (including universities).

Each of the three components of a regional research structure would require fundamental adjustments in their respective strategies. Moreover, their human and financial management should be aimed at achieving continuity and flexibility in the implementation process. The present situation where many NARES are almost completely dependent on donor project funding leads to fragmented, non-coherent and ad-hoc agendas for research/extension and creates a de-motivating atmosphere for program and personnel management. Autonomous

NARES must in the first place be built on national government commitments to the agricultural and rural sectors. For the eventual development of a coordinated, regional research and development approach a strong CORAF is an obvious pre-requisite; unfortunately it has presently, neither the appropriate strategic vision and plan, or a sufficient number of professional staff to meet these challenges.

A final conclusion of the study is that the current international and national policy environments, and the bulk of the improved technologies presently proposed to the farmer communities, are not particularly favourable for alleviating poverty in the sub-region. This study has attempted to indicate possible alternatives to rectify this situation.

1. INTRODUCTION

1.1 Background

In the early 1960's at a time that China was exporting large quantities of food grains, many millions of its poor inhabitants died in a serious famine. This situation was brought about by a combination of faulty government policies and ideals (the" *"Great leap forward"*) compounded by overzealous local officials setting unrealistic production targets for their respective districts. As a result the gap between *theoretically planned* food supply, and that which was *actually available* in the countryside was dramatically widened.

I am starting with this example, because some African regions and/or countries may currently well be moving into a similar direction. As this study shows there are large and fundamental communication gaps between major actors in the development process, and most notably between the macro/international level policymakers and those actors –first and foremost the farmers- who operate at local field levels.

Today's "globalize" economy supported by unlimited communication means, the widespread drive towards ever-increasing material wealth and competition for "power" and prestige by individuals leads to serious discrepancies between officially stated political goals and promises in comparison with what is actually achievable in reality. Also agricultural research (international and national) and development seem to have entered such a viscous spiral of increasingly spectacular goals that will be evermore difficult (if not impossible) to realize at field levels

The multifaceted complexity of agricultural development in much of Sub-Saharan Africa (SSA) is compounded by huge, local level diversity in agro-ecological, socio-economic and cultural conditions apart from other (external) policy factors in the domains of trade, education and health. These present obstacles to progress that we hardly have come to terms with. Not surprisingly and in spite of extensive dissemination campaigns through public, private and NGO development organizations, the impact of research on agricultural production in most countries in SSA, certainly for the marginal semi-arid zones, has remained modest, apart from some widely publicized successes.

Against this background it was attempted to analyze the reasons for the often limited and varied impact of agricultural research (national and international) on farming in the West and Central African region. Next lessons are drawn from this that may guide the formulation of a coordinated and integrated, regional research effort that indeed effectively supports and complements the national efforts.

1.2 Structure of this report

Following a brief section on the "terms of reference", the itinerary, the hypotheses and the approach in chapter 2, a critical review of agricultural development paradigms and concepts is presented in chapter 3. It is postulated that these concepts and paradigms have fundamentally influenced the common approaches to agricultural research and development.

Chapter 4 presents the mission's major findings from the discussions and interviews with the various development stakeholders and the field visits conducted in Mali, Guinea and Senegal.

The discussion in Chapter 5 contrasts the findings in the two previous chapters, thus leading into a vision towards a desirable future regional agricultural research capacity composed of complementary contributions by NARES and by an integrated regional IARC program. This chapter is complemented by a number of (institutional and organizational) recommendations and suggestions that may guide the establishment of such an integrated regional program (Chapter 6).

2. TERMS OF REFERENCE, ITINERARY AND APPROACH

The aim of the study (terms of reference presented in Appendix A) is to arrive at guidelines and steps for the development of an integrated regional research capacity for the West and Central African region. Therefore, the present study was oriented towards the following issues:

- the appropriateness of currently available improved technologies given the agro-ecological and socio-economic conditions in the region,
- the efficiency of the present technology transfer mechanisms in widely reaching the producers,
- the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies, and
- the implications of the above issues for the new CGIAR regionalisation strategy, leading into recommendations towards an increased impact of its future research efforts.

The study started on 10th January 2002 in Bamako (Mali) with three weeks in the field, visiting four regional Centers/Stations of IER; this was followed by a three-days stop-over in Dakar on the way to Conakry (Guinea). In Guinea a one-week field visit was conducted and major sections of the report were written; return travel to Holland was on 16/17th February (a detailed itinerary is presented in Appendix B).

Essentially, the nature of this type of study is "qualitative". Such studies demand considerable preparatory efforts and structuring in advance to achieve an acceptable degree of accuracy and reliability (Mason, 1996). Thus for each of the above issues a number of hypotheses were developed to guide the study. The hypotheses deal with:

- the process of agricultural development,
- the contributions of research to agricultural development,
- the process of information dissemination and its role in adoption of new technologies,
- how these processes function at the field level.

The field studies approached the issues from two different angles and used a matrix structure to organize the information:

a) **from a *stakeholder/actor perspective***: donors, policymakers, research administrators, public sector research and extension workers, development/NGO personnel, (local) producer organizations and individual producers (see fig. 1; and Appendix C).
b) **from an *agricultural commodities perspective***: traditional agro-sylvopastoral systems and their major staple crops (sorghum, millet, rice), cash crop-based systems (cotton, coffee) and non-traditional crops-based systems (vegetables) (see Appendix D).

The resulting information was complemented by a review of relevant documents. For reasons of time and financial constraints the study was focused on Mali, with a verification visit to

Guinea. The stop-over in Senegal has permitted feed-back from ISRA and to share the missions' findings with CORAF.

The framework presented in figure 1 has been used to analyze the Mali and Guinea cases; this figure also underscores the large number of issues involved and the need to view these in the context of an *"agricultural development continuum"*. Obviously the available time has been too short to cover all the aspects raised. As a result the analysis may at times be superficial; yet it also has forced the author to focus on a limited number of major issues/obstacles that need to be considered in developing a realistic and effective "coordinated, regional agricultural research approach".

Figure 1: Analytical framework

Intervention levels	MACRO-International			MACRO-National			MESO-Regional			MICRO-Local			
Actors / Development constraint	Donors CGIAR	CORAF + Network	Intern. R+D Centers	Nation. governm.	NARES (research)	NARES (extension)	Decentr. Regional Research (RRC)	Regional Extension	Private sector	CRU/ CRRD	NGO (intern.+ nat.)+ projects	Prod.'s groups	Indiv. prod's
international policy													
National policy													
Development/ research strategy													
Institutional													
Organisation/ management													
Communication - information													
Methodology/ approach													
Socio-econ.+ cultural environm.													
Techn. devel.+ transfer													

AGRICULTURAL DEVELOPMENT CONTINUUM

3. REFERENCE FRAMEWORK FOR THE STUDY

In preparing for this study, the author has developed an analytical framework and has formulated some concepts against which the results from the case studies can be analyzed.

3.1 Agricultural development

Agricultural development first and foremost concerns "people and policies". It therefore cannot simply bypass the interdependence between "policy", "education" (in the broadest sense), "research" and "extension" (Eicher, 1999). In the past the emphasis has been, however, mostly on technologies, without due attention to educational, administrative and organizational aspects: development of irrigation facilities without attention for maintenance requirements, depreciation costs and local farmer organization, or seed multiplication campaigns without simultaneous concerns about storage, marketing and quality control facilities. So for guiding or supporting agricultural development effectively a *holistic perspective* is a first prerequisite.

There can be no doubt that African agricultural production systems have changed considerably during the past 30 years. Much of it has come about through farmer innovations resulting from increased population pressures and shortages of suitable farming land, but also from changing trade and policy environments. There is, however, a continuous debate whether the direction of this change is positive or negative; as well as which factors and which actors carry major responsibility for it. The "optimists" emphasize the positive developments such as the "more people less erosion" perspective of Tiffen, et al. (1996) which is in line with the Boserup thesis (1965). The "Malthusian doom thinkers" see widespread evidence of impending catastrophes due to climatic change/desertification and accelerated land degradation from erosion and soil fertility mining being the combined effects of a decreasing annual rainfall and increasing population and livestock pressures. However, the latter seem to bypass the effects of the important rural out migration (notably by young males) in search of urban salaried jobs. It could well be that in Africa this factor contributes even more to the stagnating yields, than does land degradation.

So the debate is full of controversies, but mainly because it is often conducted from a technology-biased point of view that bypasses general development aspects of crucial importance in a technology adoption process:

- easily accessible schooling and education facilities for the rural population,
- strong and autonomous local producer organizations able to defend farmer interests and to provide collective services (storage, transformation, marketing, input supplies and credit) that are of common interest to the community of commercial producers, and
- primary health care facilities

Poor adoption rates and concerns about equity and sustainability have also greatly affected the research and transfer process over the past 20 years, causing important changes such as (see also Rhoades, 1989):

- introduction of a "farming systems" perspective and its emphasis on farmer participatory approaches and on indigenous knowledge within the research sector,
- increased emphasis on interdisciplinary approaches by including the socio-economic/anthropological disciplines in the research and development process,
- recognition of organizational and institutional aspects in the development and transfer process.

Another interesting and on-going move seems to be a shift from "formal" (i.e. policy and project guided) to "informal" (spontaneous, locally initiated) development processes, as a pragmatic response to the presence or absence of certain development partners or services. An increased awareness of “informal” processes will permit to stimulate dissemination in vast areas that are thinly covered by formal agricultural services, as is commonly the case for the region. Therefore one needs to accept that adoption is not necessarily a linear or an easily predictable process, and that the origin of many changes may not always be obvious.

In this study the various factors affecting agricultural development have been associated with different (intervention) levels. These range from the macro, international and national levels to the meso-intermediate and finally the micro-local level. Moreover, the levels are associated with different types of intervention that can be roughly subdivided into those of a policy and institutional, of an organization and management, and of a technical/biological nature (see table 1).

Table 1: The major levels of intervention according to geographic/administrative, ecological and socio-economic perspectives and the related major types of interventions involved in agricultural development.

Levels	**Geographic**	**Agro-ecologic**	**Socio-economic**	**Type of intervention**
Macro level	-Continent -Region (trans-national) -Countries	-Eco-region	-Population -Government (nat.) -International agencies	-Policies (econ./envirm.) -International laws and regulations
Macro/meso	-Countries -Provinces (national regions) -Towns	-Eco-region	-Population -Government (national and local) -Institutions (national/ regional/local)	-National policies, laws and regulations -Technologies
Meso/micro	-Districts -Villages -Village territory	-Agro-ecology -Watersheds -Toposequence	-Government (local) -Rural communities -Farmer organ.'s -Develop. Agencies -Private traders	-Local rules/ regulations -NR-Management -Technologies -Farm support facilities (credit/market inputs)
Micro	-Village -Farm -Field plots	-Agro-ecology -Watershed -Toposequence	-Village community -Family/household -Individual	-Local rules/ regulations -Social organization -Technologies/ practices *crop-livestock manag. *crop husbandry

Against this background the present study views adoption of new technologies and adjusted practices as evolutionary processes. These depend on inputs by many different actors, operating at different intervention levels (see figure 1: stakeholder matrix); as a result the conditions for farming evolve continuously. Hence a holistic perspective and a "process approach" which by definition is of an "iterative" nature, are required when evaluating the impact of research results. In orienting such an approach the "indigenous knowledge" and a confidence in "farmer rationality", or more generally *a people's focus*, are important starting points.

3.2 Evolving agricultural systems

A large part of the dynamics in agricultural development results from factors over which we have hardly any control. As population pressures increase and land availability decreases a number of changes is automatically set in motion. With land use becoming more permanent, farmers must change their practices (e.g. in water and soil fertility management) to ensure the

sustainability of their operation. Next with the introduction of a market and monetary economy, profit maximization and intensification through the use of external inputs lead to further profound changes in agricultural systems. The result is that farmers become increasingly dependent on factors that are beyond their direct and immediate control and hence the need for them to get organized among themselves. So in terms of farming systems there tends to be a logical –though not always equally desirable- evolution from:

- **Subsistence, often shifting, agriculture**: supposed to be primitive, small-scale, resource-poor, hand labour, low-yielding, and non-sustainable (at least beyond a certain population pressure), to
- **Modern, commercial and permanent agriculture**: large scale, mechanized, high-yielding, depending on reliable agricultural services and a functional marketing sector for external inputs and as outlet for the surplus production.

The continuous adjustments in farming practices are a condition *sine qua non* for a sustainable agriculture so that the possible detrimental effects of certain practices (but also policies) can be counter-balanced timely, and before irreversible changes set in (Stoop, 1990). This implies that also degradation features are an integral part of agricultural development as it evolves from shifting to permanent types of farming (Stoop et al., 2000).

Concerns about the sustainability of "modern agriculture" have led to the development of a range of alternative, more "environment-friendly" systems. These tend to be based mainly on a more *knowledge-intensive* farm management, involving a more precise timing of operations (in relation to weather conditions) and increased labor inputs, leading to smaller optimum farm sizes:

- **Integrated agriculture**, medium to large scale, increased *input use efficiency* thus reducing production costs, and improving sustainability
- **Ecological agriculture** (organic, bio-dynamic, low external input, etc.): small to medium-scale, high labour requirements, sustainable, and with an increased emphasis on "high quality" agricultural products that sell at a premium.

Much of the debate among donors, policymakers, researchers, development workers (extension and NGO's) and the general public is dominated by sustainability aspects as related to the above "stereo-types". These debates, however, tend to bypass the huge *variability and diversity* in agro-ecological and socio-economic conditions, and the inherent *complexities* of the adoption/change process at farm levels.

3.3 Agricultural research and development paradigms; implications for technology transfer and adoption

Generally, rural communities tend to be more preoccupied by issues, such as health, transport, markets, prices, education, water and electricity, etc, than by agricultural technologies (Sherwood and Larrea, 2001). This is not to say that new "agricultural technologies" are not important, rather that their successful introduction will depend on a wide array of local conditions. Key conditions would be (Boyd and Slaymaker, 2000):

- **importance of agriculture in rural livelihoods**, as affected by the opportunities for diversification and/or for out migration (alternative non-agricultural sources of income),
- **shortage of agricultural land**, as related to population pressures, and

- **type and security of land tenure systems.**

Change and adoption patterns (and thus impact from research) will vary considerably in response to these conditions apart from the local policy, institutional and marketing environments. So changes will generally be slow, continuous and progressive (Vierich and Stoop, 1991; Meertens, et al, 1994), but can also be rapid and substantial in areas with high population pressure as in peri-urban areas, and in the Machakos district in Kenya (Tiffen, et al., 1994). Moreover, farmers tend to introduce changes "spot-wise" and in direct response to localized problems (see Mazzucato and Niemeijer, 2000 for on-farm studies in Eastern Burkina Faso and Kante, 2001 for fertility management in Southern Mali). By contrast externally funded development projects tend to apply blanket improvements that bypass the local micro variability in terms of agro-ecologies and of different social strata in the target population. For the resource-poor farmer the latter is obviously inefficient, hence his non-responsiveness.

The technology transfer process, as an element of agricultural development, has often been considered as "linear", and has been dominated by "top-down" thinking. As far as public and private sectors are concerned, it has been based largely on standardized technological packages and "blanket" recommendations that were developed by research and passed on to extension for dissemination. Together with concerns about organizational efficiency, this has led to highly structured mechanically functioning organizations, that culminated with the Training and Visit (T+V) system. Such a system again bypasses many field realities as related to problems of local diversity/variability and complexity that are dealt with more effectively through *informal* "farmer-to-farmer" communication.

While there have been fundamental changes in the organization of extension services in recent years, most of these changes have resulted rather from the non-sustainability of the organizational structures than from changed views on the process of "technology transfer". Top-down attitudes are strongly entrenched in both national and international institutions when it comes to field implementation. The attitudes are linked to two common paradigms that dominate the modern agricultural development perspective:

- the intensification paradigm
- the efficiency paradigm

Under the influence of the "Green revolution" successes in Asia and the example that this has provided to the IARCs in general, a particular *intensification paradigm* has evolved, which has widely influenced the global agricultural research establishment. This paradigm presupposes that agricultural improvements must come to a major extent from improved cultivars (through conventional and/or bio-technological breeding approaches) in combination with the (increased) use of agricultural chemicals, and increased levels of mechanization. The resulting standardized technologies are presumed to be widely known and only need to be taken *from the shelf* to have major impacts. Such a view tends to reduce the development issue to a *technology transfer* problem that can be solved through "organizational efficiency"; hence the efficiency paradigm that has widely affected both the research and development sectors.

The *efficiency paradigm* also tends to bypass some critical roles of agricultural research that in addition to "technology generation" provides essential "information" to policymakers and donors as a basis for policy decisions, but also to researchers in identifying constraints and research opportunities. In addition, research institutions develop "concepts" and

"methodologies" that guide the national development process. This overall capacity is, however, highly dependent on *continuity* in the form of "maintenance research" and the active, continued presence of interdisciplinary teams of scientists.

Another popular notion in donor circles and among research administrators is to distinguish between different types of research. *Fundamental and strategic research* are generally considered to be complex, long-term, requiring costly equipment, to be conducted by highly qualified, competent (and prestigious) researchers. This form of research is better to be left to the rich, industrialized countries and/or international centers. Incorrectly, this might suggest, that therefore *applied and adaptive research* are easier and require fewer resources, and thus can be conducted more appropriately by the "poor" national institutions and their less highly educated scientists.

A central hypothesis of this study is that poor adoption rates of research results can be attributed largely to some of the common research paradigms and to various rigid and simplified conceptions about the agricultural development and technology transfer processes. These paradigms have worked relatively successful in the uniform, high potential agricultural environments as in *parts* of Asia; it is postulated that for the heterogeneous and marginal (therefore more complex) situations as prevail in West and Central Africa we may need to substantially modify/adjust our paradigms.

4. RESULTS AND DISCUSSION

This chapter presents the results of the field studies conducted first and foremost in Mali, to be complemented by a short visit to Guinée, and discussions in Senegal with ISRA, CORAF and FRAO. In both Mali and Guinée the field studies have looked at the factors ranging from international and national policy to institutional as well as methodological, social and technological that may have affected agricultural development and the adoption of research results in recent years.

4.1 The MALI case

The study in Mali has focused on meeting the major national actors (CNRA, IER, DNAMR, SG 2000 and ICRISAT/ICRAF) in Bamako; subsequently their regionalized units and the Producer Organizations were visited during the field tour. The field tour covered the Sikasso, Segou and Bamako Regions.

The Southern Mali – Sikasso region, served by the Sikasso Regional Research Center, represents the cotton-based systems. The Segou region covers two very different systems: the rainfed millet/sorghum - based systems as served by the Cinzana Research Station, and the irrigated rice-based systems of the Office de Niger served by the Niono Regional Research Center. Finally, the Sotuba Regional Research Center that serves the Central (Bamako) region was visited. A more detailed account of the Mali case study is presented in Appendix E.

4.1.1 Historical background

For the country as-a-whole it is informative to place the agricultural developments in an historic perspective. Some of the events that have had major impacts, since the colonial occupation by the French are:

1890 –1960:	Colonial government
1960:	Independence: First Republic with centralized government structure following the socialist model; para-statals responsible for regional development (CMDT for Southern Mali; Office de Niger); creation of national agricultural research institute: Institut d'Economie Rurale (IER)
1970 – 1974:	Sahelian drought followed by large in flux of donor support, leading to:
1972:	"Operations de développement" to achieve regional food self-sufficiency
1985:	Start of large scale World Bank "structural adjustment programs"
1990:	Start of World Bank-guided national extension project (PNVA),
1991:	Reorganization of IER: creation of a national, regionalized research structure based on six Regional Centers
1992:	First democratic elections for Presidency, parliament and local government; start of "decentralization" policies and increased emphasis on democracy
1994:	50% devaluation of the Franc CFA
1995:	General liberalization of land use (important impact in Office de Niger); start of World Bank sponsored "National Agricultural Research

	Project" (PNRA) and introduction of the "Comité National de Recherches Agronomiques" (CNRA) and the "Regional User Committees" (CRU)
1995 – 2001:	Further withdrawal and reduction of public sector services (including CMDT and Office de Niger); increased responsibilisation of private sector
1998:	End of World Bank sponsored PNVA project
2001:	End of PNRA
2002:	Start of new comprehensive World Bank coordinated agricultural support project (PASAOP): increased privatization of research and extension services.

Generally, Malian society has always functioned under centralized and directive forms of government, starting with the colonial period and through the First and Second Republics. With the reductions in the public sector and increased decentralization during the Third Republic came, however, other centralized, large-scale and "donor-imposed' policies towards agricultural development associated with large multilateral projects such as PNVA, PNRA, and currently PASAOP.

4.1.2 National Policy environment

Most important to recent agricultural development in Mali, have been the democratization and decentralization processes that started in 1992 with the Third Republic. This has created a favourable national policy environment that has attracted donors, NGOs and private investors. Likewise, the liberalization of land use in 1995 has had important effects on stimulating the development of the non-traditional crops (vegetables) sector.

To what extent the multilateral donor assistance, in particular the creations of a national extension service (PNVA) following the "Training and Visit" (T+V) system, of the "Comité National de la Recherche Agronomique" (CNRA) and of the "Comités Régionales des Utilisateurs" (CRU), has been beneficial to agricultural development, is difficult to ascertain. However, some major efforts, like the T+V system for extension were discontinued after several years; likewise funding gaps of one or more years between consecutive project phases have caused serious disruptions and reduced credibility of the actors involved.

4.1.3 Institutional context

Starting in 1995 and through the PNRA a central national coordinating and funding institution for agricultural research (CNRA) was created within the "Ministry of Rural Development". The CNRA evaluates and funds research project proposals that are subsequently implemented mostly by IER. Simultaneously, a bottom-up and "demand" structure -the CNU/CRU- was created to strengthen the influence of users on the national and regional research agendas.

The development context of the Mali case is complicated by considerable differences between the countries' major regions with respect to agro-ecological conditions and farming systems, and as a result the group of development actors in each region. The situation is further complicated by the present transition period between two major multi-lateral donor projects (coordinated by the World Bank) along with the on-going institutional reorganizations for the development and extension sector.

The Southern Mali region of Sikasso constitutes the cotton belt of the country and therefore is one of the major pillars of the national economy. Since independence in 1960, the comprehensive development of the region – including all aspects ranging from health, education facilities to agricultural services and infrastructure construction- has been dominated by one single institution: the "Compagnie Malienne de Développement Textiles" (CMDT). While initially this has accelerated the development process and cotton production in particular, it has also had some distinct drawbacks that over time are becoming increasingly clear:

- the monopolization in terms of institutional development has delayed a balanced evolution towards the wider array of support institutions and an active private sector that are all essential for a diversified, market-driven agricultural sector as compared with the former subsistence and subsequently cotton dominated systems,
- some important sectors of considerable economic potential, such as fruits (mango's and citrus) and vegetables (in particular potatoes) in peri-urban agricultural systems have been neglected in spite of their considerable economic potentials,
- the presence of a well-functioning CMDT has provided attractive opportunities for additional donor investments, which has further strengthened its dominant role.

The ongoing, large scale restructuring of the CMDT (since 1999) and its reorientation and narrowing of mandate to cotton-based systems leaves presently a confused situation. The resulting institutional gaps need to be filled by a host of new players such as DRAMR as extension service for all non-cotton commodities, the "Chambre d'Agriculture", the private commercial sector and the relatively young CRUs. Their roles are complemented by NGOs and foreign projects like the Swiss-supported organization "Gestion et Développement des Resources Naturelles" (GDRN). The latter plays an important facilitating role in the complex communication between CRU and Producer organizations on the one hand and the research – development/extension organizations on the other, to clarify, translate and eventually fund demands raised through the CRUs.

As the development scene in the South was dominated by the CMDT, the "Office de Niger" (OdN) played that role in the vast irrigated area North of Segou. In the agro-ecologically more marginal, rainfed areas of the Segou region, the actors have been more divers including combinations of public sector extension (PNVA), NGOs and various development projects (including from FIDA and GTZ).

The PNVA was initially structured around the T+V approach to extension. In 2002 a new comprehensive project "Programme d'Appui aux Services Agricoles et Organisations Paysannes" (PASAOP) will get underway. Among other things it will be aiming at decentralised and privatized extension services (DRAMR) that will collaborate closely with other development actors (Projects, NGOs, CRUs and Producer Organisations) on contract bases. During its initial phase PASAOP will focus on five Regions (Mopti, Segou, Sikasso, Koulikoro and Bamako).

The NGO group is an increasingly important actor on the development scene. A distinction is made between "international" NGOs such as SG 2000, Winrock International, Voisins Mondiaux etc, that tend to work in support of and/or in close collaboration with the public

sector development services, and a large number (1300) of "national" NGOs of varying strength and competence. This latter group often operates in relative isolation and feels rather left out of the development activities. In that respect it is important that 17 of the larger national NGOs are currently creating a Federation (CREDO) to facilitate their implication and collaboration with the other development actors, notably DNAMR/DRAMR and IER. In view of their important contributions in terms of education/alphabetization, health services, support to social organization, and women empowerment, this group of actors has an increasingly important role to play certainly in the context of the new Project PASAOP.

For Southern Mali *farmer organizations* have been introduced at an early stage through the CMDT as "Associations villageoises" to facilitate the cotton production. For other commodities and in the rest of the country, farmers are less, or not organized at all. As a result the rather recently created CRUs tend to operate in a vacuum.

4.1.4 Research impact

Partly as a result of the different institutional contexts, the impacts of research vary greatly between the major regions, the predominant cropping systems and between types of technological improvements proposed.

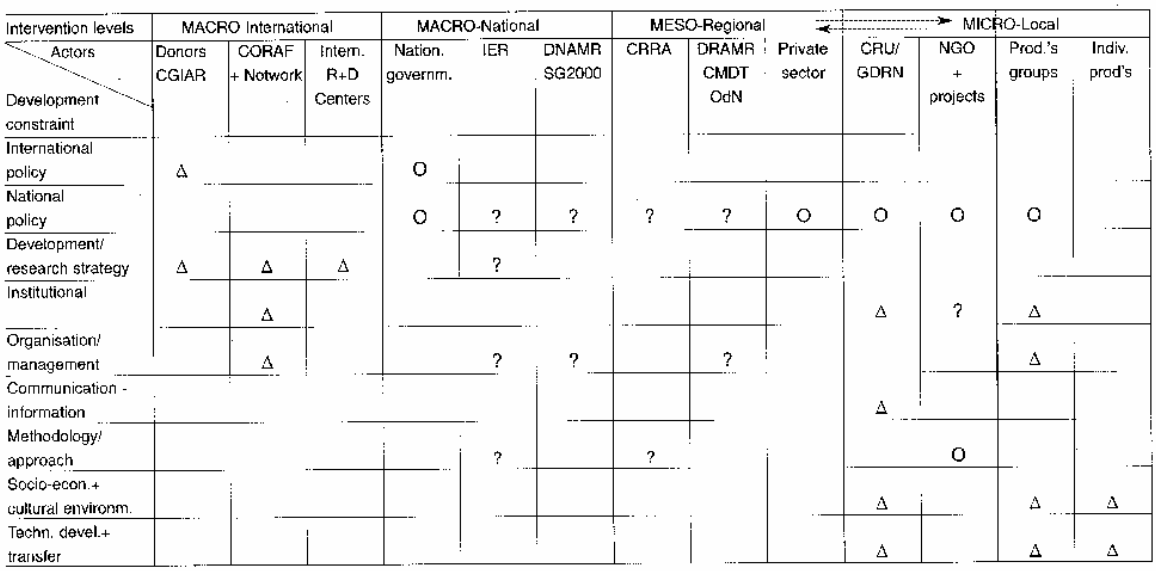
Impacts have been considerable for cash-crop-based systems (cotton, maize and irrigated rice). Table 2 presents a typical example for adoption trends (even though it is for rice in Burkina Faso: INERA, 1999). This shows relatively easy adoption of new varieties (certainly by commercially oriented systems), while the adoption of various *cultural practices* lags behind. A similar pattern occurs for the "traditional" staple crops (sorghum, millet) and in general rainfed cereal-based production systems (Yapi, et al., 2000). Adoption rates decrease for all components of a technological package as the farming conditions become more marginal (in terms of soil fertility and rainfall). For further details see Appendix E.

Table 2: Adoption rates for rice technologies (INERA, 2000)

Rice system	Adoption levels in percentages (%)			
	Varieties	**Mineral fertilizers**		**Plant protection**
		NPK	Urea	
Rainfed upland	50	10	3	0
Rainfed bas-fond	25	8	5	rare
Bas-fond	75	50	50	20
managed	92	80	80	70
Irrigated				

Yet, over the last 20 to 30 years many changes in agriculture have occurred spontaneously and through informal contacts among farmers. This applies to the non-traditional vegetable crops that have greatly increased in importance. But also in the traditional agro-sylvopastoral systems some distinct and important changes have occurred, such as: increased use of organic manure and the substitution of mineral fertilizers by organic manure (Stoop and Kebe, 1998). The increased storage of crop residues as animal feed during the dry season, and the widespread adoption of animal-drawn charts, are two additional, highly visible features.

Figure 2: Opportunities (O) and constraints (Δ) for research impact: Mali case



4.1.5 Constraints

An analysis of the wide range of constraints, but also opportunities, that affect the impact of research results in Mali is presented in Figure 2. The types of constraints/opportunities have been presented for the various major actors, while focusing on the main issues. An interesting first conclusion is that major barriers seem to be associated with the two extremes of the agricultural development continuum: the *macro-international* actors and the *micro-local* level actors. These results are elaborated below.

a) Policies

A distinction needs to be made between policies originating at the *international* and at the *national* level. The former involves events like globalization and international trade agreements as well as donor policies and visions on "development" that are hardly influenced by individual African countries. Yet the impacts, on for instance the Malian agricultural sector, are profound. Likewise, the consequences for national institutions and for the continuity in their activities and services can be serious, because of the "project-mode" through which much assistance is made available. Obviously, the *international policies* have not been tailored to Malian needs, or for that matter to the agriculture-based economies of African countries. To some extent Mali has managed to compensate for this through its national liberalization and decentralization policies that have created a favourable environment for the private sector and that have attracted donors.

b) Institutional

The institutional landscape for the Malian agricultural sector presents a number of particular issues.

IER mandate: IER is by-and-large the only major national institution with a research mandate in support of the national agricultural sector. The present donor pressure for a greater privatization of research efforts may have undesirable effects in skewing the institutes' research agenda towards short term issues through research contracts with the users. However, much research should be aimed at "preparing for the future", which will involve medium to long term research activities including essential maintenance research, that require funding stability and a continuity in implementation.
For the future of IER, its programs and activities must be balanced between:

- *short-term, demand-driven research* projects funded through contracts with the users, and
- *long-term, strategic research* projects of a wider national interest that are funded from public resources.

Overlaps between IER and ICRISAT: such overlaps should be of serious concern, because based on the comparative advantages of each institution, very complementary research agendas can be defined easily. In that context there is little justification for an international Center to conduct an extensive on-farm testing program. The on-farm testing of "best-bet technological" packages for instance should rather be a domain for collaboration between the *national research* and *extension services* (see also section 5.3.1.). Since international Centers will generally have more abundant resources, and also a narrower research agenda (focused on just one or two commodities) than the average national program, there is an understandable temptation for them to intervene in areas that are the obvious prerogative of the national program. This report will argue (see Chapters 5 and 6) that Centers should resist this temptation and use their resources on issues where they do have the comparative scientific advantage. Only in exceptional cases and upon an explicit request by the host Government for support to the national institute, should IARCs take on such types of location-specific research.

Overlaps between research (international and national) and the development/extension sector: this overlap is common and originates from the desire by all parties to show "impact" at farmers' level. The result is, however, that research gets over-expanded in the on-farm environment, conducting studies and trials in numerous villages (being unable to adequately monitor and guarantee data quality), or that extension starts to conduct on-farm experiments and tests without having the professional qualifications. Through "special projects" and/or "contract research", that provide additional funding to the respective institutions, this trend has been reinforced in recent years by the donors. It has been noticed both at the levels of national and international institutions.

The CRUs were created in 1995 as part of the World Bank supported PNRA. The CRUs are aimed at strengthening the "farmer-demand" structure vis-à-vis the research and development services. The fact that the CRUs were created through an "external" intervention has had considerable consequences for the effectiveness of their operations, the representative ness of its members, its financial sustainability, as well as for the anchorage at its basis: the farming

community. A large proportion of Malian farmers is apparently still unaware about the CRUs existence and certainly about its role.

In both the CRU and the T+V cases, that were major elements of World Bank projects, disproportionate amounts of funding went into the built up and functioning of multi-layered (national, regional, district, community) administrative structures, while the anchorage at the local community level was weak. It might be concluded that such outside interventions, though perhaps desirable from a theoretic point of view, in the end prove to be non-sustainable for lack of both adequate local financial resources and local motivation.

One domain where the liberalization process has had a most pronounced impact has been in the *"non-traditional"* vegetable production sector, mainly concentrated in peri-urban areas. This sector is highly profitable and probably could become even more lucrative if the producers were organized, instead of each operating on an individual basis. In this respect the Guinea case offers a sharp contrast in clearly demonstrating the impact producer organizations can have on the efficiency of linkages for demand-led research as well as on efficient private sector involvement in securing input supplies and marketing. Yet, in Guinea the "Federation of Fouta Djallon Farmers" evolved more naturally, because of a widely felt local need to get organized in facing jointly the external commercial and political environments (see the Guinea case: section 4.2.).

c) Approach/Methodological

In spite of considerable efforts to introduce *demand-led* and *participatory* approaches to all IER staff at one stage, one can question the effectiveness at present when the ESPGRN researchers do not spend a considerable part of their time on-farm. The very same reservation applies to scientists from international centers when they work with numerous villages.

In spite of the "participatory" logic in terms of diagnosing constraints and developing technologies, neither national or international technical and biological scientists or the average extension agent, have had adequate training to master the (interviewing) skills required. This probably explains why the average diagnosis is of very limited value, not going beyond simple observations of the type: "the variety is not good", "the soil is poor" or "weeds are a problem".

On the other hand there were reports of farmers getting seriously annoyed by the frequency of research and extension meetings, tests and surveys. This may be indicative of the many organizations involved (extension, projects, different NGOs) that compete and contradict each other, while following different, uncoordinated approaches that have been mostly "technology-focused" without due attention for human and social aspects.

d) Social Environment/Farmer organizations

In the more risky and marginal (often physically more isolated) environments of the savanna and sahelian zones, farmers are more conservative and superstitious about foreigners and about innovations in general. Here the traditional communal household structures are still strong, while in the more progressive, more commercially oriented (cotton) farms, many of the extended farms have broken up into smaller units as the result of conflicts between the older and younger generations. As a result a diverse social environment has evolved. In the CMDT zone different categories of farmers (A = large, mechanized, B, C and D = small,

non-mechanized) have long been recognized, as well as the implications for their respective capacities to adopt new technologies. In other parts of the country this will not be any different, but it has generally not been an element of the extension approach.

There are also important differences in terms of local organization between regions and as influenced by the major commodities produced. While the cotton producers are understandably well organized through the CMDT; the traditional household organization prevails among the cereal/livestock farmers; surprisingly enough the commercially attractive non-traditional (vegetable) crop sector has no organizational structure.

Apart from this, there can be remarkable differences between neighbouring villages in their respective interest and motivation to participate in research and extension activities. This is a phenomenon, linked to social dynamics that should be exploited by development institutions.

e) Technological

Most of the formal research and extension interventions are highly technology-biased. Researchers and extension agents are hardly concerned about how a proposed technology will fit into the calendar of farm activities in terms of labour requirements and what are the (financial) risks involved. Often the additional labor requirements and the local availability of the required external inputs at affordable prices are overlooked (see fig. 2: technological constraints at producer level). Very complex is the situation for livestock and certainly for impacts on the sylvo-pastoral/traditional staple crop systems that involve complicated socio-cultural issues in particular as it concerns land tenure issues.

The CRU representatives pointed out that their major need is in the post-harvest domain, dealing with local transformation, improved conservation and storage of fruits and vegetables but also of the traditional cereal crops.

4.2 The GUINEA case

The study in Guinea has been very short; its main objective was to identify some distinct differences with the Mali case. In terms of factors and conditions that have had major effects on agricultural development and on the impact of agricultural research results, the Guinea case is indeed very different. At the same time it could be considered as fairly representative for a substantial group of countries in the West and Central African Region.

The study started with discussions in Conakry at the headquarters of the major actors: IRAG, SNPRV, DNE and SG 2000. Next it continued with field visits to two major regions: Moyenne Guinée (including the Fouta Djallon mountains) and Basse Guinée. In both regions discussions were held with the local actors: researchers of the IRAG Regional Centers of Bareng and Foulaya, SNPRV and SG 2000 extension staff, NGOs, Producer Organizations and farmers in the two study villages Senghen and Touguikhoure. Details for the Guinea case are presented in Appendix F.

Already during the colonial period Guinee was recognized for its very diverse and rich natural resource base. These cover tropical rainforests in the south-east, savanna zones in the north-east, as well as medium elevation (up to 1500 m) mountain areas of the Fouta Djallon, and the humid coastal zone in the west, which includes extensive areas with mangrove tidal swamps.

4.2.1 Historical background

The historical events that have most profoundly affected Guineas' agricultural development can be summarized as follows:

Before 1958:	Colonial period under French rule; in 1920s creation of first agricultural research stations in Séredou (forest zone: coffee), Bordo (savanna zone: cotton and rice), Foulaya (coastal zone: tropical fruits) and Koba (mangrove rice).
Sept. 1958:	Referendum: population votes against the "union" with France.
Oct. 1958:	Independence, Sékou Touré as first president; all relations with France broken off and total withdrawal of all French assistance and technical aid.
1958 – 1984:	First Republic: socialist government and creation of a one-party national political system;
Apr.1984:	Death of Sékou Touré
1984 – 1986:	Transitional governments: introduction of multi-party political system with independent legislature (Parliament) and judiciary (High Court) bodies; opening to the West and introduction of a market economy; privatization.
1986:	"Direction Nationale de la Recherche Agronomique" (DNRA) moved from Ministry of Agriculture to the Ministry of Higher Education and Scientific Research
1987:	CRA Bareng established as research center for the Fouta Djallon; Start of movement to create local, farmer organizations.
1989:	DNRA is transformed into "Institut de Recherche Agronomique de Guinée" (IRAG), which is placed under the Ministry of Agriculture.
1990 – 1994:	"Projet Service Agricole" (PSA-1) including IRAG, funded through the World Bank
1992:	Creation of the "Federation des Producteurs de Fouta Djallon" (FPFD)
1996 - 2000:	"Projet National de Services Agricoles" (PNSA), including IRAG and the "Service National de Promotion Rurale et de Vulgarisation" (SNPRV) funded by World Bank.
1996 – 2002:	Border tensions with Liberia and Sierra Leone; large in-fluxes of refugees.
2002:	Negotiations with World Bank towards "Projet National des Services Ruraux" (PNSR)

As for Mali, Guinée has also operated mostly under directive forms of government through the colonial period and the First Republic. Important changes in the system of government were introduced in the years following the death of Sékou Touré. As a result the country has opened up to the West and multilateral donor support started to arrive leading to great improvements in the road infrastructure and a modest increase in private sector activities.

4.2.2 Agricultural development

The abrupt de-colonization and the subsequent policies by the First Republic have seriously delayed the development of the agricultural sector. In spite of some "pockets" of commercial crops (cotton, coffee) and non-traditional vegetable (potatoes, onions) production, the

predominant form of agriculture remains *subsistence farming*. Evidence for this is the fact that the countries' major traditional food crop -rice- hardly enters the commercial circuit being almost totally consumed at the household and local village levels.

Eventually, the agricultural sector will have to evolve towards more permanent and more capital intensive systems. As population pressures continue to increase and "land" becomes a limiting factor farmers will need to make additional investments in terms of labour, mechanization and/or external input use. However, agricultural intensification and specialization involve considerable risks (biological and economic), which farmers will only accept, when being assured of reasonable financial returns, the presence of capable research and extension services, and of an efficient and reliable agricultural services sector (input supplies, credit facilities, marketing and transformation channels). Experiences elsewhere show that these conditions can be enhanced by an enabling policy environment that promotes the development of a divers and competitive private sector.

4.2.3 National Policy Environment

For some time Guinea has been under pressure by the international community, which has reservations about the Governments' democratization policies and lack of transparency. The country has also been affected by the political troubles in neighbouring Liberia and Sierra Leone and the resulting large influx of refugees. The desperate financial situation of the Government doesn't aid the overall policy environment either.

4.2.4 Institutional context

Agricultural research and development institutions have come a long way since the first evaluation in 1988 by ISNAR (Stoop and Bosso, 1989). Both research and extension services are young institutions having been created only 10 to 15 years ago.

For IRAG the successful introduction of a regionalised research structure has been most important. It consists of 4 Centers and 2 Specialized Stations according to the major agro-ecological regions of the country; each unit operating fairly autonomously.

As part of the PNSA, the SNPRV built up an extensive national structure and network of extension agents all over the country, following the T+V model of operation. Some of the major developments in both the research and extension structures and activities are described in an evaluation report prepared for the World Bank (Stoop, et al., 1998). This report has led to some major changes, notably the introduction of "study-villages" by IRAG to create a concrete interface between research, producers, extension and NGOs. A description of this approach to an integrated, multi-stakeholder, on-farm research program has been presented by Béavogui, et al. (2000).

Collaborative arrangements such as research and development *networks* for the sub-region (e.g. WARDA/ROCARIZ Task Forces for rice; and the WARDA based Inland Valley Consortium -IVC), play important roles in providing some vital additional funding, as well as information and technical support. The same applies for the support provided by SG 2000 to the SNPRV. These arrangements become "life lines" for IRAG and for SNPRV during transition periods between projects permitting a minimum number of field activities to continue, as is presently the case.

Most important during the last decade has been the creation of numerous local farmer organizations and their combination at regional levels into "unions" and "federations". Most prominent today is the "Féderation de Producteurs de Fouta Djallon" (FPFD), that covers 380 formalized farmer groups with a total of 13,000 individual members of which 70% are women. The "Federation" has sub-sections for potato, tomato and onion producers.

The presence of strong farmer organizations will greatly facilitate the operation of the "Comités Régionaux de Recherche/Développement" (CRRD), that are comparable to the CRUs in Mali and that serve a similar objective of introducing a "demand-led" perspective in the research and extension interventions.

4.2.5 Research impact

So far the adoption of new technologies by farmers has been limited mostly to improved varieties for rice (lowland and upland), maize, cassava and various vegetable and fruit crops. Improved cultural practices requiring additional investments in labour and external inputs have not been adopted widely.

4.2.6 Constraints

The constraints and opportunities for the Guinea case are presented in Figure 3. In comparison with the Mali case, an interesting difference is the problematic situation at the Macro International, Macro National and Meso Regional levels as it concerns the policy environment under which major actors (institutions and the private sector) have to operate. On the other hand the conditions are distinctly more favourable at the meso/micro level in terms of NGOs and farmer organizations. The constraint at the individual producer level (right bottom corner of figure 3), reflects the "supply" nature of most of the technologies offered to farmers and which ignores the very limited resources available to most farmers.

a) Policy

The *national policy environment* in Guinea, as created jointly by government and donors, presents the major constraint to agricultural development. Two issues stand out:

- **Barriers to the development of an effective and competitive private sector** (presently constrained by many obstacles to local and international trade and to easy transport), and
- **Inadequate support to the development of competent research and extension services**.

It needs emphasizing that in the absence of any changes in the present policies, also the on-going initiatives by NGOs, such as SG 2000, will only have very limited and temporary impacts, and will not have tangible long term effects on the SNPRV and its institutional sustainability.

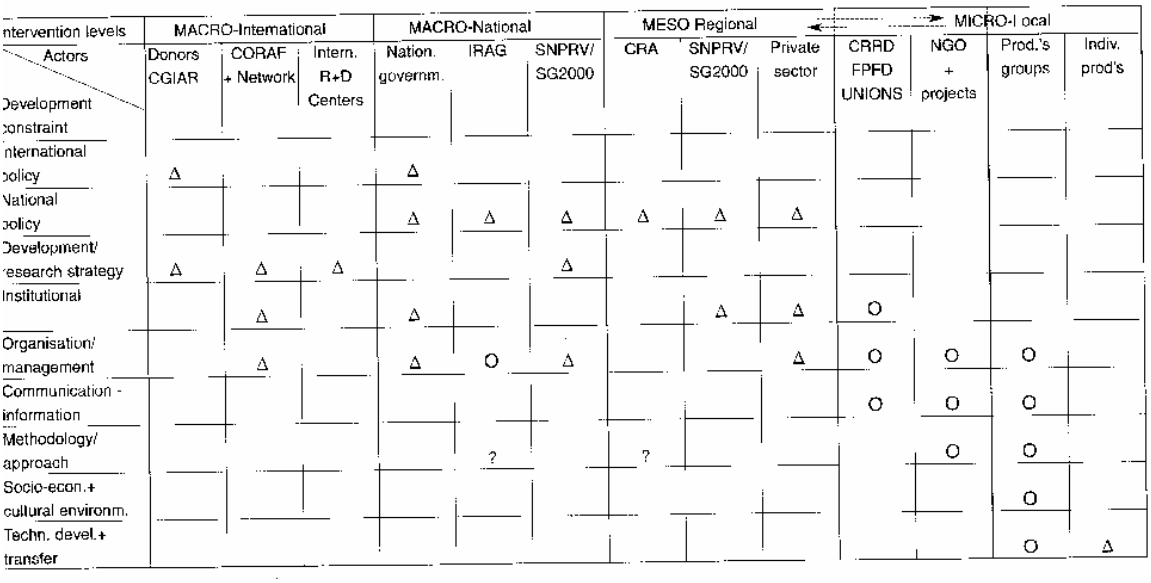
b) Institutional

IRAG and SNPRV have lacked continuity because of their "project" status, and the absence of a fixed annual financial contribution to operating costs by the government. This situation has prevented a sound personnel management (e.g. the timely recruitment of young scientists

to replace the aging IRAG staff), as well as an appropriate financial management that would ensure institutional sustainability and thus continuity in field activities.

Presently both IRAG and SNPRV activities have almost come to a halt in the transition period (2 years) between two consecutive World Bank projects. SNPRV continues a minimum of activities through SG 2000, while IRAG has only some funds from contract research (e.g. with the Federation) and from some commodity-related networks

Figure 3: Opportunities (O) and constraints (Δ) for research impact: Guinea case



Approach/methodological

In the past IRAG has made several attempts to introduce "farming systems" and "participatory" approaches into its programs. A handicap here has proved to be the absence of the social science discipline, but also the conflicting recommendations by foreign experts. Likewise the SNPRV has set up a massive administrative structure to introduce the T+V extension system for the entire country, during the past PNSA project. In either case the efforts failed, because either the required professional staff was not available and/or the effort was financially not sustainable.

Presently privatization of the research and extension services are fashionable approaches. Yet for most countries of the region it would seem inappropriate: in Guinea the two services are professionally weak; the producers are mostly poor small-holders who are operating mostly non-monetarised production systems. Therefore, there are few alternatives in the short and medium term, but continued and increased support by the public sector. The aim should be to first strengthen the professional capabilities of these services that constitute the backbones of intensified commercial farming.

c) Social environment/Farmer organizations

The transition from subsistence into commercial, permanent agriculture is technically complex, but also involves many fundamental social and organisational aspects. This must have implications for the approaches to research and development that will be used. The IRAG study villages reveal important information about the importance of local social

dynamics and farmer organization, as well as alternative, mostly informal, communication channels (see Appendix F).

d) Technological

As in Mali, the research and extension services have been greatly biased towards technological interventions. Unfortunately, most of the required external inputs are either not available locally, do not meet the required quality specifications and/or are excessively expensive.

4.3 Meetings in Senegal

The stop-over in Dakar proved very useful, since the meetings with CORAF/WECARD, ISRA and FRAO covered a number of issues on research coordination, policies and methodologies that were highly relevant for the outcome of the overall study. In the following sections brief backgrounds to the three organizations are provided, as well as on the main issues discussed.

4.3.1 CORAF

CORAF was created in 1987 as a coordinating institution between the agricultural research institutes of the francophone African countries and the research and development institutions based in France. Over the years CORAF has evolved considerably by becoming the collaboration and coordination body of the West and Central African region representing also the Anglophone and Portuguese countries of the region. At present CORAF/WECARD operates a small Executive Secretariat (a total of 13 personnel including secretaries and drivers) based in Dakar, and a total of 20 regional (commodity) networks, thematic research poles (e.g. for irrigated agriculture) and base centers (CORAF, 2001). Each of these collaborative efforts is guided by a coordinator who is based either at a national or international center. For instance the rice network coordinator is based at WARDA, the one for root and tuber crops at the Crops Research Institute in Kumasi (Ghana), the one for sorghum at ICRISAT-Bamako, and the one for cotton at ITRA in Togo. Each coordinator is assisted by a steering committee and oversees the activities conducted by his network in the member countries concerned. The coordinator reports to the steering committee and the general assembly of the network that meets once every two or three years, and annually to the CORAF/WECARD Executive Secretariat.

CORAF/WECARD's aim is to establish itself as an efficient and sustainable institution for coordination and collaboration on agricultural research and development efforts conducted in the sub-region. This involves the NARES, IARCs and ARIs, but also the other development actors including the producers and their organizations as well as the NGOs and private sector. It has lined out its vision in a comprehensive strategy document that distinguishes between vertical priority commodity themes, horizontal systems-based, and transversal programs (genetic resources, biometrics, technology transfer aspects). This strategy is largely based on the national strategies formulated by the respective member countries (CORAF, 2000).

While the strategy is a useful background document, it is very broad and general, and doesn't provide concrete priorities. Actually the strategy deals with the entire range of topics that presently are covered by the CORAF-coordinated networks (10 commodity, 6 thematic and 2 systems networks, in addition to the two base centers). In view of CORAF's small size

Executive Secretary and limited human and financial resources, one could question how realistic the proposed strategy is, but also the actual portfolio of regional networks. What is CORAF's "added value" with respect to the implementation of these networks?

The proposed CORAF strategy is very "technology-biased" without a clear vision about how to cope with the "human" element that is crucial in the technology generation and transfer, as well as in the development processes. Neither does it indicate how to cope with the issues of diversity/variability (= location specificity) and the complexity of production systems which on top of that are stretched out over vast areas. For further suggestions see sections 5.3 and 6.

4.3.2 ISRA

The meeting at ISRA focused mostly on political and economic aspects of the global trade liberalization and how this affects the adoption process of improved technologies by small farmers, but also the sustainability of their farming operations. Obviously, the low world market prices for major commodities like rice, groundnuts and cotton is likely to lead to lower investments in external inputs and in soil conservation measures by farmers. In the longer term this may seriously affect the sustainability of local production systems, and thus the national food security situation. The smallest and poorest farmers and notably women and children, would be the first victims of such situation. Moreover, the other countries in the region are likely to face very similar problems in this respect. Further implications of this issue are discussed in section 5.1.1.

4.3.3 FRAO

The "Fondation Rurale de l'Afrique de l'Ouest" (FRAO) was created in 1993 and works in partnership with rural communities to improve their living conditions and the sustainability of the natural resource base on which their livelihoods depend. FRAO seeks to strengthen the local organization and knowledge of farmer communities and the effectiveness of their communication with the public sector research and development services, but also with NGOs and the private sector, through participatory methods (FRAO, 1997, 1998). It is particularly in the communication domain that biological and technical researchers (international as well as national!) and extension personnel show serious weaknesses that largely blocks the potential effectiveness from jointly conducted, on-farm technology development and transfer activities. In this capacity FRAO has been developing new participatory tools for on-farm work, has conducted training programs and has played a mediating and facilitating role between producers and development agents.

Among other activities FRAO has been mobilized by the World Bank to initiate training programs in Mali for IER staff and CRU members, and more recently by FAO to work with the WARDA-Saint-Louis team in the introduction of "integrated crop management" practices to farmers in the Senegal river irrigated rice schemes.

The meeting with FRAO staff underscored that in spite of the widespread "participatory rhetoric" among researchers and development personnel, there exist fundamental shortcomings with respect to field implementation. The common attitude of scientists' "superiority" towards extension and NGO personnel as well as towards farmers, remains serious constraint to the development and transfer of adapted technologies. Moreover, this attitude often prevents scientists from capitalizing on valuable farmer knowledge as a basis for the subsequent development of demand-generated, adapted technologies and their

effective on-farm testing. It was also agreed that inadequate communication and interview skills of most researchers and extension agents are largely to blame for the shallow results that are generated through most on-farm, diagnostic exercises.

5. ANALYSIS AND DISCUSSION

The discussion is organized broadly according to the *major intervention levels* and the major issues linked to each level. So at the macro level the emphasis will be on *policy* aspects and on the *principal actors/institutions* involved. At the meso and micro levels, the emphasis will be on *methodological* aspects, and the *technological* and *social* aspects as linked with field level interventions. Obviously, the discussion is complicated by the many factors (associated with the different levels) that in one way or another affect the impact of research results on farming.

5.1 Macro level: international policy issues and development strategies

At the macro international level the issues are mostly related to the domains of *international policy* (trade; development aid) and general development *strategies*, as applied by the international community. Both Mali and Guinea, and for that matter the other African countries face similar constraints.

5.1.1 Impact of world trade - globalization policies on the African agricultural sector

Obviously, the globalization issue that was raised during the discussions with ISRA in Senegal (section 4.3.2.) is equally relevant for other African countries where the agricultural sector dominates the national economy and where efforts are ongoing to raise production through intensification. The lowering of world market prices for major (food) commodities that results from free-trade, will provide serious disincentives to small, resource-poor, African farmers to intensify and thus invest in their agricultural operations by adopting the proposed new technologies. With agriculture becoming more permanent, due to increased population pressures, this will have potentially serious effects on the natural resource base and its sustainability. But the ramifications still go further: deteriorating rural livelihoods will stimulate the migration to urban centers and to the more prosperous countries of the Northern hemisphere, leading to increasingly complex and serious social problems.

Conclusion-1: lowered world food prices will further undermine the sustainability of African farming systems and consequently will impact negatively on the goals of poverty alleviation among resource-poor farmers and of natural resources sustainability with eventually serious implications for social stability.

The notion that free trade policies facilitate the development of an efficient, large scale, mechanized farming operation, as occurred in the Western world, is unrealistic for most African countries. Mainly so, because the vast majority (more than 60%) of the population is currently involved in farming, real incomes are very low and alternative employment options are very limited for the time being. As emphasized also by Roling (2002), agricultural development implies much more than “technology” and “market”, and includes ecological as well as socio-cultural issues that profoundly affect the efficiency and sustainability of production systems. For instance, studies in South Mali and also elsewhere, show that *the small family farm* with secure land ownership tends to operate much more efficiently than *the large industrial farm* (Quan, 2000). To place this issue in a West African context, one only has to look at the success and high yields obtained from small plots in the peri-urban settings (see Mali and Guinea case studies: the non-traditional crop systems).

Recommendation 1: The international community should support African governments in taking corrective and selective agricultural trade policy measures to protect their national agricultural sectors and ensure their long term viability in an effort to deal with food security, poverty and sustainability issues.

5.1.2 Fundamental contradictions in the agricultural development strategies for Africa

The impacts of research on agricultural development in Africa, apart from some successes, have been rather mixed. (Or perhaps expectations had been raised to unrealistic levels?) This applies in particular to the traditional sectors of staple food crops, livestock, pastures and natural forest vegetation management. In response the research and development propositions to rectify this situation are becoming more comprehensive (and costly), while the supporting coordination and administrative structures increase in number, size and complexity. Is this an appropriate response, or is there something fundamentally wrong with our strategies and approaches?

It is also common knowledge that spatial variability and social diversity are huge, that the climatic conditions are risky (droughts and floods), and that as a result the traditional African farming systems are complex (Eicher, 1999). Why then are researchers developing standardized recommendations and decision models for vast and heterogeneous areas? Why have major development and extension efforts been following standardized model approaches to technology transfer? For many years the costly T+V model has been imposed on African countries. Currently, *contract research* and *farmer field schools* are becoming the latest fashions, seemingly without questioning whether these are suitable in view of the local development conditions.

The present case studies on just Mali and Guinea highlight fundamental differences between these two countries in terms of their respective national policy environments. But also within each country and between their respective major agricultural sectors (traditional agro-sylvopastoral, cash crop-based and non-traditional systems) there are distinctly different development patterns, which need to be taken into account when designing an appropriate strategy for a country and/or a sector.

Conclusion-2: While "diversity" and "complexity" have been recognized as key features of African farming systems, neither international or national research have come to terms how to cope with it strategically. Research and development need to be far more *imaginative* and *creative* in their strategies and approaches. This is not necessarily a matter of using "modern" science and/or strengthening the social sciences as expressed by the CGIAR (2000) in its new vision and strategy.

Recommendation-2: research, development and extension services require *flexible* approaches towards technology generation and transfer to cope with variability, to adapt to unforeseen local conditions, and to capitalize on local social dynamics and informal communication. This aspect will be elaborated in the subsequent sections.

Permitting and promoting "flexible" approaches requires, however, substantial changes in the enabling policy environments and management perspectives from the ones that actually prevail in both international and national institutions.

5.1.3 Discrepancies between formal research policies and practical (farming) realities

There is "hunger" in the world and there are large areas with serious "poverty". Yes! However, there is NO shortage of food in the world (Lappe, et.al., 1998), as demonstrated also by falling food prices over the last 30 years (CGIAR/TAC, 2000). So it should be questioned, to what extent technological improvements leading to increased yields perse would contribute to alleviating hunger and poverty. What contributions could international and national *research* make that would indeed alleviate poverty, improve food security and the sustainability of agricultural production systems?

In that respect the research goals and objectives as set forward by international research administrators are becoming increasingly utopian, leading to alarming gaps between "theory" and "farming realities". In spite of the "bottom-up" and "participatory" rhetoric of many policy and strategy documents, the resulting field operations remain basically "top-down", because of inappropriate, top-heavy administrative structures (like T+V), or for reasons of inadequate tools and skills of the field staff (see section 5.4.1.).

Likewise donors are getting increasingly concerned about "impact" and the "efficient" use of funds. As a result "impact" assessments have become a common feature. Also in this respect a widening gap between the "theory" of donors and administrators, and the "practical realities in the field" is occurring. To measure impact in the field one is confronted by diverse and complex situations and issues of "how to measure" impact, at "what geographic scale" and with "what degree of precision". As a consequence the reliability of "impact" information is often questionable, because institutions tend to use it for publicity purposes, and yet the (opportunity) costs of obtaining it, are exceedingly high. While the author agrees with the need to monitor impact and to critically review and evaluate research progress regularly (annual), one also needs to be realistic about the limitations and the speculative nature of many impact assessments.

So it is not surprising that the Mali and Guinea case studies are not very positive about the contributions made by international research and development so far. Conclusion 3: the major international trade policies and the proposed yield increasing technologies have had mostly adverse effects on alleviating rural poverty[2]; the richer segments will always be better positioned to profit, and therefore the gap between rich and resource-poor farmers (officially the main target group) is likely to widen. Conclusion 4: instead of exploiting the asset of environmental and social diversity/variability, both research and development are "fighting" it through standardized "magic-bullet" type solutions and large-scale blueprint approaches.

Then what policies, technological concepts and strategies by research and development would indeed help the poorest while protecting the environment? Probably this would require **a kind of paradigm reversal** by policymakers and scientists. This study suggests that the conventional conceptions for yield increasing technologies, need to be complemented by conceptions for **maximizing efficiency in the use of *available* production factors** (time, space/location, water, plant nutrients, labour, knowledge and capital as a last resort), leading to a widened choice of technological options. As concerns the dissemination/transfer process,

[2] Arguments will differ for the *urban poor*, who will profit from lower food prices, and again with increasing off-farm employment opportunities

"learning" and social organization concepts should complement the conventional teaching and instruction approaches. In sections 5.4.2 and 5.4.3 these issues will be elaborated further.

5.2 Macro level: national policy issues

At the macro level, there are distinct differences between African countries in terms of their respective national policy environments. Overall government stability and good governance are crucial in creating the economic policy coherence and the enabling policy environment that are required for agricultural development. From it will flow the incentives for donors, the private sector and the general public to make (long term) investments. Obviously the present study can only touch these policy issues superficially. Yet, policies are a determining factor for the impact that research results can have on agricultural development. The national policy environments also constitute one of the major differences between the Mali and Guinea cases.

5.2.1 Government national policies: implications for creating an enabling environment in support of a modern, sustainable, commercial agriculture

A first major element of the national policy needs to be the recognition that *agriculture* constitutes the predominant sector of the national economy, thus impacting directly on the well being of major parts of the population. Since alternative employment options are still scarce in most of the countries, the agricultural sector deserves stable government support. For most African countries this is obviously not the case, as demonstrated most clearly in the present study by the Guinea case.

Currently there is an international trend to leave the development of the agricultural and food sectors predominantly to the private sector and/or (international) market forces. However, it is mainly the **public sector that has the general responsibility and the means to safeguard the vital, long-term interests related to equity, environmental protection, long-term food security and public health of its population**. Therefore, national governments –for the sake of internal social stability- should seek to counter-balance through their national policies some of the undesirable effects that may result from the international policies, as linked with globalization, international trade and structural adjustment.

An element of such national policy should be to raise the support for public sector research and development, thereby ensuring an essential balance between:

- *short term research activities* demanded and funded by the users/private sector, and
- *long term strategic research activities* dealing with issues of food security, equity and sustainability of the natural resource base (including essential maintenance research) that are funded through the public sector.

This balance between short and long term, and between public and private sector funding serves a dual purpose: the development of a balanced and comprehensive research agenda as well as an improved funding stability to achieve research program continuity. Currently, neither balance, nor continuity in research and development operations is found in Guinea, while for Mali considerable improvements are still possible.

Apart from the balance at national level, there is another balance to be achieved between national and international/regional coordinated research interventions that will be discussed in section 5.3.

Both international and national policymakers have so far greatly underestimated the complexity, and far-reaching policy implications that are involved in changing the traditional production systems (often shifting agriculture) into modern, permanent, sustainable and commercially viable farming systems. So far international donors, research and technical assistance have tried to bring this change about or at least try to accelerate this process, mostly through technological means, and sometimes limited policy support in the form of subsidized inputs like fertilizers. National programs for research and development have – partly under the influence of donor pressures- followed the same strategy.

However, this technological approach has bypassed a host of other problems. In particular, the need to involve a whole range of other partners composed of a **viable and competitive private commercial sector** providing agricultural supplies at reasonable prices and an effective marketing structure that handles the surplus production at reasonably attractive profit levels for the producers. Simultaneously, a **professional agricultural research service** is required that can cope with the unexpected technical and biological problems that are a common feature of an intensified agriculture. Finally, a **reliable extension service** needs to evolve progressively to signal problems timely through its regular contacts with the farmer communities, and to expose these communities to the new concepts and technologies of a modern agriculture.

Conclusion 5: to fulfill these conditions eventually requires policy interventions by national governments:

- to remove as far as possible the barriers to easy and rapid transport and national trade operations, thereby enhancing the development of a diverse and competitive private sector, and
- to ensure that the national research and extension services can rely on a stable and annual contribution from the national government's budget.

A permanent and commercial agriculture requires from the farmers, additional technical and administrative skills. Therefore, general educational aspects and national educational policies need to be an integral element of a strategy for accelerating agricultural development.

However, rather than through directive policies, this agricultural transition requires mostly **enabling policies** that create favorable conditions for development, so that locally available resources, skills and knowledge can be exploited to a maximum (Pretty, 1998), before resorting to foreign aid and external models of development.

5.3 Macro – Meso level: Major actors and institutional issues

The national research and development/extension system (NARES) and its national partners are a central issue in the present study. In the second place the question is how the NARES can benefit most from collaboration with the international/regional actors.
At this level *institutional* aspects as related to *mandates* of national research and extension/development organizations in relation to their international counterparts are of

major concern. Likewise *management* aspects will directly affect the impact of research results.

5.3.1 National agricultural research and development institutions and programs: the evolution in their mandates and scope

National agricultural research and extension systems (NARES) obviously do not operate in isolation; their functionality and effectiveness will be greatly affected by a countries' overall government stability, good governance and the extent of policy support to the agricultural sector.

For agricultural development, the national agricultural research and development capacity, should be considered as a vital element in two ways:

- it constitutes the "*first line of defense*" for a sector of crucial national importance, and
- it serves as the national linkage to the "*world agricultural knowledge system*".

The NARES of the West and Central African region have to operate most of the time with very limited resources (in terms of funds and qualified personnel). However, the scope of their responsibilities (an entire national agricultural sector, including livestock and the natural resource base) is very wide and complex.

The national programs have generally evolved enormously during the last twenty years in terms of their organization, planning and management and the quality of their respective outputs. This has been achieved through a combination of national commitments to building an agricultural research infrastructure along with large funding contributions and technical support from the donor community. Also a large group of African nationals have had opportunities to travel overseas for advanced training (MSc and PhD levels).

During the last decades, the national agricultural research institutes in most countries have increasingly been structured to cover the major national agro-ecological regions through a network of sub-centers and/or stations and experimental farms. These regionalised structures are uniquely placed for close contacts to the rural community (either directly or through linkages to national extension/development services, including NGOs) to cope with location specific agricultural problems and issues. It should be emphasized that international/regional agricultural research institutions can **in no way** substitute for this capacity to deal with local diversity and variability in agriculture.

National regionalisation is a precondition to achieve a "bottom-up" input. On-farm and participatory activities therefore need to be integral components of an agricultural research program. Without it research would become readily isolated from its major client group and thus from the farming reality. Of course this applies in the first place to the national programs; but it is no less relevant for international research. The emphasis of the latter should be different, however, by focusing on *methodological* aspects (e.g. of *participatory* research and extension).

On-farm research activities are confronted by a common dilemma: what should be the appropriate scope of field interventions? Because of the vastness and diversity of the on-farm environment, as well as pressures by the development sector (and by donors) there exist a

dangerous tendency for research to over-expand and thereby to take on "development" responsibilities. Over-expansion by research readily leads to program fragmentation, a loss of focus and excessively expensive operations. Apart from that, over-extended on-farm programs are easily marginalized by unreliable data because the technical personnel are no longer supervised adequately by the responsible, center-based scientists (see also section 5.4.1. on participatory research). These concerns are substantiated by the observations in the Mali case (for both national and international research institutions). By comparison Guinea has succeeded to create both a functional, decentralized and autonomous network of centers, as well as operational, limited-scale, on-farm interventions and studies (see Beavogui, et al., 2000).

In many countries, decentralization has encountered problems with the out-posting of scientists and technicians to often rather remote locations (Mali; Burkina Faso), as well as with a fragmentation of on-farm research over numerous locations. These are fundamental management issues that should be handled pro-actively by the research leadership, because of the serious "cost" and "efficiency/research quality" implications involved.

Counter to research, the public extension services have been linked mostly to the administrative structure of a country. In the early 90s Mali and Guinea created large and costly, multi-level extension structures that spanned the entire country, or at least major parts of it. Both followed the T+V model, which in both cases collapsed when the World Bank funding came to an end in the late 90s.

In the context of the present decentralization and privatization policies, both countries are in the process of negotiating/starting new projects with the World Bank in support of rural development. Thus in Mali the PASAOP and in Guinea the PAMR projects are getting underway. Both are based on the principle of "research and development contracts" in an effort to make the respective services more client-oriented, while operating through "producer organizations". However, also in this case it remains questionable to what extent this mechanism can continue to function after the projects come to an end, since a major part of the clientele is composed of resource-poor, subsistence farmers. Again it appears that too much attention will be directed towards building and operating formal administrative structures and mechanisms that in the end remain remote from the farmer community, while being non-sustainable in the absence of donor funding.

Even so, the present perspective on extension/development has become more realistic in recognizing that to reach rural communities widely one must:

- build partner coalitions (between: development projects, NGOs, extension, producer organizations and research), and
- mobilize the farmer community as an active participant in the process.

In coping with the problem of local rural diversity and to create the required enabling environments (with respect to communication and education) decentralized national institutions tend to be best positioned. Moreover and in view of the limited national resources (human and financial) it would have been realistic to follow a "process approach" by gradually building up a modest capacity, and by starting in those parts of the country where impact would have been most likely.

This also implies the need to increasingly stimulate and mobilize rural communities to deal with local constraints through their own initiatives through "self-help" groups, rather than being "passive recipients in a technology transfer" process. Two elements of greatest significance in this process are: *informal communication channels* and *local social dynamics*.

Donors, in their desire to demonstrate rapid, tangible "impact" on agricultural development, are often to blame for over-extended on-farm activities. On the other hand there is the inability from research management to stick to research (rather than development) priorities, while being tempted by additional short-term funding. However, the negative effects as encountered in Mali and Guinea are substantial:

- the creation of costly, over-extended/over-ambitious infrastructures and programs, that go beyond the medium term availability of adequately trained local personnel both for the research and extension sectors,
- the creation of heavy administrative structures to plan, monitor and evaluate the impact of research funding, along with an unrealistic emphasis on "impact for development" through over-extended, formal "technology transfer" efforts,
- the non-sustainability of programs once donor support is halted, reduced and/or shifted to other sectors for donor-related political purposes (NGOs; debt-relief, emergency aid, etc),
- the reliance on donor funding and an over-emphasis on "client orientation" have led to a "project-based" type of research programs that tend to lack the flexibility and continuity in field operations that are essential for research endeavors.

Conclusion 6: Donor pressures to demonstrate development impacts by national (but also international) research and extension institutions have frequently led to over-expanded programs (geographically and in content) in relation to the available *national* human and financial resources.

This has negatively affected the efficiency of research output, but has also undermined the sustainability and credibility of national institutions and their research activities. A pressing question for all of the NARES currently is: "what is possible given the currently available, national resources?" The answer to this question has been greatly distorted by the relative abundant availability of external, short-term project funds.

Recommendation 3: *National* research and development institutions should take the lead to review rigorously what are the essential national needs and where are major development impacts most likely. These should be ranked in order of priority and be compared with the nationally available resources (funds and qualified personnel) to arrive at more modest programs that will bring continuity in the support for vital, national interests. Such reviews would also contribute to the identification of major research domains of a more fundamental nature, where regional efforts will be justified (see section 5.3.5.).

5.3.2 NGOs (international and national)

From the Mali and Guinea case studies the NGOs appear as important actors in the local development process and in meeting local needs. A distinction needs to be made between *international* NGOs (such as SG 2000, Winrock International, Voisins Mondiaux, etc.) and the *national* NGOs. The former tend to be well funded and be part of extensive and influential international networks that can also mobilize important professional resources.

The latter are extremely diverse in all respects: personnel, professional qualifications, interests and funding; they often have fragmented and overlapping activities (see Mali case). In spite of their variable capabilities NGOs play potentially important roles in particular at local levels, and in terms of education (alphabetization), social organization, women empowerment, alternative employment options and creating a local dynamics as discussed under 5.3.3.

The role of the NGOs is very complementary to that of research and extension institutions and therefore merits much closer integration into the general agricultural development efforts and the scaling-up process. With respect to the national NGOs a major obstacle in mobilizing them is their fragmented nature. It should be considered a priority by the NGO group to get better organized among themselves to become an effective and reliable partner in development.

5.3.3 Local social organizations and producer organizations as elements of rural development

In "development" the components of general education and social organization of rural communities are as important as technologies. Recently, Honkounou (2001) in West Africa and Berdegue (2001) for Chile have drawn attention to both the diverse forms of local farmer organizations, their different origins, their internal dynamics (the type of leadership) and the overall relevance and motives behind their creation in explaining their success or lack of it. Their results link well with the findings in the Mali and Guinea case studies. First of all there are considerable differences in "farmer organizations" between the major agricultural sectors distinguished in this study. The strength and considerable political influence of these organizations for the non-traditional sector in Guinea is understandable. However, for a more diffuse sector like the traditional staple crops, it would be difficult to repeat.

The creation and development of regional producer committees (the CRUs in Mali; the CRRDs in Guinea) through external project interventions is proving rather complex. Identifying/selecting representative committee members and ensuring anchorage at the grass-root levels are much more problematic, than when the local organization evolves naturally because the producers feel a common need to combine forces.

Apart from the differences between the agricultural sectors, there are also profound differences in social organization and local dynamics between villages, and within villages between households and individuals. In Southern Mali the CMDT has been distinguishing for a long time between A (large and fully mechanized), B, C and D (small non-mechanized) types of households. Further studies (Stoop and Kebe, 1998; Kante, 2001) revealed that the impact of household diversity upon technology adoption/change can be substantial. Both research and development have normally bypassed the implications of this feature for their interventions. While a complicating factor when trying to disseminate routinely a standard technological package, it can also be exploited to accelerate a local development process through key individuals, thereby enhancing the local informal communication. The Guinean study village "Senghen" provides an interesting example of such a situation (see Appendix F: The Guinea case).

5.3.4 CORAF as a coordinating institution

For the West and Central African region, spanning some 20 countries, each of which has "agriculture" as the major economic sector, there is obviously scope for *coordination* and *collaboration* on research and development issues of a common interest. Presently, both these functions are handled by CORAF. In addition it serves as the "regional forum" for the agricultural development debate. Section 4.3.1. described the present CORAF program and its (draft) strategic plan. The question is whether CORAF with its extremely limited human and financial resources, should aim for these very wide-ranging responsibilities, or that it would be more effective when focused on a more limited agenda?

The author believes in the latter, provided that agreement can be reached between member countries on a concrete set of tasks and an appropriate size. As mentioned also by Janssen and Kassam (2001), the presence of a strong sub-regional organization is a prerequisite for the development of a balanced regional research agenda. Rather than claiming responsibility for an extensive program of research networks, research poles and base centers covering the entire range of agricultural sectors and systems, CORAF could play a strategically much more important role by limiting itself to the coordination aspect. Even if that were the case, CORAF would require additional professional staff to cover the major agricultural sectors: crops, livestock, forestry/NRM, agricultural development (socio-economic aspects) and policies. Moreover an ICT capacity would be essential for a regional organization.

The following indicative suggestions are made for a future CORAF:

- It needs to be a small, functional and efficient organization, with a limited, highly qualified, professional staff (about 5 to 6 senior officers),
- It should become the reference base with respect to "agriculture" (potentials and constraints) in the region, and the research and development capabilities available in each of the member countries,
- It should serve as a broker between NARES, and between NARES and IARCs in the identification of common research needs of broad regional interest and/or of common interest to a group of countries,
- It should have a financial autonomy, permitting it to sub-contract specific research projects to a relevant IARC and/or other qualified institutions in or outside the region.

To meet these conditions CORAF will have to build up its legitimacy and credibility with the member countries, with the donor community and with the other major development actors. Simultaneously, it should progressively strengthen its role as a broker and a source of funding for research projects of significance to the sub-region. This would instill a sense of "ownership" and responsibility for regional research programs also in the member countries. Moreover, it would lead to a greater empowerment of CORAF by having a degree of financial autonomy over resources that -at least partly- consist of contributions from member countries.

A coordinated regional research agenda should be constructed around a limited number of relevant, concrete themes, that can muster broad support from member countries and that are also attractive for donors to "buy into". The major themes will follow logically from the considerations of:

- objectives, priorities and direct practical needs of national agricultural sectors,
- "appropriate intervention levels" as related to major themes,
- considerations of complementarity between decentralized national research structures and a coordinated regional/international research structure,
- comparative advantages in terms of available expertise and physical facilities,
- minimal transaction costs

As such CORAF should evolve over the coming years, as a crucial, coordinating institution in the development of a regional program that is implemented partly through an integrated IARC program and partly through collaboration among NARES. The aim should be to avoid creating an additional research bureaucracy and/or to embark on over-elaborate priority-setting and planning exercises (for which it would be difficult to find the required donor funding).

Some possible research themes of regional significance that came up during the case study discussions are:

- creation of central databases[3] on the natural resource base, current agricultural systems, major production and development constraints; national research programs and their available expertise/human resources,
- (economic) policy research: a domain in which most NARS lack adequate capacity (e.g. impact of globalization and of WTO rules and regulations on the African agricultural sector and its sustainability),
- regional breeding programs (e.g. rice, maize, cassava etc); RYMV resistance breeding for rice,
- role of soil organic matter and micro organisms in sustaining long term soil fertility; contributions by different sources of organic manure; complementarity between organic and mineral fertilizers,
- water management,
- integrated control of striga,
- methodology development: participatory approaches, actor coalitions for development.

Conclusion 7: In realizing a bottom-up, coordinated regional research effort for West and Central Africa, as aimed for by the CGIAR (2000) in its "New vision and strategy", the presence of a strong regional coordinating institution is essential. CORAF still requires considerable strengthening of its human and financial resources to be able to fulfill this role successfully.

Recommendation 4: in the short term the present CORAF team should focus on developing a "medium-term plan of operations/business plan" that specifies to member countries, donors and other development partners, how it intends to evolve as an institution, how it will function and what resources it would therefore require.

[3] Obviously there is no sense in developing the respective databases if at the same time there is no guarantee of funding for the long-term maintenance; this can be considered the main drawback of the otherwise useful "project" proposed by ISRIC (Wageningen) to CORAF.

5.3.5. (CORAF) Regional Networks as a collaborative mechanism

Since the 80s a wide range of regional commodity networks have been created. Most operate currently under the aegis of CORAF, while being hosted and operated from a basis in either a national or international institute. These various networks have made important contributions in:

- information and material (germplasm) exchanges,
- training,
- breaking the scientific isolation of national scientists,
- providing support (scientific and financial) to the implementation of national research studies.

While these contributions of the networks are important, the transaction costs are exceedingly high with the annual meetings taking up a major share of the budget. In that respect the restructuring and redefinition of the WARDA/WECARD rice network/Task Forces in 1999 has set a useful example:

- reduction of the number of Task Forces,
- one shortened (4 days) regional meeting/conference once every two years,
- complementary funding on a competitive basis for an increased number of national rice research proposals of regional significance, that are implemented under the Task Forces program, and
- funding of regional monitoring tours by combined teams of national and WARDA scientists.

The present study has been unable to look in detail into the functioning of the various networks. However, questions can be raised about their effectiveness and about what purpose it serves to have all of them attached to CORAF? After all, CORAF completely lacks the human resources to oversee this wide range of networks.

The networks regularly span more than ten countries, while being handled by a single coordinator. There is no way that this person can provide more than limited, mostly administrative support. Consequently, the potential spill-over effects in terms of the creation of a data/knowledge base about the participating countries, focused support to specific national needs and capitalization on the results achieved by individual members for a wider regional purpose, do not materialize.

Presently the contributions by regional networks tend to be overvalued as far as *data quality* and *scientific relevance* are concerned. In several cases the supplementary financial support provided to the NARS for the implementation of network trials has become crucial in maintaining a minimum level of operations in the absence of adequate national funding. As a result the value of the scientific output is marginalized, and the justification for such networks might eventually be jeopardized.

Successful networks require initiatives and dedicated scientific inputs from the *"bottom"* i.e. from motivated scientists in the individual member countries. One or two experienced senior scientists could then ensure overall coherence and guidance as well as the regular exchange of results from the *"top"*. The reality in the region is, however, that most networks are driven predominantly from the "*top*", mainly because of funding/donor arrangements.

5.3.6 Donors, CGIAR and IARCs policies and research strategies

Certain shortcomings in the policies and development strategies originating at the international level when judged against the specific needs and conditions of individual countries, have been signaled already (sections under 5.1.). This implies that the international level is not always positioned appropriately to resolve issues of more local concerns and importance.

CG Centers, being positioned at the macro-international level, have to focus on "broad and major technological and policy issues". As a consequence the Centers need to accept that they are rather distant from field level realities, in particular the problems associated with the variability and diversity in the natural resource base and with local social/cultural environments. Irrespective of the considerable competence and financial resources available at international levels, these constraints must be faced by donors as well as by the international scientific and development communities. In spite of the ambitious goals for poverty, malnutrition and hunger alleviation, while protecting the natural environment that the CGIAR has set (CGIAR/TAC, 2000), these issues fall largely in the "national policy research" domain.

Moreover, research at the Centers is dominated by technical and economic disciplines that lead to a focus on technological improvements and economic impacts. These biases may lead to technological options that in the context of resource-poor national programs and as related to hands-on "agricultural development" for resource-poor farmers, are inappropriate. Moreover, the disciplinary research focus (as associated with "Centers of excellence") leads readily to a degree of *compartmentalization and reductionism*, because the "human/people" component in the research and adoption processes tends to be bypassed. This is compounded by increasing donor pressures for rapid "impacts" and the resulting emphasis on short to medium term, (spectacular) quick-fix technological outputs. However, there is a need to view and to address agricultural development problems and constraints from more than just one angle by employing multi-dimensional approaches (Gubbels and Ghimire, 2002). This applies as much for policies and organizational issues, as it does for technologies.

Increased food production can be achieved technologically in different ways; some will be quicker, less costly and with fewer unknown risks (health and environment) to producers than others (compare solutions derived from genetic improvement, from genetic engineering or just simply from agronomic research). Different research strategies and approaches (at various levels of sophistication) tend to be associated with large differences in research costs and efficiencies, but may also have ramifications for the subsequent dissemination and adoption process. Agricultural production systems based on liberal use of external inputs will always be more costly to farmers than a more *knowledge-intensive*, integrated crop management approach. The latter firstly seeks to adapt the choice of the crop (and its varieties) to best exploit the G x E interactions and the naturally existing potential of the resource base, and secondly to optimize the crop growth environment through limited external inputs (for details see section 5.4.3.). If indeed our target group is the *resource-poor farmer* and our objective *poverty alleviation* than the latter system would be the most appropriate.

As analyzed in the past for the "Green revolution" in Asia, food production in uniform, high potential areas can be successfully increased. It has been well documented, however, that this bypasses the specific needs of the poorer sections of the rural populations. For the marginal and risky environments that prevail in most of Sub Saharan Africa, this same social phenomenon will be even more pronounced. Conclusion 8: In view of the marginal and risky agro-ecological environments of SSA, the Centers have to a large extent followed inappropriate research strategies that were overly inspired by "Green revolution" concepts.

As mentioned already under 5.1.3, it would require a mere paradigm shift for scientists to be able to correct this (see section 5.4.). And yet, IARCs should be expected to achieve this and thereby capitalize more effectively on their considerable intellectual resources by conducting imaginative research (NOT the same as "modern science") on issues of practical relevance, that are beyond the capacities of the NARES. This applies equally to biological, technical as well as social and economic disciplines.

While the author is fully aware that the current donor environment with its short-term emphasis on development and impact, is rather unfavorable, the IARCs do have sufficient independence (through unrestricted core funds) to ensure balanced research agendas. Such agenda should cover both the "short-term donor wishes" through special projects/contract research, and the longer term needs for the development of creative, non-conventional research for which the NARES often lack the human and financial resources.

Another concern should be that the heavy governance structure of the CGIAR system (presumably covered increasingly by the *unrestricted core funds*) and the administrative demands that follow from it for individual scientists, has started to interfere with "creativity". Principal scientists tend to be overloaded increasingly with non-research tasks, which cannot remain without impacts on their scientific performance.

The CGIAR and IARCs have over the years increasingly created an "excellency" and "success" culture around their various operations. In many cases this has resulted in paternalistic attitudes that have negatively affected relationships with national programs. A serious drawback of this CGIAR culture is that it interferes with realistic assessments of the comparative advantages that flow from its international and sub-regional position in the agricultural development continuum and therefore its complementary status and role in relation to their national partner institutions. But even more serious this culture prevents the Group from facing its limitations and failures.

5.4 Meso – Micro level: field interventions

At this level *organizational* and *management* issues prevail as related to interactions between regionalised research services and the scaling-up activities by development and extension services

Here the agricultural development continuum is confronted by the problem of technology generation for different agro-ecological environments. And next how to *adapt technologies* to specific local conditions to ensure adoption and impact on agricultural production. Also at this level the *participatory approaches* and the local social dynamics become key elements in the dissemination /scaling-up process.

5.4.1 Methodologies and participatory approaches in development-oriented research

In spite of the widespread and common "participatory" and "demand-driven" rhetoric in research proposals and reports, the author considers this still a major weakness in both international and national programs. There are a lot of on-farm activities going on in terms of tests, demonstrations and surveys, but many do not deserve the classification "participatory", and are implemented in the usual top-down and supply-driven fashions.

The shortcomings show up in several ways:

- the outcomes of diagnostic surveys or constraint identifications of the type "the soil is poor"; "the variety is no good" or "weeds are a problem" - - - . Such information is too general to be useful, and does not permit a focused and effective response by thematic specialists, nor does it provide any insight in the dynamics of farm operations,
- the same holds for formal surveys conducted routinely through standardized questionnaires, where masses of data are collected by technicians,
- the format in which the results of on-farm experiments are analyzed and presented tend to be the same as for on-station experiments (i.e. treatment means). Yet, the main reason for working on-farm is to involve and expose the farmers (individuals or groups) and to get information on the socio-economic acceptability/constraints associated with the proposed technologies. By presenting the results as "means" much of the information is effectively eliminated,
- inappropriate use of "farmer trials": there is a common belief that "farmer trials" (designed by research and/or extension) ought to be simple (i.e. only 3 or 4 treatments) and need to be implemented in large numbers (preferably covering tens of farmers). Field implementation including field lay-out, data collection and analysis are therefore left almost entirely to poorly supervised technicians, the responsible scientist being too occupied to spend adequate time in the field.

What kind of viable conclusions could possibly be drawn from such efforts? To what extent are these efforts indeed "demand-driven"? Will the considerable costs (vehicles, gas, per diems, inputs, labour, etc.) weigh up against the meager results and shallow conclusions of such efforts?
In many cases the major objective of going on-farm –that is to obtain socio-economic feedback from the farmer community- is not realized.

These shortcomings cannot be rectified very easily. A classroom-training course of one or two weeks for technical scientists and/or technicians will not solve the problem, nor does the introduction of additional interventions that have not been thought through adequately from a pluri-annual development perspective.

As commented earlier the research and development interventions have been largely technology-biased. This is not surprising, since both international and national research institutions are dominated by biological and technical scientists, who have never received any formal training in the social sciences and who do not have any experience with interviewing techniques. This is a widespread problem throughout the region that was underscored also by FRAO during the discussions in Dakar. Another handicap is that most agricultural scientists nowadays do no longer have a farming background and thus lack an appreciation of the risks and labour bottlenecks that are integral parts of any farming operation. This problem is

compounded by the present popularity among scientists of computer modeling techniques, at the expense of time spend in the field and the ability to make professional field observations. Conclusion 9: increasingly scientists (national and international) attempt to improve production systems of which they hardly know, let alone understand, the intricacies of the mechanisms and processes (biological, ecological, technical and socio-economic) involved.

In recent years "participatory variety selection" (PVS) and "community-based seed systems" (CBSS) have been interesting approaches to involve farmers in identifying promising varieties and their desirable traits, and to multiply seeds locally in the absence of a private seed industry. But considerably more thought needs to be given to raise these interventions beyond a "one-off" variety/seed multiplication intervention and to link it to the existing local knowledge, the livelihood systems and to the informal communication systems in a multi-stakeholder context.

In Mali there are reports about reduced farmer cooperation, because farmers were getting tired of questionnaires and tests. Rather than reflecting lack of collaboration by farmers this may well indicate a non-professional approach by research and extension personnel. Conclusion 10: communication between producers and research/extension is still inadequate, because of a lack in "interviewing skills", "time constraints" by senior personnel, and a lack of logistics permitting scientists to stay in the field for adequate periods of time.

5.4.2 Social organization: Field implementation and organization of participatory approaches

The farming environment in Africa is so stretched out and variable with small communities in remote places, that any formal national organization faces an impossible physical task, apart from the lack of professional staff and financial resources. The recent failures in Mali and Guinea to establish such extension services underscore this problem.

Continuation of the formal, conventional project format aimed at building administrative (top down) bureaucratic structures complemented by artificial hand-outs in the form of inputs and credits to the poor, or the temporary funding from project resources of local farmer organizations (CRU or CRRD) will not prove sustainable either. So what alternatives remain?

Maybe a complete rethinking of how to cope with extension and development under these conditions is required. This report has emphasized repeatedly the importance of indigenous knowledge and technologies, of the local social structures, of local dynamics, and of informal processes (communication and experimentation). It is suggested, that research and development (involving biological, technical as well as socio-economic aspects) need to capitalize on these processes and reinforce these through "lean" projects that follow a "process approach" while using local social dynamics as a criterion for initiating interventions (see also: Sherwood and Larrea, 2001). The mechanical, blue print and blanket approaches of the past, have largely ignored the crucial factors of local motivation of individuals and communities, and of informal processes. As demonstrated by the Senghen village study in Guinea this approach is not necessarily very complex, but requires the "human" component. Motivated research and extension personnel, open communication, awareness of informal processes and of local (social) dynamics are probably more effective in technology transfer and in accelerating agricultural development, than creating multi-layered bureaucracies following formalized approaches.

Key elements are a *client* and *problem* orientation (see Beavogui et al., 2000) that exploit local indigenous knowledge, both in terms of technologies, social organization, local rules and regulations; it is mainly through an emphasis on local communication structures that the development process is enhanced through:

- creation of local farmer groups/organizations,
- farmer-to-farmer communication,
- the mobilization of prominent farmers in the community as local advisors, and
- the recognition of different social strata in the target population.

Conclusion 11: In coping with the agro-ecological and socio-economic variability and diversity typical for African agriculture, the mobilization and strengthening of local capabilities and knowledge needs to be emphasized increasingly. In other words one should seek to strengthen the local capacity to deal with its own problems through informal experimentation and/or through farmer groups/farmer field schools. In general, the local educational level will be reinforced by facilitating communication and learning, rather than through standardized prescriptions.

5.4.3 Technology generation, testing and dissemination

An issue of considerable concern to resource-poor farmers is the unavailability of inputs, their high costs and/or inappropriate or even unreliable quality (see Mali and Guinea study villages). As recorded also in the case studies technology development and the subsequent scaling-up tend to bypass key elements of agricultural livelihood systems, notably the "variability" and "diversity" aspects, as well as the "peoples" factor (Kwesiga et al. 2001; Sherwood and Larrea, 2001). Consequently, **the bulk of the technologies proposed by research and extension are basically supply-driven and rely heavily on external inputs** (see on-farm experiments and demonstrations as conducted by SG 2000).

In spite of the "poor farmer" target group and the official research goal of "poverty alleviation" little innovative research (international and national) is being conducted that is aimed specifically at these issues and towards forms of agriculture that are specifically adapted to these conditions. Such forms would have to be based on agro-ecological adaptation in combination with cultural practices that permit minimal use of external inputs. Indigenous knowledge, as expressed through traditional production systems, tend to provide important leads for this type of research. Its concepts involve an effective exploitation of "G x E interactions" by using different land types within farms for different crops and crop varieties through intricate cropping systems (Vierich and Stoop, 1992). Other local concepts (photosensitive varieties; early seeding; crop adaptation to major different soil types; and intercropping) that permit a more even distribution of labour and risks over the season (van Staveren and Stoop, 1984; Stoop, 1987) are also particularly relevant to the target group. The relevance of these concepts increases further for the marginal and risky environments that make up major parts of SSA. The point is that imaginative research could exploit these concepts to arrive at a better understanding about the biological/technological processes and mechanisms involved in agricultural production, and how these can be influenced to the benefit of the producers (and ultimately the consumers). In a recent paper by Stoop, et al. (2002), similar possibilities have been explored for rice with quite amazing results in terms of the "knowledge gaps" that even to-day exist for this "well-researched" crop.

In a rather similar way, the relevance of informal "farmer-to-farmer" communication and trade, as well as the role of informal, on-farm experimentation are widely underestimated and hardly exploited by formal research and development approaches. There are at community levels nearly always a number of individuals that are particularly knowledgeable about the properties of various locally available varieties (Richards, 1985). Moreover these people tend to be involved in local seed selection, multiplication and distribution and/or trade (Jusu, 1999). Though these local seed systems should not be over-idealized, this local knowledge and the resulting informal local trade/exchange in seeds are valuable elements of a traditional agriculture (Tripp, 2000). Only rather recently has WARDA been capitalizing on this local knowledge in multiplying and disseminating the new NERICA rice varieties in Guinea through the "Community-based Seed Selection (CBSS) system (Beye, 2000).

As emphasized by Tripp (2001) each new technology is associated with various types of "quality information" according to the ease with which it can be transmitted. He thus distinguishes between *"search quality"* which includes readily visible features; *"experience quality"* which becomes clear during field observation, and *"credence quality"* which involves non-readily verifiable characteristics like improved nutritional quality (increased protein or vitamin A contents). The types of quality information have serious implications for information management, but also have ramifications for farmer education, and the abilities of public and private sectors to deliver essential information and to build up a reputation for reliability and credibility. This raises the issue of *farmer confidence* in public sector research and extension institutions, which for good reasons (unreliability and incompetence) is very low in most countries of SSA. In this respect actor coalitions/platforms might be in a better position to accelerate "agricultural development" and to cope with the diversity of issues that will all affect the impact from research results.

6. SUMMARY AND CONCLUDING REMARKS

This study concludes that the causes for low adoption rates of research results find their origin at different intervention levels and are of different (interdependent) types. Most far-reaching are the constraints identified at the highest international and national (policy) levels, because these have ramifications up to the local grass roots. Creating the right (enabling) policy environment will most likely resolve many of the lower level constraints.

In general African countries were poorly prepared for independence. As a consequence many countries have had to rely excessively on foreign expertise, leading to an "expert/consultant culture". In many cases this has led to very costly, often over-ambitious projects (not in line with the national/local resources, needs and cultures). This indeed should be considered as one of the major causes for the current foreign debt crisis of many African countries.

The "expert" culture tends to rely on "success stories" from elsewhere often copied uncritically. In that way approaches, like the T + V system and currently the FFS model, are being promoted as blueprint solutions. Frequently these approaches can be proved inappropriate and/or requiring substantial revision when viewed and analyzed more comprehensively against the local conditions (agro-ecological as well as socio-economic and cultural) and the national policy environment. Unfortunately the expert culture has instilled a form of over-dependency on foreign advice and foreign tools in many African countries.

Generally, the "experts" have been pre-occupied with technology development and economics; the influence of human/social sciences has been weak or even absent. As the development emphasis has been shifting increasingly to issues like poverty alleviation and technology transfer, the weakness in social sciences becomes a serious handicap (at international and national levels). Moreover, the "expert culture" has also been responsible – for efficiency reasons- for the introduction of management principles that were largely copied from the western industrial sector. Many of these principles are particularly suitable for mechanical, routine processes, but not for a *research* process. The latter needs to be creative and imaginative, requiring flexibility to cope effectively with diverse and complex problems typical for African agriculture. In this context also many forms of transnational regional research are vastly over-rated; it certainly tends to be far removed from the principal client: the poor producer.

"Agricultural development" involves widely different aspects ranging from research and extension to general education. Education applies to all actors involved in the development continuum, though in different forms and ranging from primary schooling to university levels. From the analysis about the constraints to technology transfer, it follows that some of the problems find their origin in the University curricula through which national research and extension personnel are trained. Closer collaboration and integration between NARES and the agricultural faculties of the national Universities therefore is highly desirable.

Training and education have always had major attention from donors and the international centers. It has been, however, of a rather "static, top-down, mechanical" nature of passing on information and skills often through short courses of one or two weeks using rather standardized training packages. By contrast an emphasis on "learning" provides a more open and dynamic environment, that permits to learn from errors committed in the past. To cope effectively with the African development problems will require a greater reliance on non-conventional processes and approaches like farmer participation, informal communication

and learning-by-doing types of interventions (Roling and Wagemakers, 1998). This will involve quite fundamental adjustments in the way institutions are organized and managed, and in the approaches and methodologies used. This applies also for the education facilities, ranging from primary to university levels.

According to this study the ***primary*** causes of low adoption rates of research results –in particular for the marginal environments of West and Central Africa- can be summarized as follows:

At the **international level**:

- Conceptual gaps between "scientific theory" and "management theory" versus the "practical, grass root realities of African farming" (in theory: "bottom-up and demand-led" approaches; in reality: "top-down and supply-led" approaches). This gap finds its origin in the "expert/superiority culture" associated with international technical assistance organizations, leading to the constraint of "over-ambitious/over-stretched projects" (see below).

At the **national level**:

- Absence of adequate national policies in support of the agricultural sector. Leading to:
    - Lack of incentives for the private trade and transport sectors, resulting in non-availability of agricultural supplies and services, and inadequate marketing facilities,
    - Ineffective national services for research and extension largely because of poor continuity in their interventions resulting from their "project" (temporary) status.

The above primary causes lead to a wide range of ***secondary*** causes:

- Over-ambitious and therefore non-sustainable (project-based) institutional developments, operating on basis of blueprint approaches; the resulting services have poor continuity because of the limited, longer term, availability of *national* human and financial resources,
- Inappropriate research and development approaches:
    - Research strategies (international and national), leading to technology-biased results of limited relevance to a majority of (resource-poor) farmers; research strategies biased towards yield increases, instead of yield stability and production factor efficiency (time, space, water, plant nutrients, labour, etc) under marginal environments;
    - Technology transfer approaches pre-occupied by technological impact, bypassing the "human" factor concerning local organization, (informal) communication, actor-coalitions and learning/educational aspects,
- Inefficient/irrelevant technologies with respect to local input, labour and knowledge constraints as result of an inappropriate research strategy (see above),
- Absence or weakness (lack of empowerment) of local producer organizations, leading to absence of a grass-root policy influence, and ineffective producer feedback to research and extension agencies,

- Poor integration between national development and national education (from primary school to university).

In response to these constraints a number of general **recommendations** are made:

a) in view of the unsatisfactory record of donor projects and their often limited impacts, the African institutions and African experts should accept increased responsibility for planning and project formulation,
b) national governments have to face up to the crucial importance of the agricultural sector to their populations by making annual budget allocations to their national agricultural services institutions, that would permit a minimal level of continuity in their operations,
c) instead of following some kind of costly blueprint model or procedure, proposed projects should aim at a maximum degree of flexibility in terms of implementation,
d) a "process approach" of progressively building institutions and by gradually increasing geographic coverage is required; first on basis of available national resources (human and financial) and secondly through complementary support by external donors and technical assistance,
e) research strategies should aim for improved knowledge and understanding about *mechanisms* and *processes* (biological, ecological, technical, socio-cultural and economics), that operate in agricultural production and development processes. Such knowledge would permit a more efficient use of resources/inputs, instead of trying to solve "symptoms" through "magic bullets",
f) strengthening and empowerment of producer organizations,
g) reinforcement of University curricula with items from the social sciences involving interviewing/communication skills and participatory techniques for technical students with the objective to introduce a holistic multi-dimensional perspective to agricultural development at an early stage in the education.

With reference to a) and b) above and in view of the very limited financial resources available for research at national as well as international levels, a coordinated regional effort is highly desirable. Such effort should be based on:

- firstly, autonomous, modestly sized and decentralized, national research institutions that operate in close collaboration with the other national development actors to reach effectively a maximum of rural communities (see the Guinea model as described by Beavogui et al., 2000),
- secondly a modest regional *coordinating* institution (CORAF), that is financially at least partly supported by contributions from each of the 21 member countries. The national contributions to CORAF would raise its legitimacy and credibility as regional research coordinator between NARES, between NARES and IARCs and in its negotiations with the donor community. Even to fulfill a regional mandate – limited to coordination-, CORAF would require a doubling of its professional staff from the actual 3 to at least 6.
- thirdly the IARCs would work increasingly on more fundamental issues that are beyond the capabilities and means of national programs. In addition they would work (on a special project basis) on problems/constraints of a common regional significance that are defined in collaboration with the NARS/CORAF, and eventually funded through CORAF.

The poorer and more marginal the agro-ecological environment, the more diverse and variable the constraints, so that the possibility of identifying "sweeping" solutions should be considered very unlikely. Solutions will be varied and highly location-specific, and will require the mobilization of the population at grass root levels. Local institutions and flexible approaches should guide such process. This implies that international agencies (including the CGIAR, and except for **the policy and conceptual domains)** are not adequately positioned to resolve it. Their contribution should be in providing flexible guidelines and general methodologies. There is a parallel here at the human level of "poverty", which also is a very diverse problem for which local people are going to exploit a wide range of alternative solutions, not one blueprint.

Research institutes –certainly the IARCs- should increasingly take the lead in focusing their research on biological, ecological, technological and socio-economic mechanisms and processes that operate in agricultural production systems (crops, livestock, fish, forestry, - -). The aim is to improve the "efficiency" of these production systems, permitting a greatly reduced external input use and reduced environmental pollution and health hazards, as well as raising the "quality" of the agricultural outputs. Ultimately research needs to prepare for more "knowledge-intensive" agricultural production systems that will be based on a more informed use of external inputs in combination with local production factors.

The *mechanisms* and *processes* involved will be similar under a wide range of conditions; however their *relative importance* and *intensity* will be determined by local factors, requiring the development of location-specific adaptations for which decentralized national institutions are ideally positioned.

In this perspective and from an institutional viewpoint IARCs should therefore seek to capitalize on their considerable scientific human capital and physical facilities to conduct innovative research (which is not necessarily of the "modern" or "cutting edge" type) that goes beyond what national institutes can handle. To better link national interests and to have indeed a bottom-up regional input, the strengthening of CORAF as a representative and effective interlocutor for the member countries will be a very first requirement in realizing a coordinated regional research approach. In this process all the institutions involved need to recognize their respective strengths but also their limitations and weaknesses thus permitting a most efficient exploitation of their mutual complementarities.

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APPENDIX A

TERMS OF REFERENCE

"A study about the causes for low adoption rates of agricultural research results in West and Central Africa; possible solutions leading to greater future impacts"

Terms of Reference for Willem Stoop

CGIAR Vision and Strategy:

In 2000, the CGIAR adopted a new Vision and Strategy. It defined its vision as "A food secure world for all." Its overall goal was defined as "to reduce poverty, hunger malnutrition by sustainably increasing the productivity of resources in agriculture, forestry and fisheries." Its mission was defined as: "to achieve sustainable food security and reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, livestock, forestry, fisheries, policy and natural resources management."

The scientific, institutional and policy outputs associated with this vision-goal-mission framework are, by themselves, insufficient to achieve the CGIAR's vision and goal. It is their dissemination and uptake by farmers, national research systems, civil society, private sector, policy makers and governments in developing countries that will be required to achieve the vision of a food-secure world. This will require the CGIAR to work more closely with other components of the development spectrum in determining its research priorities and in ensuring the dissemination of its research outputs. These outputs will be essential tools for promoting sustainable agricultural development, and hence in reducing food insecurity and poverty in a broad range of environments.

To implement the new Vision, CGIAR endorsed the idea of developing a two-pronged approach for the future in support of research and research-related activities to contribute both to the reduction of poverty and to improving food security. This would entail support for research on agriculture and natural resources to address the needs of the poor in the more favoured environments to ensure food security and prevent future poverty, while at the same time tacking the more complex problems of poverty in the marginal and hard areas. This strategy entails clearer targeting of the needs of people and how they will benefit from the research supported by the CGIAR. The focus of the CGIAR are the rural and urban poor, including farmers, fishers and on-farm workers and poor urban consumers.

Seven strategic planks have been identified that underlie the strategy outlined above to focus on poverty reduction and prevention, using the best and most relevant science in the most effective and efficient ways possible. These planks are:

1. *People and Poverty Focus*: Focus the CGIAR research agenda on people and the reduction of poverty, hunger and malnutrition in developing countries;
2. *Modern Science*: Mobilize new developments in social, biological and physical sciences to address the priority researchable issues;

3. *Geographic Priorities*: Give highest priority to developing a concerted approach to address the research needs of Sub-Saharan Africa and South Asia;
4. *Regional Approach to Priority Setting and Research Implementation*: Adopt a regional approach to research planning and implementation and integrate this with global priority setting;
5. *New Partners in Science and Development*: Seek new partners for problem identification, research, and dissemination of research outputs;
6. *Task Forces*: Use task forces to address priority problems in new and flexible ways;
7. *Catalytic Role*: Strengthen the role of the CGIAR as a catalyst and integrator of knowledge in support of NARS and the global agricultural research system.

The rationale and implications of the seven planks are discussed in the attached document entitled "Vision and Strategy for the CGIAR". Planks 1-4 have programmatic and investment implications for the CGIAR and its research agenda. Planks 5-7 relate to the more efficient implementation of the CGIAR's research agenda. Achieving impacts on poverty with the greatest efficiency and effectiveness possible in a given national and regional context is likely to require introduction by the CGIAR of a number of new institutional mechanisms and reorientation of others that have been used in the past.

In order to address more effectively the regional heterogeneity of the causes of poverty in the regions, the CGIAR, in close collaboration with its partners, will **adopt a stronger regional orientation in its research planning and implementation**. Also, the CGIAR will **diversify and expand its partnerships** to ensure that its limited resources are effectively leveraged in addressing the problems of the poor.

Your Consultancy:

The study will look into the following issues:

- the appropriateness of currently available improved technologies given the agro-ecological and socio-economic conditions in the region,
- the efficiency of the present technology transfer mechanisms in widely reaching the producers,
- the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies, and
- implications of the above issues for the new CGIAR regionalisation strategy, leading into recommendations towards an increased impact of its future research efforts.

Implementation and work plan:

The study has two components that will be implemented more or less simultaneously, and yet from slightly different angles to permit greater complementarity:

a) Dr. W.A. Stoop operating from the perspective of national research and development institutions in support of local client groups.
b) Dr. L. Brader, operating from the perspective of a consolidated CGIAR Center research program in support of a regional research agenda, and

Through these two components the scope of the study will be broadened, while its cost and time requirements will be reduced.

For the component sub a, for which you are responsible, the following phases and itinerary are proposed:

- Preparatory phase (till early January 2002): discussions with resource persons in The Netherlands from DGIS, ISNAR and Wageningen; review of documents; preparation of interview guide for different groups of stakeholders;
  Field study (January till early February 2002):
  a) 3 weeks in Mali with discussions/interviews in Bamako (IER, PNVA, ICRISAT), Sikasso (impact of 20 years FSR and of Inland Valley Consortium collaboration), Cinzana (impact of 20 years support by the Syngenta --formerly Novartis -- Foundation) and Niono (impact of WARDA Task Forces collaboration),
  b) 7 to 10 days in Guinee to follow-up on the progress made in the interventions by IRAG and SNPRV through the "villages d'étude" approaches, initiated in 1999, and
  c) 3 days in Senegal meetings with ISRA and CORAF.
- Report writing (February 2002): partly during the field study and finalization in The Netherlands; consultation with FAO/TAC/GFAR in Rome (3 days in February); submission of a draft report to TAC Secretariat by the 20 February 2002 for comments.
- Presentation of findings and conclusions (first half of March 2002) at a CORAF/WECARD Workshop of 2 to 3 days in Dakar.

The field studies in Mali and Guinee will be conducted together with a counterpart from the respective national program.

You should submit your final report in an electronic form to TAC Secretariat (Dr. Shellemiah Keya, Executive Secretary, shellemiah.keya@fao.org) by 22 March 2002.

APPENDIX B

ITINERARY OF THE MISSION AND PEOPLE MET

October	
25, 2001	ISNAR, Dr. Paul Perrault
November	
21	ISNAR, Dr. Willem Janssen
22	Wageningen University, Prof. A Kuyvenhove
26	" " Prof. P. Richards; Dr. S. Kante (IER)
29	DGIS, The Hague, Mr N. Tamminga
December	
14	Wageningen, IAC: Mr F. Neuman; ICRA, Dr D. Enserink
18	Wageningen University, Prof. N. Roling; Dr. J.J. Hardon
19	" " Dr. Julio Berdegue
January	
7, 2002	KIT, Amsterdam: R.M.G. van Poelje, H.J.M. Verkuijl; A. Blokland (techn. assist to IER)
9	Departure Amsterdam; Arrival Bamako; Meetings: Dr. Niangado; P. Kleene (conseiller URDOC)
10	Meetings Bamako: - Sasakawa Global 2000: Dr. M. Galiba (Directeur), M.Camara (coordinateur regional sorgho-mil); - ONGs nationales: Mme A.Kanoute; Djibril Kone(ADAF/GALE); Moussa Sogoba; Yacouba Tangara (GRAT); Mamadou Mariko (AMCFE); Seydou Togola (STOP-SAHEL) - Ambassade des Pays Bas: Mme Monique Calon - CNRA/CORAF: Dr Adama Traore
11	- IER Direction: Dr. B. Teme (DG) and A. Cisse (DGA) - ICRISAT-Bamoko: Drs. B. Shapiro, O. Youm, E. Weltzien-Rattunde, J. Ndjeunga, R. Tabo, et I. Akintayo - Direction nationale de vulgarisation (DNAMR): A. Sidibe (Directeur) and A. Sangare (Cellule Liaison Recherche – Developpement)
12	- ICRAF/ICRISAT: Dr. A. Niang
13	Travel Bamako to Sikasso
14	- CRRA de Sikasso: Dr. A. Hamadoun (Directeur); - Dr. Zana Sanogo (Chef ESPGRN et Animateur de College scientifique); - Meeting Programme Recherche forestiere: H. Yossi (Chef) and scientists
15	- CRRA de Sikasso: - Meeting ESPGRN scientists: MM M'Pie Bengaly and Hamadi Djouara - Meeting NCU of Inland Valley Consortium - Meeting CRU Region de Sikasso: Mmes Korotoumou Kone, Aissata Coulibaly, Dienebou Sidibe, Alidiata Traore and M. Mohamadou Bengaly.

	- Meeting GDRN: Celestin Dembele (coord.), Amady Coulibaly and Almami Traore.
16	- Field visit to Noyaradougo (test village of ESPGRN); discussions with farmers. - Meeting with Program “Riz de basfond”: M. Fousseyni Cisse - Meeting Program “Fruits et Legume”: Nangazana Kone (agrumes)
17	- Meeting Direction Regional CMDT: M. Oumarou Aya (Directeur regional), Mamadou Diarra (Chef Ediv. Developpement rural
18	- Meeting: Chambre d’Agriculture: Sountoura Bakary (Secretaire General) and Salif Diarra (conseiller technique) - DRAMR: Seydou Keita (Directeur regional), Abdoulaye Sanogo(Promotion des filieres agricoles, Amadou Coulibaly (Statistique Suivi-Evaluation), Natouye Bougoudogo (Documentation - Information), Nanko Mariko (Conseil rural, vulgarisation agricole), Jean Pierre Diabate (Appui du monde rural), Manassaro Togo (Formation). - CRRA Sikasso Programme Coton: Tereta Idrissa (Entomologiste) Travel Sikasso to Koutiala
19	Meeting: M. Ferko Bodnar (DDRS, impact evaluation soil conservation)
20	Travel Koutiala to Cinzana
21	- Meeting Equipe SRA Cinzana Station: Samba Traore (Chef et Agronome), Seriba Katile (Phytopath), Sory Diallo (selection niebe), Aly Boubacar (selection sorgho), Moussa Sanogo (selection mil), Mamadou N’Diaye (entom.) and Diakalia Sogodogo (ESPGRN).
22	- DRAMR Region Segou: Idrissa Diawara (Directeur), Makono Tangara (Chef Div. Conseil Rural) and Abdoulaye Traore (Chef Section Liaison Rech./ Dev.) - Meeting CRU Région Segou: Brema Traore (President),
23	- Meeting ONG Voisins Mondiaux: Bianivo Mounkoro (Directeur) and Siaka Traore - Meeting ICRAF/IER: Dommo Timbely and Mme Anne Marie Lemay (Univ. Laval). - Travel Segou to Niono
24	- CRRA Niono: Dore Guindo (Directeur) - Equipe SPGRN: Daouda Kone (Chef and animateur college scientifique) and scientists - Equipe Riz irrigue: Mamadou Coulibaly (chef) and scientists; Bangoly Cisse (Delegue Fruits et legumes);
25	Meetings in Niono: URDOC: Yacouba Coulibaly (Chef), Yacouba Sangare, Kongotigui Bengaly, Mamadi Keita (URDOC2 staff); Youssouf Dembele (Repr. POP Zone Niono); Oumar Coulibaly (Chef SLACAER Niono) Meeting: Amadou Mariko (Chambre d’Agriculture, Niono), Yacouba Diallo and Youssouf Berthe (Producers)
26/27	Report writing; field visit to vegetable production fields around Niono.
28	Travel Niono to Bamako Meetings IER: Ecofil: Alpha Kergna; Demba Kebe and H.J.M. Verkuijl (KIT).

29	Visit to CRRA de Sotuba: Meetings: Lassine Diarra (Directeur Centre). - Meeting Equipe LaboSol et Agro-ecologique: Mamadou Doumbia (Chef), Aminata Sidibe, Souleymane Dambe, Siriba Dione, Abdouramane Yorote, Cheick Diakite, Mamoutou Kouressy, Adama Bagayoko, Didier Bazile (CIRAD); - Meeting: N. Coulibaly (Chef Progr. Mais); A. Toure (Chef Progr. Sorgho) - Meeting: Equipe SPGRN: Abou Berthe (Chef), Samba Soumare, Mme Cisse Oumo n Traore (Labo Techn. Alimen.), Salif Traore, Mme Sow Penda Sissoko, Mme Sissoko Haona Traore, Diby Diakite, Boubacar Traore.
30	- Synthese de mission CORAF / IER: Adama Traore (CNRA/CORAF; President); Oumar Niangado (Syngenta Found.); Bino Teme (DG IER), Amadou Cisse (DGA IER), Aly Kouriba (DS IER), Bakary Coulibaly, Mme Diarisso Niamaye, Hugo Verkuijl, Dore Guindo, Siaka Dembele (all IER); Kabirou N'Diaye (PSI/CORAF); Mamadou Mariko (AMCFE – NGO), Djibril Kone (ADAF/Galle – ONG); Hamadoun Drame (DNAMR), Amidou Sangare (DNAMR); Barry Shapiro, Eva Weltzien – Rattunde, Ousmane Youm, Ramadjita Tabo (all ICRISAT) - Departure for Dakar
31	- Dakar: Meeting CORAF / WECARD: Ndiaga Mbaye (Executive Secretary); Marcel Nwalosie (Scientific Coordinator)
February	
1	- Meeting FRAO: Mme Ndeye Coumba Fall (Program Director), Abdou Fall. - Meeting ISRA: Mme Aminata Niane Badiane (Directeur Scientifique a.i.), Moustapha Ane (Agro-economist).
2	- Report writing
3	- Travel Dakar to Conakry
4	- Meeting IRAG: Sekou Beavogui and Philippe Morant (Direction scientifique), - Meeting SG 2000: Tareke Berhe (Res. Rep.), - Meeting SNPRV: Mody Sidi Diallo, Mamady Kante, Seydou Barry and Andre Lama; and Summary of meeting: Baba Gale Camara (Directeur) - Meeting Direction National d'Elevage: Seny Mane (Directeur Adjoint)
5	- Meeting IRAG Direction: Sekou Beavogui (DG-A), Philippe Morant (Conseiller), Boye Diallo, Abdoulaye Diallo, Sekou Diausan, Mamadi Kourouma, Cheick Conde, Thierno Bah, Boubacar Diallo, Senkoun Wague and Abdoulaye Bangoura: - Travel Conakry to Labe (Fouta Djallon)with Dr. Tareke Berhe (SG 2000)
6	- Meeting: Pierre Antoinne (Winrock International); - Field visit to "study village" Senghen and discussions with village / farm leaders and with field personnel of SNPRV/SG 2000, thematic and systems researchers and technicians of CRA Bareng involved in Seghen village.

7	Travel from Labe to Timbi Madina; visit to CRA Bareng: Mamadou Aliou Diallo (Director), Ibrahima Tanou Diallo (Coord. Scientifique); Alpha Oumar Balde (Coord. Reg. SNPRV/SG 2000) - Meeting with IRAG scientists - Meeting with Federation des Producteurs de Fouta Djallon - Travel Timbi Madina to Kindia
8	- Visit to CRAF Foulaya: Mahmoud Camara (Directeur), Ousmane Kolea Soumah (Coord. Scientifique), Bakary Camara (coord. Reg. SNPRV/SG 2000). - Meeting with IRAG scientists from Foulaya and CRA Kilissi, including representatives of SNPRV, and APEK and CLUZA (ONG) - Field visit SG 2000 to “producteur-semencier”
9	- Field visit to Tougikoure (Village d’etude) with IRAG staff and SG 2000; discussions with farmer groups.
10-13	- Report writing
14	- Travel Kindia to Conakry - Synthèse de mission at Direction IRAG and representatives from SNPRV, DNE, and SG 2000.
16	- Departure Conakry
17	- Arrival Amsterdam

APPENDIX C

MATRIX FOR STAKEHOLDERS

	Stakeholders						
	International		**National**			**Local**	
Issues	**Donors, CGIAR, Intern. Research**	**CORAF (regional coord.)**	**Nation. Policy maker**	**NARES (research)**	**NARES (extension)**	**NGO Projects**	**Producers**
Constraints -bio-physical -socio-econ. -policies -organization -management efficiency							
Adoption -technology -social organ. -methods							
Impact -revenue -yield -efficiency -risks							
Improvement -policies -laws-rules -organizations -management -technologies -social organ.							

APPENDIX D

MATRIX FOR AGRICULTURAL COMMODITIES

Issues	**Trad. food crops (sorghum, millet, maize, rice)**	**Cash crops (cotton, coffee, rice?)**	**Non-trad. Crops (vegetables; potatoes, irrigated rice)**
Agricultural changes over last 30 years			
Changes in social organization over last 30 years			
Presence, types and roles of farmer organizations			
Availability of agric. Services (credit, supplies, marketing; advice/info.)			
New technologies *varieties *cultural practices *agric. chemicals (fert./pesticides)			
Origin of new technology *neighbour, local market *extension service *NGO *others			
Needs for improvements *technologies *Agric. Services *farmer organization *others			

APPENDIX E

THE MALI CASE

The study in Mali has focused on meeting the major actors (CNRA, IER, DNAMR, SG 2000 and ICRISAT/ICRAF in Bamako; subsequently their regionalized units and the Producer Organizations were visited during the field tour. The field tour covered the Sikasso, Segou and Bamako Regions. The Southern Mali – Sikasso region, served by the Sikasso Regional Research Center, represents the cotton-based systems. The Segou region covers two very different systems: the rainfed millet/sorghum - based systems as represented by the Cinzana Research Station, and the irrigated rice-based systems of the Office de Niger served by the Niono Regional Research Center. Finally, the Sotuba Regional Research Center that serves the Central (Bamako) region was visited for discussions with thematic and systems scientists.

1. Historical background

For the country as-a-whole it is informative to place the agricultural developments in an historic perspective. Some of the events that have had major impacts, since the colonial occupation by the French are:

1890 – 1960: colonial government

1960: independence: First Republic with centralized government structure following the socialist model; para-statals responsible for regional development (CMDT for Southern Mali; Office de Niger); creation of national agricultural research institute: Institut d'Economie Rural (IER).

1970 – 1974: Sahelian drought followed by large in flux of donor support, leading to

1972: "Operations de developpement" to achieve regional food self sufficiency,

1985: Start of large scale World Bank "structural adjustment programs"

1990: Start of World Bank-guided national extension project (PNVA), following Training and Visit (T+V) model,

1992: First democratic elections for Presidency, parliament and local government; start of "decentralization" policies and increased emphasis on democracy;

1994: 50% devaluation of the Franc CFA

1995: General liberalization of land use (important impact in Office de Niger); start of new World Bank sponsored Agricultural research project (PNRA) and introduction of "Regional User Committees" (CRU),

1995 – 2001: Further withdrawal and reduction of public sector services (including CMDT and Office de Niger); increased responsibilization of private sector,

1998: End of World Bank sponsored PNVA project

2001: End of PNRA

2002: Start new comprehensive World Bank coordinated agricultural development project (PASAOP): increased privatization of research and extension services.

Generally, Malian society has always functioned under centralized and directive forms of government, starting with the colonial period and through to the independent First and Second Republics. With the reductions in the public sector and increased decentralization during the Third Republic came, however, other centralized, large-scale and "donor-imposed' policies towards agricultural development associated with large multilateral projects..

2. Mali field visits

2.1. Sikasso Region – Southern Mali

Agricultural Production Systems

The Southern Mali / Sikasso region is broadly characterized by cotton-based systems with maize, sorghum and millet as major traditional staple cereal crops of which the relative importance of each in the system varies with the agro-ecological sub-zones. Throughout the sylvo-pastoral system is closely integrated /associated with this cropping system. In addition there are localized pockets (mostly the bas-fonds) where rice has been grown traditionally as a women's crop, and/or where farming has been intensified to cultivate non-traditional crops like potatoes and a range of vegetables mainly as peri-urban systems. In the Klela plain some 1200ha are farmed with improved rice by male commercial farmers, whereas fruits (in particular mango's and citrus) constitute a major -yet under-exploited – commodity. The entire region is in transition from a largely subsistence, traditional to an increasingly intensified commercial farming system. This process has been described in detail earlier by Stoop, et al. (2000).

Institutional context and development

Within Mali the Southern region of Sikasso has for many years been the cotton belt and therefore is one of the major pillars of the national economy. Since independence in 1960, the comprehensive development of the region – including all aspects ranging from health, education facilities to agricultural services and infrastructure construction- has been dominated by one single institution: the CMDT. While initially this has accelerated the development process and cotton production in particular, it has also had some distinct drawbacks that over time are becoming increasingly clear:

- the monopolization in terms of institutional development has delayed a balanced evolution towards the wider array of support institutions and active private sector that are all essential for a diversified, market-driven agricultural sector as compared with the former subsistence and subsequently cotton dominated systems.
- some important sectors of considerable economic potential, such as fruits (mango's and citrus) and vegetables (in particular potatoes) in peri-urban agricultural systems have been neglected,
- the presence of a well-functioning CMDT has provided attractive opportunities for investment by foreign donors and with it the broad introduction of certain "external" development concepts. A major one has been the introduction in 1995 of the local and regional user committees (CRU's) to provide the users/producers with a communication and demand mechanism to signal constraints and services requirements from the various support institutions (research and extension services). Another one has been the "Projet Lutte Anti-erosive" (PLAE), supported by the Dutch and aimed at protection and conservation of the natural resource base for the cotton belt.

The ongoing, large scale restructuring of the CMDT (since 1999) and its reorientation and narrowing of mandate to cotton-based systems leaves presently a confused situation. The resulting institutional gaps need to be filled by a host of new players such as DRAMR as extension service for all non-cotton commodities, the "Chambre d'Agriculture", the private commercial sector and the relatively young CRUs, as well as some NGOs and foreign projects like the Swiss-supported organization "Gestion et Developpement des Resources Naturelles" (GDRN). The latter plays an important facilitating role in the complex communication between CRU and Producer organizations on the one hand and the research – development / extension organizations on the other, to clarify, translate and eventually fund issues and demands raised through the CRUs.

Research Impact and constraints

The recent thesis by Kante (2001) starts of with a listing of currently available technologies (emphasizing water and soil fertility management) that are available for Southern Mali. Kante's subsequent analysis points to very partial adoption of these various technologies and most interestingly how adoption differed between sub-zones (effects of agro-ecological conditions and of population pressures) and within sub-zones by the different classes of households (types A, B, C and D) in relation to their available resources (land, labour, capital and knowledge).

So the picture for the impact of research results is very different for the major commodities. Moreover, the types of bottlenecks (technical; socio-cultural, organizational or institutional) as linked to different groups of stakeholders are different for each commodity.

The various actors generally agree about the significant impacts of research on cotton, maize and commercial rice production. There is, however a total lack of impact on sorghum and millet farming in spite of years of research efforts. All the improved sorghum and millet varieties proposed so far have proved totally non-adapted in terms of maturity cycles, leading to severe grain disease problems and excessive bird damage (ESPGRN, 2001).

For vegetables -in particular potatoes- there appears much scope for large and quick impacts provided the producers become organized; to a lesser degree this applies also for the fruits producers.

Very complex is the situation for livestock and certainly for impacts on the sylvo-pastoral systems that involve complex socio-cultural issues in particular land tenure rights.

The CRU representatives pointed out that their major need is in the post-harvest domain, dealing with local transformation, improved conservation and storage of fruits and vegetables but also of the traditional cereal crops.

Constraints at the CRRA of Sikasso

The creation of the CRRA-Sikasso is a relatively recent event (1991); prior to that only the "production systems" team (ESPGRN and earlier DRSPR) was located here. Starting in 1991, thematic/commodity teams for cotton, bas-fond rice, forestry, and fruits and vegetables have complemented the SPGRN team, which however remained a dominant component, because of its liberal funding through support from the Dutch government.

For the SPGRN team the change in donor support (from a project with foreign technical assistance to an IER program with more limited "Dutch program funding") along with the introduction of the "research project/contract" system have constituted major operational changes. It was satisfying to note that the team has remained in-tact and continues to operate through the program structure and along the approaches that were developed through the collaboration with KIT staff in the past. Two observations were made:

- the new "research project contract" mode seems to lead to an increased compartmentalization within the program with scientists being pre-occupied by "their" project at the expense of inter-project collaboration. The program leader will have to ensure that this trend is effectively counterbalanced.
- the team may not yet have come to terms sufficiently with the changed financial situation, in particular the high charges of 300 FCFA/km for transport. The program may be over-stretched as judged against the allocated funds. For on-farm, participatory research to remain credible, scientists have to spend considerable and regular periods of time in the field to communicate directly with the producers and other actors, and to monitor / supervise implementation by technicians. To ensure this condition the team may have to consider to reduce the number of antennas / locations and/or number of villages. Another option is that when the "clients/users" demand an involvement by the SPGRN program that they will have to share into the transportation costs.

At a more general CRRA level, it needs to be signaled that the various thematic/commodity teams are made up of technical/biological disciplines, with mostly an experiment station orientation. For a Center that has a development-oriented mandate and a "user-demand" strategy this is a fundamental handicap. It will certainly prove a drawback for implementing complex and long term research in the sustainability, (agro)forestry and communal land conservation issues, that typically require a local awareness and social mobilization / organization for successful interventions and feed-back.

2.2 Segou Region (CRRA of Niono and SRA Cinzana)

Agricultural Production Systems

Being part of the Northern Sudanian and Southern Sahelian zones where rainfall is more marginal and more erratic than towards the South, the prevailing rainfed systems are millet-based with cowpea as important secondary crop, and sorghum in lower areas on the wetter and heavier soils. Throughout this zone livestock (cattle and small ruminants; both settled and nomadic) is an important component of the mostly "traditional" cereal-based systems.

A sharp contrast is provided by the economically important irrigated rice-based systems along the Niger river and on the vast plains of the "Office de Niger", located North of Segou and around Niono. Under the influence of land use and trade liberalization, as well as diversification policies, rice production has greatly increased (from 1 to 1,5 ton/ha during the 80s and 5 to 6 tons/ha at present), and simultaneously the off-season vegetable production has boomed with shallots in particular (30,000 tons in 1995 to 70,000 tons in 2001).

Institutional context and development

As the development scene in Southern Mali was dominated by the CMDT, it was by the "Office de Niger" for the vast irrigated planes north of Segou and around Niono. The development activities of this huge irrigation scheme started in the 1930s and 40s and were initially aimed at large scale cotton production. Around 1960 it was concluded that the potential of rainfed cotton production in Southern Mali was greater and so the efforts were moved initially to the Koutiala area and the N'Tarla station.

Subsequently the "Office de Niger" went through a dip, as the land was used for the extensive cultivation of rice. After the Sahelian drought and thanks to considerable donor support that followed it, the irrigation structures were rehabilitated, the land was leveled and intensified rice production was introduced initially through collective, state-run farms. The big production boom came when land use and production were liberalized. Presently, the once comprehensive responsibilities of the "Office de Niger" have been trimmed down to the engineering and maintenance aspects of the irrigation infrastructure and to water management. The input supply, marketing and extension services have been taken over by the DRAMR, the private sector and a host of projects. At the producers' level a wide and varied range of mostly village-based "Farmer Associations", "Cooperatives", "Tons" (a common local savings fund), "Groupements d'Intérêts Economiques" (GIE), as well as different male and female producer groups have been formed, though with little coordination among them.

By contrast the rainfed farming areas show a slower evolution, partly because of the environmental risks of droughts and poor soil conditions. Considerable public sector extension efforts –first through the PNVA (the T + V system) and currently by the DRAMR through the PASAOP project- have been undertaken during the 80s and 90s. The PASAOP multi-lateral project combines elements of the T + V system of extension with an increased user-demand orientation through service contracts with the research and private sectors. It is complemented by large scale rural development projects (FIDA), as well as by more localized interventions from national and international NGOs (Voisins Mondiaux, World Vision, CARE, Safe the Children, Winrock International, SG 2000, etc).

Obviously, the major institutions involved in the development process (public and private sectors; bilateral projects and NGOs) all operate from somewhat different perspectives. While with proper coordination their respective activities could be very complementary, there are also substantial risks of duplication and contradictory approaches and recommendations.

Research impact and development constraints

Agricultural development and research impact patterns are vastly different for the rainfed as compared with the irrigated systems. Either system has seen its changes, research impacts and failures, although these are more spectacular for the rice-based systems. For rice, impact has been particularly striking:

- the introduction of high yielding, short straw varieties since the 80s,
- the change in cultivation practices from broadcast seeding (using up to 120 kg seed/ha) to transplanting practices (40 to 50 kg seed/ha),
- the liberal use of mineral fertilizers (ammonium phosphate and urea); recently complemented with potassium

These intensification practices have come, however, with greatly increased pest and disease outbreaks of catastrophic proportions for rice-yellow mottle virus (RYMV) in 1995/6 and increased pyriculariose. This has required the rapid introduction of new resistant / tolerant varieties and adjusted management practices, that have handsomely paid off, given the extent of the RYMV damage.

Farmers' response to other proposed technologies have been much less favourable, notably to:

- the introduction of varieties having "improved grain quality" for lack of quality related price incentives,
- the use of pre-germinated seeds in direct seeding techniques,
- the use of chemical herbicides,
- the integration of a legume fodder crops to provide supplementary livestock feeding,
- the use of azolla as supplementary source of nitrogen (50 kg N/ha), and
- the composting of rice straw.

As in the case of Sikasso there exists a large potential for research impact in the irrigated vegetable sector, that has yet to be realized. Potentially large benefits can be expected from the introduction of improved, adapted varieties (shallots and tomatoes), that are resistant to the major diseases; and from improved post-harvest technologies (in terms of storage, conservation and transformation), once the newly assigned IER vegetable specialist becomes fully functional. The transfer of improved vegetable technologies may eventually be constrained by the absence of any producer organization and the extreme fragmentation of individual producers up to the level of individual family members, each marketing his/her produce separately to earn a little cash.

For the extensive, rainfed millet-based system the development and technology impact pattern is distinctly different. An adoption study conducted by Berlin (1997) and a recent inventory of technologies originating from the Cinzana station by Slaats and Niangado (2000), emphasize the introduction of new millet and sorghum varieties and some cultural practices with respect to legumes. Here the considerable risks associated with agro-ecologically, marginal environments and the poverty of the average producer are serious obstacles to investments into intensification practices. These risky conditions also make producers more prudent and reluctant to change, apart from the generally stronger cultural and superstition related influences about contacts with foreigners and their admittance to ones fields.

Even so agricultural developments are in motion, albeit at a much slower rate than in the irrigated systems. Improved millets have been adopted at a fair level (an estimated 27% for Toroniou), although the exact pattern is difficult to trace, because the materials become fully integrated into the system under local names. Adoption of Apron Plus and currently to Apron Star is widespread; the investments in improved soil fertility practices (through FYM, compost with or without NP mineral fertilizer micro-dose) move slowly because of the obvious risks of obtaining even negative effects in drought years. Locally, the improved cowpea intercrop grown in alternating rows with millet is adopted as an animal fodder crop, that is stored and sold in the dry season to the peri-urban livestock sector. Other spontaneous changes such as increased storage of crop residues as fodder and wide adoption of animal-drawn charts can be noticed in the more densely populated areas near Segou and Niono.

Constraints at the CRRA Niono

As for Sikasso the SPGRN team is a major actor in the technology transfer chain. The team as a whole (Cinzana external experimentation unit, and the Niono interdisciplinary team) operates rather independently internally (little interaction between Cinzana and Niono based team members) and externally with the thematic research team.

While the team has to operate under similar resource constraints as Sikasso, its overall program has been fragmented further by the various demands of a range of development actors, mostly in the domain of diagnostics activities to be conducted in an excessive number of villages. As a result this activity is becoming a routine/mechanical exercise for the Niono SPGRN team, that in the end adds little in-depth appreciation and knowledge about the various systems. The outcomes consist of common, very generalized constraints, while subsequently the team is little implicated in follow-up action research activities aimed at resolving the identified constraints.

On the other hand, the efforts by individual team members to document their ideas on various issues related to the technology transfer process and to the factors and issues that impede rapid adoption of new technologies demonstrate a clear progression in research attitudes.

2.3 Bamako and Koulikoro Regions: CRRA of Sotuba

Agricultural development and research impacts

Agriculture in this vast region is dominated by agro-sylvopastoral systems with sorghum as the dominant crop; maize and cotton are the other important crops. Major concerns exist about diminishing soil fertility and the resulting degradation of the natural vegetation cover. This process is compounded by the increased exploitation of the communal forest resources for firewood and charcoal production.

The agricultural development activities in this zone have been guided by the "Operation Hautes Vallées de Niger" (OHVN), which, however, has always had less resources available (human and financial) than its counterparts CMDT and Office de Niger. As a result development activities have reached the rural communities rather unevenly so that large differences exist between villages with respect to the use of improved agricultural techniques. Besides this, the agro- ecological diversity in this vast zone is considerable, which complicates the definition of "adequate" recommendations and technological packages, thus hampering the technology transfer process. Moreover, OHVN charges 5000 FCFA/ha to farmers requiring assistance for the implementation of soil conservation and anti-erosion measures, which for the poorest C and D categories of farms is a serious obstacle. The overall impact of agricultural research results therefore is judged limited and varied at best.

Constraints at the CRRA of Sotuba

In the discussions with different groups of scientists (thematic: Maize and Sorghum Programs; the LaboSEP/GIS and Agro-climatic units; and the SPGRN team and Food Technology Lab.) some interesting constraints to the technology transfer process were exposed. Notably the various commodity units all operate separately when implementing their research respective activities. This is particularly evident for the on-farm components,

with most of the teams conducting independent efforts in different locations. Not only does this deepen the divide between disciplines and between *thematic* and *systems'* units, it also tends to raise implementation costs considerably. Likewise there exist large differences in the "participatory" perspectives and the personal motivations for on-farm activities between scientists that may often explain the varying degrees of cooperativeness encountered in different study villages.

As remarked also in the case of the Sikasso CRRA, the study villages of the SPGRN team are located at an average distance of some 120 km from Sotuba. With the new rules for transportation charges this constitutes a considerable share of a limited research project budget. Since the transport charges will not be reduced, the CRRA management will have to explore how the constraints of inter-unit cooperation and the efficiency of on-farm research efforts can be reconciled and improved.

3. Over-all analyses of the Mali case

Most important to agricultural development in Mali, probably have been the democratization and decentralization processes that started in 1992 with the Third Republic. This has created a favourable national policy environment that has attracted donors, NGOs and private investors. To what extent the multilateral donor assistance (World Bank) has indeed been successful in supporting the development of the Malian agricultural sector is uncertain, however.

The Mali case is complicated by considerable differences between the countries' regions with respect to the development actors and the present transition period between two major multi-lateral donor projects (coordinated by the World Bank). In the South the CMDT has dominated the development scene, as did the Office de Niger in the area North of Segou. In the other agro-ecologically more marginal regions, the actors have been more divers including combinations of public sector extension, NGOs and various development projects.

The impacts of research have been considerable for cotton-based systems and for irrigated rice, while for most of the "traditional" production systems it has been marginal. One domain where the liberalization process has had a most pronounced impact has been in the non-traditional vegetable production sector, mainly concentrated in peri-urban areas. This sector is highly profitable and probably could become even more lucrative if the producers were organized, instead of each operating individually. The Guinee case clearly demonstrates the impact producer organizations can have on the efficiency of linkages for demand-led research as well as on efficient private sector involvement in securing input supplies and marketing.

While many changes did take place in the rural areas, these generally cannot be linked directly to the large multilateral projects in support of the agricultural sector that were implemented over the last 10 to 15 years. For instance the PNVA was structured around the T+V approach to extension, which was discontinued after the project ended in 1999; the PNRA led to the creation of CRUs in an effort to increase user influence and a demand-led approach to research. In both cases disproportionate amounts of funding went into the built up and functioning of multi-layered (national, regional, district, community) administrative structures, while the anchorage at the local community level remained weak. Up till today a large majority of farmers remains unaware of the existence and functions of the CRU and/or considers its composition non-representative.

In spite of considerable efforts to introduce demand-led and participatory approaches to all IER staff at one stage, one can question its present effectiveness with researchers being unable (because of transport limitations) to spend a considerable part of their time on-farm. On the other hand there were reports of farmers getting seriously annoyed by the frequency of research and extension meetings, tests and surveys. This may be a reflection of uncoordinated and fragmented interventions by too many actors. It may also indicate an approach that is excessively “technology-focused” without adequate attention for human and social aspects.

APPENDIX F

THE GUINEA CASE

Already during the colonial period Guinee was recognized for its very diverse and rich natural resource base. These cover tropical rainforests in the south-east, savanna zones in the north-east, as well as medium elevation (up to 1500 m) mountain areas of the Fouta Djallon and the humid coastal zone in the west, which includes extensive areas with mangrove tidal swamps.

1. Historical background

The historical events that have most profoundly affected agricultural development in the country can be summarized as follows:

Before 1958:	Colonial period under French rule; in 1920s creation of first agricultural research stations in Seredou (forest zone: coffee), Bordo (savanna zone: cotton and rice), Foulaya (coastal zone: tropical fruits) and Koba (mangrove rice).
Sept. 1958:	Referendum: population votes against the "union" with France.
Oct. 1958:	Independence, installation of Sekou Toure socialist government and creation of a one-party national political system; all relations with France broken off and total withdrawal of all French assistance and technical aid.
1958 – 1984:	First Republic
Apr.1984:	Death of Sekou Toure
1984 – 1986:	Transitional governments: introduction of multi-party political system with an independent legislature (Parliament) and judiciary (High Court) bodies; opening to the West and introduction of a market economy; privatization.
1986:	"Direction National de la Recherche Agronomique" (DNRA) moved from Ministry of Agriculture to the Ministry of Higher Education and Scientific Research
1987:	CRA Bareng established as research center for the Fouta Djallon; Start of the move to local farmer organizations
1989:	DNRA is transformed into "Institut de Recherche Agronomique de Guinee" (IRAG), which is placed under the Ministry of Agriculture.
1990 – 1994:	Projet Service Agricole (PSA-1) including IRAG, funded through the World Bank
1992:	Creation of the "Federation des Producteurs de Fouta Djallon" (FPFD)
1996 - 2000:	"Projet National de Services Agricoles" (PNSA), including IRAG and the "Service National de Promotion Rurale et de Vulgarisation" (SNPRV) funded by World Bank.
1996 – 2002:	Border tensions with Liberia and Sierra Leone; large in-fluxes of refugees.
2002:	Negotiations with World Bank towards "Projet National des Services Ruraux" (PNSR)

As for Mali, Guinee has also operated mostly under directive forms of government through the colonial period and the First Republic. Important changes in the system of government

were introduced in the years following the death of Sekou Toure. As a result the country has opened up to the West and multilateral donor support started to arrive leading to great improvements in the road infrastructure and increased private sector activities. Most important during the last decade has been the creation of numerous local farmer organizations and their combination at regional levels into "unions" and "federations". Most prominent today is the "Federation de Producteurs de Fouta Djallon" (FPFD), that covers 380 formalized farmer groups with a total of 13,000 individual members of which 70% are women. The "Federation" has sub-sections for potato, tomato and onion producers.

Agricultural research and development have come a long way since the first evaluation in 1988 by ISNAR (Stoop and Bosso, 1989). Most important has been the successful introduction of a regionalised research structure according to the major agro-ecological regions of the country consisting of 4 Centers and 2 Specialized Stations, each having a fairly autonomous management. Some of the major developments in both the research and extension structures and activities are described in an evaluation report prepared for the World Bank (Stoop, et al., 1998). As a result of this evaluation some major changes have been introduced, notably the introduction of "study-villages" by IRAG to create a concrete interface between research, producers, extension and NGOs. A description of this approach to an integrated, multi-stakeholder, on-farm research program is given by Beavogui, et al., 2000.

2. Reports on the field visits

2.1 Moyenne Guinee (Fouta Djallon) Region – CRA of Bareng

Agricultural Production Systems

The Fouta Djallon region is composed of mountainous areas and gently sloping highland plains; elevations range between 800 and 1500 m above sea level. The region is known for its unique agriculture – livestock (cattle and small ruminants) system, based on the "tappades". These are fertile household compounds surrounded by life fences of shrubs and multiple use trees, where all major food crops are grown, such as maize, cassava, cowpeas and a range of fruit trees (mostly citrus mangoes and avocados). Outside the tappade are extensive communal grazing and forest areas and large fields cropped to fonio; all these areas have very unfertile and acid soils. In the lower bas-fond areas and along the streams vegetable production of mainly potatoes, tomatoes and onions has long been practiced because of the favorable soil and temperate climatic conditions.

Mainly due to the vegetable production a virtual agricultural revolution has taken place over the last 15 years. Large areas on the plains –formerly used for fonio- are now being regenerated by using liberal quantities of farmyard manure and compost complemented by mineral fertilizer to grow potatoes, subsequently followed by maize or rainfed rice that profit from the residual fertility. Again these areas are protected from the livestock by digging ditches and bunds on which life fences of multiple use trees are established, in the shade of which *Cafe arabica* is presently being introduced as an additional cash crop.

Institutional context and development

The above mentioned agricultural development has been greatly accelerated by strong farmer organizations. These range from local village producer groups with an average of about 40 members to the overarching "Federation" (FPFD) that organizes the timely arrival of imported planting materials and seeds, as well as the fertilizers and pesticides for their members. Also they negotiate with the traders an annually fixed price for the produce, that is sold through two collection/storage locations in the region. Due to its considerable political weight, the Federation has been able to obtain import and export tax exonerations from the Government.
However, this does not mean that all the usual barriers to transport as well as the clearing at the port of Conakry and/or at the inland borders have been resolved also.

In addition the "Federation" has concluded research contracts with the CRA of Bareng (IRAG), covering the operating costs of some scientists, to conduct specific studies on potato and onion varietal screening for better storage characteristics and for certain cultural practices. For that purpose experiments are conducted both on-station and on-farm with farmer groups. Unfortunately, and as for the other IRAG centers most work has currently come to a halt with the end of the PNSA as of January 2001. Only a limited number of activities continue through contract research with the Federation, and through limited funds from various international crop networks

Besides the "Federation" that supports the non-traditional crops sector, the SNPRV/SG2000 is responsible for the traditional staple crops and livestock. Since the end of the PNSA in 2000 the extension service has been in a crisis, and the roles of international NGOs like SG 2000 and Winrock have become increasingly important in keeping extension work going. For maize and (rainfed) rice this has involved the multiplication of seeds of improved high protein maize (QPM) and the NERICA rice varieties partly by local seed producers on a contract basis, as well as organizing the availability and sale of essential agricultural chemicals (mineral fertilizers, pesticides and herbicides).

Research impact and constraints

The research group at the CRA of Bareng has made important contributions in the identification of adapted varieties for potatoes, onions, peppers and maize and the associated cultural practices; it has also contributed greatly to the improved management of the fertility problems on the extensive, fonio-cropped plains of the Fouta. Through the latter studies, an intensified cropping system based on heavily fertilized potatoes followed by improved maize (QPM) and/or NERICA rice has become possible.

Comments on the Study-village Senghen

The study-village of Senghen constitutes a rather unique case. Started in 1999, it was build around a large, local farm. Its dynamic leader, who headed a group of about 100 farmers (mostly women) could easily afford to take the risks in trying the various suggestions made to him by the Bareng (systems and thematic) research group. These involved a wide range of subjects: potato farming on the poor fonio soils and the required soil fertility measures (based on organic and mineral fertilizers), the subsequent rotation with early rainfed NERICA rice varieties, maize or hot peppers; the establishment of improved pasture management, the planting of a wood lot, the planting of arabica coffee in the shade of the life fences. These

activities were complemented by SNPRV/SG 2000 with improved maize storage cribs and local seed multiplication of the NERICA rices following the "community-based seed selection" (CBSS) system as developed and promoted by WARDA (Beye, 2000). The introduction of fruit trees and the establishment of a nursery for Acacia seedlings for communal woodlot plantings were the work by an NGO "ESSOR".

By early 2002, the single large farmer group (mixed) had split up into several smaller, commodity-based groups for rice seed multiplication, for potato production, for livestock and for coffee. In total these groups have now 380 members. Members of these groups are active in teaching others both inside and outside of the Senghen village; through some radio advertising a whole informal communication flow has been set in motion. Moreover, the dynamic and respected leader holds several additional and influential positions in the community (the Union of farmer groups, and the "Chambre d'Agriculture"). As such this village provides an interesting example of "local dynamics" and how it can be exploited by the development sector in accelerating the dissemination of technologies through mostly informal pathways (Hounkonnou , 2001). Of course this dynamics has been spurred further by the presence of both motivated and able research (systems and commodity specialists including livestock) and extension personnel. Two research technicians are permanently based in the village. In terms of scientific effort, the work in the study-village is not very high-powered; yet its impact, without a significant input by social scientists, is all the more remarkable.

As a next step the researchers may now want to include studies on the cropping calendar to identify labour bottlenecks, that could provide useful entry points in the identification of further research issues. At a later stage, scenarios about future land use, soil fertility evolution and land property rights in response to increasing human and animal population pressures might be elaborated as suggested by Billaz (2001).

2.2 Basse Guinee (Guinee maritime) Region – CRAF of Foulaya

Agricultural Production Systems

Basse Guinee covers a very diverse region, ranging from the mangrove coastal plains to the footslopes (up to about 800 m above sea level) of the Fouta Djallon mountains. Many different food crops (mangrove, upland and lowland rice; maize, sorghum, groundnut, cassava, cowpea) and vegetables are grown, as well as oilpalm, fruit trees (avocado, citrus, mangos and bananas) and pineapple. Livestock (cattle and small ruminants) are important both as sedentary and transhumance systems. Farming is predominantly of a subsistence nature, which is complemented by small-scale commercial trading.

While there are some interesting exceptions of larger farmers, that produce surpluses for the market and/or are specialized in one commodity like pineapple, most farmers are small and grow a large variety of crops mostly for auto-consumption with the relatively small surpluses marketed locally.

Institutional context and development

Farmer groups are again important as linked to specific commodities (e.g. pineapples), but are less prominent than for the Fouta Djallon region and are definitely less of a political force in the absence of formalized structures. The private sector is small scale and little organized;

agricultural supplies and services are marginal. The public sector research and extension (SNPRV) services have mostly come to a halt with the end of the World Bank project (PNSA) at the end of 2000. SG 2000 has contributed in filling some of the gaps notably for maize, rice and cowpea cropping through the multiplication of seeds and by organizing the availability of agricultural chemical inputs.

Agricultural research is concentrated in the CRAF of Foulaya, where the fruit crop, cassava and vegetable research programs, and farming systems team are based, as well as the agro-technology and sols labs. The Center is complemented by the Koba station near the coast where research is conducted on mangrove rice and by the Kilissi station just outside of Kindia with the national programs for rice, maize and groundnut breeding.

Research impact and constraints

Research impact has been mostly in the introduction of improved varieties for irrigated, lowland and upland rice, for improved cultivars of pineapple and banana, and for mosaic virus resistant cultivars of cassava. Through SG 2000 a high-quality protein maize variety is being introduced, as well as improved cowpea varieties from IITA in combination with the regular technological package including mineral fertilizer and pest control measures. Efforts are also undertaken by SG 2000 to increase the legume component in rotations (to reduce the N fertilizer requirements by a subsequent cereal crop) and to introduce zero-tillage practices through a "Round-up" herbicide treatment and mulching.

As general constraints came forward the lack of reliable agricultural services, and the high costs, poor availability and unreliable quality of agricultural inputs, but also the absence of a reliable marketing outlet for surplus production. These constraints come on top of the earlier mentioned human and financial resource problems with which the IRAG centers and researchers have to cope.

Comments on the Study-village Touguikhoure

The Touguikhoure study-village presents a diverse agro-ecological environment with a large, managed basfond area (the structures were rehabilitated with help of IRAG in 1999) and abundant uplands and lowlands. Consequently, a wide range of traditional food crops is grown. In addition oilpalm and fruit trees are common, and provide some additional income; in the basfonds vegetable crops like aubergines, peppers, tomatoes, watermelons and cucumbers are grown during the off-season.

In 1999 the farming systems team of the CRAF of Foulaya -in collaboration with the respective commodity scientists- started a series farmer trials introducing new pineapple and banana cultivars, improved cassava planting materials, a cashew tree planting, and lowland and upland rice varieties. Replications of the trials were assigned to different farmer groups. The village had about 4 groups at the start of the research intervention, which increased quickly to 10 groups (including women groups for vegetable trials) each with 10 to 15 members. The results of the trial replications, differed greatly in response to the farmer group in charge, which provided useful comparisons in terms of the cropping calendar and labour constraints. After the first year the introduced pineapple and banana planting materials found their way to individual group members and/or to new collective plantings by the group.

The bananas suffered from phyto-sanitairy problems, that could be partly resolved by the researchers. The potassium-rich fertilizers required for bananas and pineapples proved unavailable, so mixtures of 17:17:17 and urea were applied; the expensive herbicide brought by one farmer proved to be an inactive white powder. The sale of the additional produce encountered unforeseen problems and had to be organized by the IRAG technician.

Apart from the technical information, the results obtained in the Touguikhoure village study are particularly informative in terms of the problems encountered in introducing commercial crops and their subsequent marketing. Moreover, the different local organizational format (small, non-formalized groups) and a less prominent village leader provide valuable insights in the importance of local social dynamics in comparison with the Senghen village.

3 Over-all analyses of the Guinee case

The Guinee case is distinctly different from the Mali one. However, it is likely to be quite representative for a substantial number of countries in the West and Central African region.

In spite of its large and diverse agricultural potential, the abrupt de-colonization and the subsequent policies by the First Republic have seriously delayed the development of the agricultural sector. In spite of some "pockets" of commercial cash crop (cotton, coffee) and non-traditional vegetable (potatoes, onions) production, the predominant form of agriculture remains *subsistence farming*. Evidence for this is the fact that the countries' major traditional food crop –rice- hardly enters the commercial circuit being totally consumed at the household and local village levels.

Eventually, the agricultural sector will have to change to more permanent and specialized forms (farms focusing on one or two commodities) as population pressures continue to increase and "land" becomes a limiting factor. To make these changes farmers will need to make additional investments in terms of labour, mechanization and/or external input use. Intensification and specialization of farming involves considerable risks (biological and economic), which farmers will only be willing to take, when assured of reasonable financial returns, the presence of capable research and extension services, and of an efficient and reliable agricultural services sector (input supplies, credit facilities, marketing and transformation channels). Experiences elsewhere show that these conditions are enhanced by a divers and competitive private sector and by an enabling policy environment.

Against this background it must be concluded, that the national policy environment in Guinee, as created jointly by government and donors, constitutes the major constraint to agricultural development. A more favorable environment would have stimulated the creation of:

- **an effective and competitive private sector** (presently constrained by many barriers to local and international trade and to easy transport),
- **competent research and extension services**: both services are young institutions having been created only 10 to 15 years ago. So far these have lacked continuity because of their "project" status, and the absence of a fixed annual financial contribution to operating costs by the government. These conditions have prevented both a sound personnel management (e.g. the timely recruitment of young scientists to replace the aging IRAG staff), as well as an appropriate financial management that are essential to achieving institutional sustainability.

Presently both IRAG and SNPRV activities have almost come to a halt in the transition period (2 years) between two consecutive World Bank projects aimed at strengthening the agricultural sector. SNPRV continues a minimum of activities through SG 2000, while IRAG has only some funds from contract research (e.g. with the Federation) and from some commodity related networks (e.g. WARDA/ROCARIZ Task Forces) and the WARDA based Inland Valley Consortium (IVC).

The ROCARIZ and IVC activities have been approved by the IRAG Directorate in Conakry and are part of a pluri-annual collaboration. A special national coordinator has been appointed to follow up that the project proposals for ROCARIZ are integral elements of the national program and that reporting requirements are met, because otherwise funding is halted. In that respect the collaboration between IRAG and WARDA is fully transparent.

In 1998 another consortium effort started when two locations (one in the savanna and one in the forest zone) were selected as sites for the "ecoregional-EPHTA" program coordinated out of IITA. Unfortunately, these two efforts have never come off the ground for lack of transparency in the agreements between IRAG and IITA, and the fact that the implementation was linked primarily to two individuals, instead of being properly anchored in the host national institute.

While the transition to a more dynamic and commercial agricultural sector (that would catalyze overall development in the country) is delayed by an unfavourable policy environment, there are important ongoing movements at local levels in terms of farmer organizations and evidence that farmers are indeed ready to adopt intensified practices. At present the required preconditions are only fulfilled locally through activities by NGOs such as SG 2000. However, in the absence of simultaneous government policy adjustments, the overall impacts will be minor and not sustainable.

With the exception of the vegetable (potatoes, onions) and fruit (pineapple) sectors that have strongly organized producer groups, the Guinean agriculture is predominantly of a subsistence nature. For that reason, a privatization of the research and extension services would be inappropriate: the two services are professionally weak; the producers are mostly poor smallholders who are operating mostly non-monetarised production systems. Therefore, there are few alternatives in the short and medium term. Continued and increased public support will be required in first strengthening these services that constitute the backbones of intensified commercial farming.

So far the adoption of new technologies by farmers has been limited mostly to improved varieties. Improved cultural practices requiring additional investments in labour and external inputs have not been adopted widely for the obvious reasons mentioned above. More substantial impacts from research and extension therefore will also be conditional on an enabling policy environment for the private sector as a whole. The reinforcement of "demand-led" perspectives for research will be facilitated by the presence of strong farmer organizations. The latter will also positively affect the functioning of the CRRD coordinating units (comparable to the CRUs in Mali).

Annex 2

"A Study about the Causes for Low Adoption Rates of Agriculture Research Results in West and Central Africa: Possible Solutions Leading to Greater Future Impacts"
(SDR/iSC:IAR/02/22)

Lukas Brader

SDR/ISC:IAR/02/22
iSC Working Document

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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Interim SCIENCE COUNCIL

A Study about the Causes for Low Adoption Rates of Agriculture Research Results in West and Central Africa: Possible Solutions Leading to Greater Future Impacts

iSC SECRETARIAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
August 2002

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Preface and Acknowledgements

This study about the causes for low adoption rates of agriculture research results in West and Central Africa: possible solutions leading to greater future impacts, has been carried out at the request of the interim Science Council of the CGIAR. It starts by making the point that the title of the study creates a wrong impression. As results presented in this report show, there has been a very significant degree of adoption of certain international and national agriculture research results in West and Central Africa. However, the impact has not been as high as could have been hoped for. Therefore, the expression "low adoption rates" should better be read as "limited impact".

Sincere thanks are addressed to all the persons who have assisted me in collecting the necessary information for this study. Various staff members of IITA were extremely helpful in assembling relevant reports and data sets. In this respect I would like to express my special appreciation to A. Menkir for maize related materials, B.B. Singh for cowpea data and related matters and V. Manyong, for socio-economic research reports. Arrangements for the travel in Nigeria were made in the well known efficient manner by Mrs. J. Cramer, and staff of IITA's travel office. My special thanks to all concerned.

The outstanding support received from different staff members of Sasakawa Global 2000 is acknowledged with particular pleasure and special gratitude. They allowed access to the large amount of valuable data available from work carried out by farmers with the assistance of SG 2000. In Nigeria, Dr. A.M. Falaki and his staff spared no efforts in providing me with a comprehensive overview of production results and related costs. The Directors in Ghana and Sierra Leone also provided very useful information.

It was a stimulating experience to carry out this study. I accepted this task in the expectation that it may contribute to the furtherance of agricultural research and development in sub-Saharan Africa. I do hope sincerely that these expectations will be met to some extent. I am convinced that significant progress can be made in agricultural development in sub-Saharan Africa. Excellent tools are already available for this, and even better ones are under development. But it needs the wisdom and will of a wide range of players to allow the farmers in Africa to significantly improve their living conditions. I do hope sincerely that substantial progress will be made in the near future.

Lukas Brader

July 2002

Executive Summary

This study, has been undertaken at the request of the interim Science Council of the CGIAR, and is meant to contribute to the adoption of a stronger regional orientation in the research planning of the CGIAR by looking at the following issues in relation to the West and Central African region:

- the appropriateness of currently available improved technologies given the agro-ecological and socio-economic conditions in the region,
- the efficiency of the present technology transfer mechanisms in widely reaching the producers,
- the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies, and
- implications of the above issues for the new CGIAR regionalization strategy, leading into recommendations towards an increased impact of its future research efforts.

To address these issues the adoption of improved maize and cowpea technologies has been used as an example. The review of relevant literature indicates that both maize and cowpea technologies have been adopted quite extensively by farmers in West and Central Africa. Maize research seems to have been most successful in this respect, and currently all the area planted to maize in the region is either occupied by improved varieties or by materials derived from them. The results obtained by farmers clearly show that the available improved maize and cowpea varieties can produce excellent yields, provided farmers have access in a timely manner to the necessary production inputs. Over the past 40 years maize has evolved from a subsistence crop to a food and cash crop. Originally maize was mainly grown in the humid forest zone, but the availability of well adapted germplasm has allowed it to become a major crop in the savannah zones, where growing conditions are more favourable for maize production. Consequently, the new maize technologies have affected in particular agriculture in these agroecological zones.

However, in the region as a whole maize and cowpea yields are still very low. The main reason for this seems to be the insufficient use of the necessary production inputs, in particular fertilizers. This affects very strongly agricultural productivity in this region where soil fertility is generally low and where pest pressure, especially for cowpea, is high. There are a variety of causes for the very limited input use including inconsistent government policies, inadequate infrastructure, insufficient private sector development, and high costs of inputs. The harsh reality in West and Central Africa is that farmers must not only cope with difficult crop production conditions, but also with mostly ineffective government policies and actions, and very poor support services. Notwithstanding this almost total lack of support, farmers have adopted to a very significant extent improved varieties, especially in the case of maize. A significant benefit is that currently all maize grown in the region is resistant to the major diseases, and as such the introduction of the new materials has significantly increased production security.

The efficiency of the present technology transfer mechanisms in widely reaching the producers was the second issue to be addressed. The performance of technology transfer mechanisms in the region has been quite variable in effectiveness over time. The rapid spread of improved maize varieties in Nigeria in the 1980s was due to the successful operations of the Agricultural Development Projects. Excellent examples are also available from other countries in the region. But, at present in West and Central Africa the agricultural extension systems are under-funded and often lack well motivated staff. In this region also NGOs try to fill the vacuum, but with the exception of Sasakawa Global 2000 and a small number of in particular church related groups, it is too early to judge the overall benefits of their actions.

The third issue referred to the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies. In order for a technology to be of interest to farmers it has to fit well into his/her production practices. As mentioned in the report international agricultural research in West and Central Africa originally followed the green revolution approach. In a sense that is surprising because of the lack of a number of essential conditions required for the success of that approach. These include a favourable production environment, in particular through irrigation, and effective access to technical information and production inputs.

Much more progress might have been made if from the start of international agricultural research in the region, critical production constraints had been analyzed, and if solutions to address them had been undertaken in a more pragmatic manner. Such an approach might have led to a situation where the availability of more sustainable production technologies would have been more advanced than is currently the case. However, the fact remains that the unfavourable socio-economic circumstances in the region would still have impacted in a negative manner on agricultural productivity.

The institutional problems are well known in the West and Central African region. National agricultural research and extension structures have in almost all countries been severely under-funded in particular over the last ten years. There is a significant number of well qualified staff but they lack adequate operational funds to carry out their work effectively. From an organizational point of view it will be important to further strengthen the ongoing effective collaboration between international and national agricultural research institutions. The national systems can, for example, draw significant benefits from collaborative projects through which they can complement their limited resources. At the same time, international research will be able to better focus on matters of direct interest to national systems.

Cultural differences in the region do not seem to have a marked effect on farmers' interest and capabilities to adopt new technologies. Provided that it can be clearly proven that a new technology fits into farmers' production practices and brings substantial benefits, without increasing production risks, it will usually be considered with interest by the farmers.

Opinions will most probably differ significantly on the implications for agricultural research of (i) agricultural developments over the last 40 years, and (ii) current socio-economic conditions in West and Central Africa (the forth issue to be addressed).

Without doubt there will continue to be a strong need for research aimed at increasing crop productivity and ensuring that natural resources and production inputs can be used most effectively. Research on sustainable production systems will remain a key element in this. This will require close collaboration between plant breeders and natural resource management specialists. Natural resources must be considered in the broad sense, i.e. it must also involve extensive pest management research. Labour productivity must be increased to reduce production costs and augment production efficiency. It might be worthwhile to analyze the type of research needed to try to overcome the shortcomings of insufficient government support. This could lead to the conclusion that more efforts should be undertaken to strengthen farmer organizations.

A critical problem is also the remuneration that farmers receive for their products and this will require further research on effective farm product storage, transformation, and commercialization. As noted earlier all these issues need to be addressed in a pragmatic manner by working closely with farmers in order to fully understand their needs. In the current situation in West and Central Africa this does not require a great deal of fundamental research. The agricultural development problems are of a very practical nature and need solutions accordingly. It has sometimes been argued that the more applied agricultural research should be undertaken by the national systems. Research must be undertaken in effective partnership with the national colleagues, and this means that both should be working on the full range of research problems.

Poverty as defined by the international development community is very widespread among the rural population of West and Central Africa. Reduction of poverty is a major goal of the CGIAR. The data presented in this report in relation to the activities promoted by Sasakawa Global 2000, show that farmers can earn a net income from improved maize production in the order of $200 to $600 per hectare per year. About similar incomes might be generated by effective cowpea production. These results are obtained by maize farmers that produce 4 to 6 tonnes of maize per hectare. These are good maize yields given the overall production circumstances in the region.

In West Africa the amount of arable land available per capita of the rural population is about 0.4 hectares, or some 4 hectares per family. It might therefore be speculated that the average farmer, when using effective maize production practices, could earn between $800 to $2400 per year. But if the average family size is eight persons and the poverty level is one dollar per person per day, than the average family must have a minimum annual income of $2920. Thus, given the current socio-economic conditions in West and Central Africa, there is little hope that significant numbers of farmers will be able to raise their income above the poverty line in the near future.

1. Introduction

The title of this study is misleading. As results presented in this report will show, there has been a very significant degree of adoption of certain international and national agriculture research results in West and Central Africa. However, the impact has not been as high as could have been hoped for. The expression "low adoption rates" should better be read as "limited impact".

This study has been undertaken at the request of the interim Science Council (iSC) of the CGIAR. It is a follow up to the decision of the CGIAR to address more effectively the heterogeneity of the causes of poverty in different regions. As a consequence the system agreed to adopt a stronger regional orientation in its research planning and implementation, and to diversify and expand its partnerships to ensure that its limited resources are effectively leveraged in addressing the problems of the poor.

This study is meant to contribute to this new approach by looking into the following issues in relation to the West and Central African region:

- the appropriateness of currently available improved technologies given the agro-ecological and socio-economic conditions in the region,
- the efficiency of the present technology transfer mechanisms in widely reaching the producers,
- the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies, and
- implications of the above issues for the new CGIAR regionalization strategy, leading into recommendations towards an increased impact of its future research efforts.

The study has two components looking into the matter from different angles:

c) W.A. Stoop operating from the perspective of national research and development institutions in support of local client groups.
d) L. Brader, operating from the perspective of a consolidated CGIAR Center research program in support of a regional research agenda.

This part of the study concerns the second component. It analyzes the introduction and use of improved cowpea and maize technologies to look into the above mentioned issues. In view of the limited time available, only Nigeria has been visited to collect the necessary information and data, and experiences of this country have been used mainly for the development of the report.

2. Improved maize and cowpea technologies developed through agricultural research for West and Central Africa

Over the last 35 years improved maize and cowpea technologies for West and Central Africa have been developed mainly by IITA and its national partners, with significant inputs from CIMMYT for maize. Before the establishment of the International Agricultural Research Centers, breeding for the improvement of these two crops had

been undertaken by a number of national programmes in the region. For both crops the major international agricultural research effort has been the development of pest resistant higher yielding varieties, to enhance both crop productivity and security. Originally these research activities were strongly inspired by the successes obtained in Asia through the introduction of high yielding rice and wheat varieties, combined with the increased use of agricultural inputs. Over the last two decades in West and Central Africa, more efforts have been devoted increasingly to the development of improved production systems, to better address the typical agroecological, socio-economic and institutional conditions of the region. This had led to different demands on the breeding programmes. To place these developments in an overall perspective it may be useful to briefly summarize the efforts undertaken by an International Agricultural Research Institute like IITA in planning an effective research agenda that addresses the wide-ranging needs of agricultural development in sub-Saharan Africa.

IITA was established in 1967 to provide in the tropics a high-quality international research organization devoted to finding ways as quickly as possible to increase the output and improve the quality of tropical food crops. To develop the first scientific programme for the institute a series of seminars was held. From these it was concluded that international agricultural research must strive, at least in the immediate future, to cover a wide range of activities to meet the broad array of research needs of agriculture in sub-Saharan Africa. Thus, in the mid 1970s the institute was working on 13 agricultural crops, as well as on three vegetable species and various forage legumes and grasses. Successive internal and external reviews made it clear that the institute needed to narrow its focus to use its resources most effectively. By 1989 the programme was reduced to six crops (maize, cassava, yam, cowpea, soybean and banana/plantain, and it has remained so since then. In the strategic plan for the period 1990-2000 it was noted that the green revolution approach remained valid for SSA, although it was recognized that the problems are more complex and the rate of achievement not as spectacular[4].

One of the reasons cited for the limited rate of achievement is the basic vulnerability of the predominant rainfed farming systems in Africa to rapid and irreversible degradation under more intensive cultivation with the improved technologies currently available. And the lesson from the experience gained was that improved germplasm and related technology components are a necessary condition but not a sufficient one for achieving adequate and sustainable rates of growth in food production. It is noted in the strategic plan, that there is no doubt that these powerful instruments (improved germplasm) for beneficial change need to be promoted more actively and effectively. But it is equally apparent that these interventions must be accompanied by the development of farming systems whose internal mechanisms make the use of external inputs more efficient and permit improved production technology to remain effective over the long term. Consequently, under IITA's 1990-2000 strategic plan, in addition to the crop improvement programmes, agroecological zone working groups were established. Plant health management research was also given increased attention. Thus, over the last decade, international research in the region has placed more emphasis on sustainability and less on yield increases. Both maize and cowpea offer good examples of this.

[4] IITA (1992), Sustainable Food Production in sub-Saharan Africa, IITA's Contributions.

2.1 Maize research

Since the early 1970s international research on maize has been directed at increasing the yield potential of tropical maize, while at the same time breeding for durable resistance to diseases and pests has also been pursued actively. This, because small-scale farmers are just as concerned about yield stability as about increasing yield (Buddenhagen, 1985[5]). A wide range of germplasm has been developed jointly with various partners since the 1970s and this has been widely used and distributed by national programmes in Africa, in particular in West and Central Africa. In regional trials the improved maize materials generally produced 50-100% more than the traditional varieties, under both high and low input conditions. Both open pollinated varieties and hybrids were developed.

Maize streak virus was the first disease for which resistant germplasm was developed and this was followed by resistance to downy mildew (*Peronospora sorghi*), rust (*Puccinia polysora*) and leave blight (*Bipolaris maydis*). During the 1980's and 1990's breeding for resistance to the parasitic weed, *Striga hermonthica*, was carried out with a high degree of success. In the meantime, breeding for increased yield and grain quality has been continued successfully. Early maturing maize varieties were developed for the humid forest zone and for the dry savanna, the latter since 1977 under the Semi-Arid Food Grains Research and Development Project (SAFGRAD). Over the last decade this work has been extended to breeding for nitrogen use efficiency and drought tolerance. This again has led to very promising results, offering new opportunities for the development of more sustainable production systems.

Table 1. presents examples of the range of yields obtained with improved varieties in field trials in West and Central Africa. It is evident that also in this region good maize yields are possible. The yield of over 11 tonnes per hectare was achieved in farmers' fields.

Table 1. Average yields from international maize trials carried out in West and Central Africa during the 1999 cropping season.

Type of maize	Sites	Varieties	Average kg/ha best performing variety	Average kg/ha least performing variety
Late maturing white grain	14	14	4426 (1284-8339)	3520 (1130-7017)
Late maturing yellow grain	13	7	4574 (1915-7544)	4121 (1624-7694)
Intermediate maturing white and yellow	12	10	4105 (1113-7713)	3238 (972- 6684)
Hybrid white	13	15	6163 (1480- 11270)	4357 (995-8066)
Hybrid yellow	12	10	5640 (3217-8365)	4690 (2227-8737)

[5] Buddenhagen, I.W. 1985. Maize diseases in relation to maize improvement in the tropics. Pages 243-275. In: Breeding Strategies for Maize Production Improvement in the Tropics, edited by A. Brandolini and F. Salamini. No. 100, Relazione e Monografie Agrarie Subtropicale e Tropicale, Nuova Serie. FAO and Instituto Agronomico per l'Oltremare, Firenze.

The increased knowledge base resulting from some 30 years of research on crop and soil improvement has been used in recent years for the development of more sustainable maize/grain legume rotations, whereby well adapted varieties of in particular soybean are effectively used for the partial replenishment of soil nutrients and organic matter. These systems involve the rotation of dual-purpose soybean with maize varieties with increased nitrogen use efficiency in combination with optimum fertilizer application. The grain legumes used in rotation with maize contribute to the improvement of soil fertility, while at the same time providing the farmers with food, as well as income by marketing their farm products. A drawback of using cover crops like mucuna, pueraria or lablab in food production systems to replenish soil nutrients and organic matter, is that they occupy the land without providing agricultural products and income to the farmer.

Currently the most widely grown maize hybrid in Nigeria, Oba Super 2, is of the group of materials with higher N use efficiency. It produces significantly higher yields than the traditional varieties at low N (the gains are equivalent to some 30 kg N/ha), and reacts like the traditional varieties to higher N. New open pollinated maize varieties with similar characteristics are now also ready for use by farmers.

In the Northern Guinea Savanna (NGS), the dominant maize production zone in West and Central Africa, locally available sources of organic matter are inadequate to meet farmers' requirements. Leguminous annuals and trees often do not fit into the socio-economic conditions of the farmers. Thus, over the last 10 years, the breeding objectives for soybean have been changed to develop so-called dual purpose soybean for the maize cropping systems in the NGS. Varieties were developed that produce a higher biomass in addition to good grain yields, fixing higher amounts of N. These improved materials are being increasingly used by farmers in the current maize-based cropping systems.

The soybean lines that are now available can produce about 2.5 tonnes of grains and 2.5-3 tonnes of forage per hectare, and there is every indication that further progress can be made. Comparison of the nitrogen fixed by these improved materials with a traditionally grown variety shows the positive N balance in a maize rotation and a significant increase in maize yield. Soybean varieties have now also been identified that can access additional soil P.

Maize in the NGS suffers very serious losses from the parasitic weed *Striga hermonthica*. This has become the most severe biotic constraint to intensive maize production in this agroecological zone. Maize varieties with partial resistance have been developed. However, strain variation in *S. hermonthica* complicates efforts to develop maize cultivars with stable resistance over wide geographic areas and over time. Resistance needs to be combined with other control strategies to attain sustainable control of striga.

The focus of the integrated control strategy for this problem is crop rotation with selected legume cultivars, in particular soybean. Soybean can bring striga seeds in the soil to premature, so-called suicidal germination, and thus reduce the pressure on the following maize crop. Very significant variation among soybean cultivars has been found with respect to the suicidal striga germination capacity. Therefore in the breeding program lines have been developed that show both superior agronomic

performance and high stimulant production. Rotation with these soybean cultivars resulted in significant reductions in emerged striga in the subsequent maize crop.

The benefits to be derived of maize-soybean rotations incorporating the above mentioned characteristics of increased N-fixation by improved soybean varieties, better exploration of soil P, and striga control through the use of appropriate soybean and maize varieties, as well as the introduction of N use efficient maize varieties have now been extensively demonstrated under farmers' conditions. Economic analysis of these systems shows already an increase of the gross income of farmers of 50-70% compared to those following the current practices of mainly continuous maize cultivation. This reflects at the same time an equivalent increase in land-use productivity and with further spread there are excellent prospects for additional economic and environmental benefits.

There is no doubt that international agricultural research in Africa has made excellent progress in the development of highly improved and well adapted maize varieties, with adequate resistance to the major diseases. The introduction of these new technologies has stimulated significant increases in maize production in West and Central Africa. Details of this will be discussed later in this report. Moreover, the results described above should, in the coming years, offer excellent opportunities for significant increases in the sustainability of the maize production systems, while at the same time further reducing input costs.

2.2 Cowpea research

Cowpea is a popular crop in the dry savanna region of West and Central Africa for the production, under difficult growing conditions of limited soil fertility and rainfall, of protein rich food, as well as mineral and protein rich fodder for livestock feeding. Cowpea is traditionally grown in intercropping systems. This usually meets the farmers' objective of sustained production at minimal risks to satisfy subsistence and commercial needs. But these needs have increased in recent decades due to the increasing population in the region. The resulting reduction in arable land per capita needs to be compensated for through improved yields. There are over 20 different types of cowpea cropping systems in northern Nigeria of which millet-cowpea, sorghum-cowpea, millet-sorghum-cowpea, and millet-sorghum-cowpea-groundnut are the most common. Cowpea grain yields in these systems vary from zero to a maximum of 200kg/ha. Major production constraints in the intercropping system are low soil fertility, low plant population, heavy losses caused by a wide range of pests and diseases, lack of fertilizer and pesticides, shading of cowpea and groundnut by the millet and sorghum, as well as late maturity and poor yield potential of the local varieties.[6]

Farmers grow two distinct types of cowpeas, the one is a photo-insensitive variety that matures long before the cereals, and provide a source of food when supplies have dwindled. The other is a late maturing photo-sensitive cowpea that is planted in alternative rows with the early more erect type and produces abundant vegetation as it

[6] van Ek, G., A. Henriet, S.F. Blade and B.B. Singh. 1997. Quantitative assessment of traditional cropping systems in the Sudan savannah of northern Nigeria II. Management of productivity of major cropping systems. Samaru J. Agric Res. 14: 47-60.

spreads across the ground after the cereals have been harvested. It matures after the cereals, producing small amounts of grains, but significant amounts of fodder.

From 1970 onwards international agricultural research served as a catalyst of continued research on cowpea, building on work undertaken by national programmes in Nigeria, Senegal, Uganda and Tanzania. Emphasis has been until the 1990s on the development of high yielding grain producing varieties with increased resistance to the various pests. Materials have been developed with a yield potential of 1500-2000 kg/ha and with varying degrees of resistance to the following pests:

- cowpea aphid-borne mosaic virus
- cowpea yellow mosaic
- anthracnose (*Colletotrichum lindemuthianum*)
- bacterial blight (*Xanthomonas vignicola*)
- scab (*Elsinoe phaseoli*)
- brown blotch (*Colletotrichum capsici* and *C. truncatum*)
- Septoria leaf blight (*Septoria vignae* and *S. vignicola*)
- leafhoppers (*Empoasca spp*.)
- aphids (*Aphis craccivora*)
- bruchids (*Callosobruchus maculates*)
- Striga (*Striga gesneroides*).

The first improved materials produced during the 1970s did not meet the farmers preferences for seed quality and this had to be addressed in succeeding years before introduction could become successful. However, the highly productive and improved materials that subsequently became available during the 1980s continued to suffer from attacks by thrips (*Megalurothrips sjostedti*), the pod sucking bug (*Clavigralla tomentosicollis*), and in particular the pod borer (*Maruca testulalis*). Thus, the high yield potential of the new varieties could only be realized in case the farmers were able to apply insecticides. But reliable access to effective pesticides proved to be a problem on many occasions in West and Central Africa, and this has limited the introduction of these new materials. In addition the improved varieties were all grain types and therefore did not meet sufficiently the needs of farmers for fodder production. Interestingly, some of these materials are very extensively grown in a number of countries outside Africa.

Since the early 1990s international cowpea research changed significantly its focus. Through cross breeding with local varieties it concentrated on the development of so called dual purpose cowpeas, producing higher amounts of both grain and fodder. Close collaboration was established with the ILRI team in West Africa to effectively address fodder quantity and quality in the breeding and selection programme. These efforts resulted in the development of well adapted dual purpose cowpea varieties for the dry savannas. Excellent progress has been made and good material is now available and widely used. In addition varieties have been developed that can be grown during the dry season, either under limited irrigation or on the so-called flood recession plains. During the dry season insect pressure is much less and very remunerative yields can therefore be obtained. Efforts are ongoing for the development of integrated pest management approaches to address the remaining pest problems. The pod borer continues to be a major production constraint, and

expectations are high for the use of biotechnological tools to effectively address this problem.

Table 2. gives an example of the results of trials in farmer's fields during the 2000 crop season in Kano State, Nigeria. In general they show a clear superiority of the improved materials over the local variety.

Table 2. Kano State cowpea trials in farmers' fields during the 2000 crop season. Grain yield in kg/ha, 2 sprays, 100kg/ha NPK 15/15/15

Variety	Zone I	Zone II	Zone III
IT95K-321-1	1333	1205	1017
IT95K-193-2	1459	1143	1316
IT90K-277-2	1250	1171	1521
IT95K-222-14	1250	888	887
IT95K-181-9	1333	502	1183
Local	792	670	784

2.3 Production systems research

Increased sustainability of the production systems in the dry savanna still remains a major challenge, but the availability of dual purpose cowpea may offer good opportunities for this. Joint research efforts in recent years have lead to very encouraging developments as described in the following paragraphs. These results are presented in a rather detailed manner, because of the very significant shift in research approach they represent and the promising results achieved. Like in the maize/soybean example it shows the benefit that can be obtained through an effective multidisciplinary crop and resource management research programme.

In the dry savannah cropping is cereal-based with sorghum and millet dominating. Intercropping with grain legumes is common in over 90% of the fields, with cowpea, together with some groundnut being the most common legume components. Traditionally 1 cereal to 1 cowpea row arrangement is used; the cereals are planted at the onset of the rains and the cowpeas 3-4 weeks later, Even though cowpea occupies 50% of the land its grain and fodder yields are between 10-20% of a sole crop of cowpeas. This is the same for local and improved varieties. Experiments have shown that cowpea should be planted as soon as millet has been sown to reduce the negative effect of shading. Efforts were made to develop alternative systems which minimize shading. A strip cropping system involving 2 rows of densely planted cereal to 4 rows of densely planted cowpea appeared to be significantly more productive, particularly when limited amount of fertilizer was applied to the cereal and one or two sprays were given to the cowpea. Experiments showed that sole crop of cowpea performs best. However, farmers showed the greatest interest in the 2:4 system because it provides them sufficient millet or sorghum for home consumption, and a large amount of additional cowpea for food and cash.[7]

[7] Singh, B.B. and H.A. Ajeigbe. Improving cowpea-cereals based cropping systems in the dry savannah. Paper presented at the World Cowpea Research Conference III, 4-7 September 2000, IITA, Ibadan, Nigeria.

Over 50% of the total ruminant livestock in West and Central Africa are found in the dry savannah and they contribute towards livelihoods through the provision of meat, traction and manure, as well as income generation. In this way crop livestock integration is already a common feature of the farming systems. In the context of such systems cowpea is an important crop for farmers in much of the zone. It plays an important role with respect to improved food security, income generation, and improved resource management by the small holder farmers in the region.

When seeking to address the opportunities posed by the intensification of crop livestock systems in the dry savannas, it was apparent that a key component should be improved dual purpose cowpea varieties. What was equally clear, however, was that cowpea, livestock or cereal crops never function in isolation in farm fields or households in the dry savannas. Likewise there is a complex of interactions between the biophysical, economic, social and policy environments that influence farmers' decisions in these environments. To address this challenge, scientists from IITA with experience in cowpea research, ILRI for livestock and ICRISAT for cereals began to plan joint research in 1997. IFDC with an interest in the soils component of the system and the Centre for Overseas Research and Development of the Durham University (CORD) with experience in participatory research and resource management, together with scientists from national research and development institutions joined later.

Two major principles were elucidated. Firstly, the idea of using "best bet options" and secondly, to use a holistic, on farm approach to evaluate these options. Combining the best bet of each aspect of the integrated crop livestock system; varieties, crop husbandry and geometry, crop residue/manure management and livestock feeding constituted the best bet options. These options were designed to address the major needs in the mixed farming system, increasing grain and residue production, improving livestock output and preserving the natural resource base. The option of using optimal amounts of minimum inputs (in this case fertilizer for sorghum and an insecticide for cowpea) for maximum effect was also included.

The best bet options were to be assessed in a holistic manner together with farmers, taking account not only of the grain yields, but also of fodder yields, the livestock production resulting from feeding the fodder, manure output, and the effects on subsequent crops when the manure is returned to the same plots. This entails, among others, measuring nutrient cycling and determining the economic and social benefits or disadvantages of the best bet options as a whole.

Recognizing the challenges that were posed by this holistic approach, the initial strategy was to start small and in 1998 the trial was established at just one location in northern Nigeria in Bichi Local Government; 11 farmers volunteered to participate. Good information on village characterization was already available from a survey carried out earlier by scientists from ICRISAT and the Institute of Agricultural Research in Nigeria.

The package that was ultimately agreed upon for testing consisted of the following three treatments. All treatment plots received 3 ton/ha of manure at the start of the growing season.

1. Best Bet + (BB+), involved improved dual purpose cowpea and improved sorghum varieties that had shown to be well adapted to the agro-climatic conditions in this particular region. The sorghum and cowpea were planted in rows 75 cm apart, in the above described 2:4 arrangement. Minimum inputs included fertilizer application of a basal dose of 100 kg/ha NPK (15-15-15) and a topdressing of 20 kg N/ha on the sorghum rows only, and two insecticide sprays for post-flowering insects of cowpea.
2. Best Bet (BB), same as BB+ but without any inputs of inorganic fertilizer and insecticides.
3. Local (L), farmers' traditional mixed cropping system of sorghum and cowpea.

In 1999 thirteen more farmers joined the program in Bichi, as well as 23 farmers in Unguwan Zangi, a village in the same region in Nigeria. Two villages in Niger were also added. In 2000 the program was extended to a third village in northern Nigeria, Minjibir, the work continued in the two villages in Niger, and four villages in Mali were added. In each country the villages were chosen because they represent different farmers' circumstances which will facilitate the scaling up of the research results. The studies started in 1998 and were supported by socio-economic studies through household interviews. The increase of the number of locations was stimulated by the strong farmer interest. All the component options used were in themselves identified as a result of on farm experiments, and they are further modified as a result of interactions with farmers.

The quantities of grain and fodder in the BB treatments were greater than those in the local treatment. The most dramatic difference was for the cowpea grain at Bichi in 1998 when the BB+ treatment yielded more than double the BB and about 16 times the L. Fodder yields for BB+ were 1.5 and 5 times more than BB or L respectively. In 1999 these differences were less marked, partly because the yield of the local sorghum was higher than the improved sorghum. In many instances, although not quantified, this could also be related to an increase in the number of farmers adopting in their traditional practices some aspects of the best bet options, varieties and/or cropping patterns.

The data on livestock feeding in 1998 indicated that animals on the BB+ treatment gained significantly more weight during the last 6 weeks of the 16 week feeding period than those on BB or L. Whilst manure quantities produced by the animals on the different treatments did not differ significantly, the N content for BB+, BB and L was 1.35, 1.09 and 0.80% respectively. P contents were estimated as 0.28, 0.27 and 0.25% for BB+, BB and L respectively. Results from livestock feeding in the 1999/2000 dry season, indicated that again BB+ was superior to BB and L

Analysis of the nutrient dynamics shows strong positive balances for N and P for the best bet treatments. At the end of the 1999 crop season, the BB+ had a net positive balance of 40.5 kg N/ha and 14.3 kg P/ha; BB had a net positive balance of 33.7 kg N/ha and 13.4 kg P/ha compared to a negative balance of 28.3 kg N/ha and 0.67 kg P/ha for the local treatment (L).

An economic evaluation has been carried out to compare the costs, returns and profits among the three treatments. The data collected in Bichi during 2000 showed a total revenue of about Naira 33,000/ha for BB+ (1US$=Naira 110), 22,700 for BB and

17,000 for L. BB+ yielded the highest profit per hectare, about four times that of BB and L. The benefit/cost ratio was as high as 1.77 for BB+ compared to 1.18 for BB and 1.26 for L. The economic superiority of BB+ over L is clearly demonstrated by a marginal return of 1.84. That is an additional 84% of economic gains for farmers who adopt the improved system. A comparative economic analysis over time between the 1999 and 2000 cropping seasons shows an increase in total revenue and profit, and a reduction in production costs for material inputs and labour. Reasons could be the above mentioned positive nutrient balances and the farmers' better mastering of the new system over time.

Farmers' major reactions to the best bet options centred initially on grain yield, and subsequently the fodder yield, and perceived quality. The quantities of cowpea grain and fodder in the BB treatments were at least twice as much as those in the local treatment. It should be noted that the productivity of crops and livestock is only one dimension of this research, the implications for the human well being and the environment, as well as the interactions between these also need to be considered in the final analyses. The benefits of the two best bet options are probably best demonstrated by the fact that the village chief of Bichi recently stated that an estimated 90% of the farmers have now adopted elements of the system on their own.

3. Production statistics

Maize and cowpea production data for West and Central Africa have been derived from the FAOSTAT Production Statistics. In all tables and figures three year averages have been used. Details are presented in Annex I. To determine the potential impact of new maize and cowpea technologies resulting from collaborative international agricultural research data for the period 1980-2000 have been compared to those from 1960-1980. Improved technologies for West and Central Africa resulting from international agricultural research were released mainly from 1980 onwards.

In Central Africa over the period 1960-1998 the arable land area increased from 19.1 to 21.7 million ha, an increase of only 13.7% (Figure 1.). Arable land includes land under temporary crops (double cropped areas are only counted once), temporary meadows, land under market and kitchen gardens, and land under temporary fallow (less than five years). The abundant land resulting from shifting cultivation is not included in this category[8]. The limited expansion of the arable land area is explained by a significant reduction in the area of land left to fallow. To analyse this change the total of arable land is compared with the area harvested to annual crops (these crops include total cereals, fibre crops, groundnuts, soybean, pulses, root and tubers and vegetables and melons). In the 1960s the annual crops occupied about 43% of the arable land, while in the later part of the 1990s this percentage had increased to 59. This shows that the area of land under fallow must have decreased by some 17%. The amount of arable land available for the agricultural population has decreased from 0.70 to 0.37 ha per capita over the last 40 years. If the average family seize is estimated at eight, then the average area of arable land available per rural household would be about three hectares.

[8] FAO Production Yearbook 1999. FAO, ROME, Italy

For Central Africa there are no data available for cowpea in the FAO database. From the early 1960s to the end of the 1970s maize production increased by slightly over 20%, and this was entirely due to an increase in the area cultivated (Figure 2.). There were no consistent yield increases over that period. The situation is slightly better for the next 20 years, during which the production increased by over 80% and the area harvested by about 40%. Yields increased in particular during the 1990s although they continued to be low. It might be concluded that there has been a moderate effect of improved production technologies. The average yields are well below the potential of the improved maize varieties.

In West Africa over the period 1960-1998 the arable land area increased from 42.8 to 56.5 million ha or by 32% (Figure 3.). The area harvested to annual crops more than doubled over the same period, indicating a very significant reduction in the percentage of land under fallow. This is a well known fact in most countries of this region. Strangely enough, according to the FAO data, during the 1990s the area harvested to annual crops in West Africa had become larger than the arable land area (this shows a weakness of the FAO data, but more reliable alternative sources are not available). The amount of arable land available for the agricultural population has decreased from 0.69 to 0.51 ha per capita from 1960-1998. Taking again an average family size of eight would mean that about four hectares of arable is available per rural household in West Africa.

In West Africa maize production during the period 1960 to 1980 stayed unchanged , there was a slight increase in yield at the end of the 1970s but this was accompanied by a reduction in area cultivated (Figure 4.). This reduction in area cultivated can be attributed to the change in maize production in Nigeria (Figure 5.) As a result of the oil boom there was a very strong reduction in agricultural production during the 1970s in this country. A very large proportion of the rural population moved to the cities and the oil producing areas because of better employment opportunities and conditions.

There has been a very strong increase in maize production in the region during the 1980s when total production increased almost fourfold, the area cultivated tripled and yields increased by some 30%. However, these increases were not sustained during the 1990s. As discussed later in this report changes in government policies in a number of countries had a strong negative effect on agricultural development. The extensive introduction of improved varieties, which apparently had gained increased farmers confidence, has certainly contributed to these positive developments, as well as the increased use of agricultural inputs, in particular fertilizers. However, average yields are also in this region still on the low side. For the period 1999-2001 average maize yields in the world were 4,350 kg/ha, and 2,956 kg/ha for the developing countries as a whole.

The combined production trends for maize for West and Central Africa as presented in table 3, show again the very significant increase in production during the period 1978-87[9]. This coincided with the wide-scale introduction of improved varieties and the increased use of fertilizers. The annual increase of maize yield of 3.3% during the period 1978-87 demonstrated clearly that in this region improved technologies can

[9] Pingale, P.L. (ed.). 2001. CIMMYT 1999-2000 World Maize Facts and Trends. Meeting World Maize Needs: Technological Opportunities and Priorities for the Public Sector. Mexico, D.F.: CIIMMYT

have a very significant impact. The lower figures in the following ten years highlight that without supportive socio-economic conditions positive production developments cannot be sustained in this particular region. These aspects will be further considered in the following part of this report.

Table 3. Maize production trends in West and Central Africa.

Period	1966-77	1978-87	1988-99
Growth rate of maize area (%/yr)	-0.5	7.6	1.5
Growth rate of maize yield (%/yr)	0.5	3.3	0.4
Growth rate of maize production (%/yr)	0.1	10.9	1.9

Cowpea production in West Africa has increased from some 900,000 tonnes in the early 1980s to almost 2.7 million tonnes by 1998 (Figure 6.). During the period 1960-1980 there was no increase in cowpea production. The increases during the last 20 years are exclusively due to an increase in area cultivated. Average yields stayed around 300 kg/ha, about 15-30% higher than in the preceding 20 years. Nigeria produces about three quarters of the total cowpea production in West Africa (Figure 7.). In this country yields increased significantly during the 1980s but levelled off during the 1990s. This might be explained by the introduction of improved cowpea varieties during the 1980s. These varieties required the use of pesticide sprays to fully exploit their production potential. The socio-economic situation in Nigeria during the 1990s had a very negative effect on the costs and availability of agricultural inputs. The data for cowpea production in Nigeria show again the detrimental effect of the oil boom during the 1970s. The figures for Niger, the other major cowpea producer, show an almost seven fold increase of production over the last 40 years, and this increase is exclusively due to an increase of the area harvested (Figure 8.). There has been no consistent change in the low yields. The overall increase in cowpea production, notwithstanding the low yields, demonstrates the important role that this crop plays in the dry zones of Niger and Nigeria.

4. Adoption of improved maize and cowpea technologies: opportunities and constraints

Originally the Centres made improved germplasm available to national collaborators mainly through the international variety trials. Further use of these materials was supposed to happen at the initiative of the collaborating NARS. Since the mid 1970s this was expanded in West and Central Africa through the establishment of the Semi-Arid Food Grain Research and Development Project (SAFGRAD) which started in 1977. Its purpose was to enhance the generation and transfer of technology by fostering closer linkages between IITA, ICRISAT and the NARS. Strengthening of NARS capacity was also an important component of the project, to allow them to become active partners in the technology development and adoption activities.
The project covered four crops: sorghum, millet, maize and cowpea. Phase I of the project ended in 1986; under phase II four networks covering the four crops were established.

During the 1990s the technology transfer activities were completed with on farm research. This meant, in addition to working with the traditional national agricultural research institutes, direct collaboration with the extension services, and other relevant groups such as NGOs. In Nigeria, for example, this involved very close collaboration with the Agriculture Development Projects, for on farm testing, but also, to undertake farmer participatory research and, in certain cases, to promote farmer to farmer diffusion of seed of improved maize and cowpea varieties.

In particular improved maize germplasm has been widely distributed, and adopted by farmers, in West and Central Africa as various studies show. Analysing the impact of the above mentioned SAFGRAD project, Sanders et al. (1994)[10] note "It is a popular misconception that there has been little progress in developing new technologies for the food crops of concern to the SAFGRAD programme". Under the project maize and cowpeas research has been much more successful then research on sorghum and millet in introducing new cultivars and technologies.

Sanders et al. (1994) emphasize that in West and Central Africa maize performs an important supplementary role in the food supply situation. Because. in the drier Sudanic regions the early maize varieties become available before the sorghum and millet, thus providing food before the major harvest. These early maturing varieties were specifically developed for the particular agroecological conditions of the Northern Guinea and Sudan savannas. Fajemisin et al. (1997) note that the extra early maize varieties produce dry grain in about 90 days. They have good drought tolerance and resistance to striga, virus and fungal diseases. The development of these varieties has created niches for maize production, consumption and improved food security in a sub-region confronted by recurrent droughts and consistent decline in per capita food production.[11]

In Ghana approximately 55% of the maize area was in improved cultivars in 1992. Maize production increased from 265,000 tons in 1982 to 932,000 tons in 1991. In the early 1990s new maize cultivars occupied 65% of the maize area or 133,900 ha in Burkina Faso. From 1982-1991 in Ghana the internal rate of return to the public investment in the maize programme was 74%. The cowpea experience under the SAFGRAD project has been very similar to that of maize. Mali and Burkina Faso though small producers are good examples of this. It has been estimated that there would be a 50% decline in cowpea yields in the absence of the new cultivars. Critical issues for the successful spread of improved technologies are input supplies and reliable prices (Sanders et al., 1994).

Smith and Weber (1997) provide a good overview of the development of maize production in Nigeria following the introduction of improved varieties.[12] Their findings are summarized in the following paragraphs. They note that from an

[10] John H. Sanders, Taye Bezuneh and Alan C. Schroeder. 1994. Impact of the SAFGRAD Commodity Networks. USAID/AFR OAU/STRC-SAFGRAD 111 pages.

[11] Fajemisin, J.M., B. Badu-Apraku and A.O. Diallo. Contribution of the maize network to alleviating maize production constraints in West and Central Africa. Proceedings of a regional maize workshop 21-25 April 1997, IITA-Cotonou, Benin Republic: 126-137.

[12] Smith J. and G. Weber 1997. Fostering sustainable increases in maize production in Nigeria. In: Africa's emerging maize revolution, edited by D. Byerlee and Carl K. Eicher, London, United Kingdom: 107-124.

agroecological point of view only the Northern Guinea Savanna, which occupies 17% of western Africa, is appropriate for intensive maize production, because of the high solar irradiation and the low night temperatures. From a development perspective agricultural systems follow two different evolutionary paths: a subsistence-oriented path, driven primarily by population growth, or a market driven path, driven primarily by opportunities for cash cropping. Preconditions for the market-driven path are investments in transport infrastructure and technologies for crops with a natural comparative advantage. With fertilizer application, as occurs in market driven systems, the response of maize to applied nitrogen reaches about 30 kg of grain per kilogram of nitrogen in the sub-humid zones, whereas only half of that response is achieved in the humid zones.

In Nigeria maize production and consumption have grown rapidly over the past two decades. Growth in area and production can be attributed to the successful development of high-yielding varieties combined with the provision of cheap fertilizer, improved infrastructure, and extension services. In 1972-1973, the humid forest and the derived savannah together accounted for 60% of total maize production, the Southern Guinea Savanna for 24%, and the Northern Guinea Savanna and Sudan Savanna only for 16%. By 1983-1984, the Northern Guinea Savanna and the Sudan Savanna combined were the largest maize-producing area (54%), the humid forest and derived savannah produced just 23% of Nigeria's maize.

The IITA maize improvement strategy emphasized increasing yield potential, breeding for durable pest resistance, and development of distinct varieties for each ecosystem. Among the varieties emerging from this programme were TZB developed for the sub-humid zone, and TZPB, adapted to the humid zones. The release of TZB was a technological breakthrough for the Northern Guinea Savanna. The variety gave dramatically higher returns to land – six times as much as sorghum and millet, the traditional food crops, and seven times as much as cotton, the traditional cash crop. The pure white grain of TZB, its improved husk cover, and its resistance to ear rot all contributed to its acceptance, but farmers stressed that maize owed its new importance largely to its dual role as a food and a cash crop. When maize prices were unattractive maize could always be stored for home consumption. Aside from the development of suitable maize varieties, another precondition for the expansion of maize in the north was the development of transport systems.

The authors note that the performance of maize in Nigeria has been affected by the overall policy environment, which in turn has been dictated by oil revenues. During the oil bonanza from the mid-1970s to the early 1980s, inter-sectoral terms of trade moved strongly in favour of food crops in spite of an overvalued exchange rate and soaring food imports. Maize prices fluctuated strongly but remained well above the 1976 level throughout the period. Even with these incentives and fertilizer subsidy, food availability per capita declined. The increasing gap between urban and rural wages drew large numbers of rural people away from their farming communities to urban centres. Maize production alone fell by an average annual rate of 6.7% between 1973 and 1982.

In 1982, as oil revenues diminished, maize production responded strongly to the favourable terms of trade, policy incentives, and return migration to rural areas. Incentives for maize production were at their peak. By 1986, however, increased

production and a currency devaluation led to the real price of maize to plummet in 1987, it was less than half the 1976 level. Maize prices recovered at the end of the 1980s after the government banned cereal imports. The fertilizer subsidy remained in effect, maize once again became highly profitable, and production grew at an annual rate of 5.3%.

In the Northern Guinea Savanna, group interviews confirmed that maize, considered a minor backyard crop in the mid-1970s, had emerged by 1989 as the lead crop in 90 to 100% of the villages surveyed in Kaduna and Katsina States. Virtually all farmers were using improved maize varieties in most of the survey villages. Local maize varieties had been completely replaced by improved varieties in most of the villages.

According to Smith and Weber (1997) it is by no means clear that the expansion of maize production is sustainable. Soil organic matter has deteriorated severely in market-driven systems of intensified cereal cropping, where high levels of fertilizer have led to high biomass removal, elimination of fallow periods, and reduced area in legumes. In the mid-1960s legumes occupied 22% of the cultivated area, whereas cereals were planted on just over half of the area.. By 1991, the area planted to legumes had declined to 11%, and cereal area had increased to 70% of the cropped area. Levels of organic mater appear to decline with intensive, continuous cereal cropping and are lowest in Katsina State, where intensive maize production was initiated 15 to 20 years ago, and highest in Bauchi State where maize is less important and short fallows still exist. In spite of the high level of fertilizer use in the Northern Guinea Savanna, the nutrient balance for potassium and micronutrients is negative, indicating soil mining and a high probability of nutrient deficiencies in the medium term.

Weeds remain by far the most important biological constraint, in particular in the population driven intensification systems in which land-use intensity is high and cash to pay labourers for weeding is scarce. These threats to sustainability are also linked to recent changes in government policy. Recently the Nigerian government removed the fertilizer subsidy and partially privatised fertilizer distribution. Preliminary interviews with farmers in the Southern Guinea Savanna after the subsidy was removed show that maize area is declining in 39% of the sample villages. Maize is being replaced by sorghum in the drier part of the Southern Guinea Savanna and by cassava and rice in the more humid areas.

Research issues related to the sustainability of maize production, and that are now addressed by research include, introduction of well adapted grain legumes (soybean offers good opportunities in this respect), development of Striga resistant maize varieties, and of varieties with improved nitrogen-use efficiency (see pages 4-5).

Smith and Weber (1997) emphasize that West Africa's agricultural potential can be unlocked by using a very different approach from that which worked in the favourable and homogeneous areas of Asia. Production systems in West Africa, even intensive ones, require diversity to be sustainable. Technological priorities need to be developed within the context of a holistic vision of the agricultural systems in the mandate area. Clearly, success depends to a great extent on the ability to recognize and characterize the heterogeneity of the systems, to understand their dynamics, and

to develop an awareness of how these dynamics interact with the evolution of threats to sustainability.

Elements needed for the sustainable development of maize production have been reviewed for some francophone countries by Adesina et al. (1997)[13]. They note that in the Northern Guinea Savanna of Nigeria Agricultural Development Projects (ADPs) and effective extension and input distribution systems, and market infrastructure were key determinants of success. However, in most of the maize growing areas of francophone West and Central Africa, the expansion of maize has been linked with the institutional support provided by the cotton development agencies. This included in particular provision of credit for the purchasing of animal traction equipment. They also provided farmers with improved maize seeds. Maize production also benefited from the CFA currency devaluation in 1994. It enhanced the profitability of local maize production and its competitiveness compared to imported maize.

Adesina et al. (1997) note also that the availability of early maturing varieties has allowed maize production in the semi-arid zones Burkina Faso, Mali, Niger, Senegal and Guinea to grow phenomenally. Annual growth rates of maize production in 1983-1992 have been high in Burkina Faso (17%) and Mali (7.5%). Production rates in the other countries, except Niger and Senegal, far exceeded the regional annual production growth rate of 4.1%. Most of the growth was due to area expansion except in Burkina Faso where yields have grown at the rate of 9.7% annually. Coastal countries have also experienced positive growth rates in yields, ranging from 8.1% in Ghana, to 4.1% in Cameroon, 2.9% in Togo, 1.8% in Nigeria and Côte d'Ivoire, and 1.3% in Benin. The demand for poultry feed is the major driving force for the expansion of maize production in the forest zones.

The authors mention that maize which was traditionally grown as a subsistence crop on small plots in home gardens, has been transformed into a commercial and profitable crop in the farming systems of different agro-ecological zones of West and Central Africa. But, market liberalization in for example Mali in 1986 and Cameroon created significant uncertainties for the farmers with respect to input supplies and destabilized existing marketing systems, which negatively affected maize production.

Maize development in Ghana also demonstrates the potential benefits that can be derived from improved maize technologies, as well as the need for effective support structures.[14] Tripp and Marfo (1997) note that despite Ghana's increasingly bleak economic prospects during the 1970s and its ailing agricultural sector, the research and extension system nevertheless proved remarkably successful in developing maize technologies that were attractive to farmers. The extent of this success became apparent when the Ghanaian economy began to revive in the mid-1980s and maize

[13] Adesina, A.A., O.N. Coulibaly and V. Houndekon. Policy, devaluation, and profitability of maize production in West and Central Africa: Comparative analysis of Cameroon, Benin and Mali. Strategy for sustainable maize production in West and Central AFRICA. Proceedings of a regional maize workshop 21-25 April 1997, IITA-Cotonou, Benin Republic: 53-92.

[14] Tripp, R. and K. Marfo, 1997. Maize technology development in Ghana during economic decline and recovery. In: Africa's emerging maize revolution, edited by D. Byerlee and Carl K. Eicher, London, United Kingdom: 95-106.

production rebounded at a surprisingly rapid rate. Maize yield increased in large part because of the widespread adoption of improved technoloies.

The relative importance of maize in different areas of the country has changed over time. Maize was traditionally an important crop for home consumption in parts of the forest and coastal savannah zones. Presently, maize production in the transition zone and the Guinea Savanna accounts for more than half of the maize planted in Ghana. Farmers generally valued the new maize varieties for their superior yield, fertilizer responsiveness, early maturity, and resistance to lodging. Originally there was some concern about the storage quality because of inadequate husk cover, but maize breeding has addressed this.

The adoption of improved maize production practices during the 1980s has undoubtedly contributed to the growth in maize production and yields since the late 1980s. Adoption of an improved variety, fertilizer (90-40-40 N-P-K), and adequate plant population increased yields from 1.8 tonne/ha to 3.5 tonne/ha. Without question improved maize production contributed to the decline in the real wholesale price of maize throughout the 1980s. The authors note that input policy has a significant impact on maize production, as shown by the fact that the removal of the fertilizer subsidy in 1990 precipitated a sharp decline in fertilizer use. This in turn led to a sharp reduction in maize production.

Although more research is needed on developing new varieties suitable to Ghana's growing conditions and market demands, increased attention needs to be directed toward soil fertility and crop improvement. With fertilizer only marginally profitable in many cases without the fertilizer subsidy, efficient methods of combining chemical fertilizer with other management techniques need to be developed. Weed control is another management challenge. Weeds are the single most important limiting factor on many maize fields in Ghana.

One of the major problems having led to a reduction in maize production during the 1990s has been the disarray in the input market in a number of countries following the implementation of the so called structural adjustment programmes. The events in Nigeria are a good example of this and a recent study provides further details (IFDC, IITA, WARDA, 2001).[15] It found that the agricultural input markets are fragmented and underdeveloped. During the 1990s, Nigeria introduced input market reforms without adequate supporting developments in institutional capacity and human capital formation. As a result the use of fertilizer decreased from over 500,000 nutrient tonnes in 1993/94 to approximately 100,000 nutrient tonnes in 1999/2000. The use of improved seeds and pesticides also decreased. Because the input markets are not functioning properly, the transaction costs of acquiring inputs are high and even then inputs are not readily available on time and in good quality. Quality control regulations are not enforced properly. In the seed sector, funding arrangements for the National Seed Service remain inadequate and uncertain for performing training and quality control functions. Dealer networks in rural areas are not well developed, and farmers must travel long distances to acquire inputs.

[15] IFDC, IITA and WARDA, 2001.Agrixultural input markets in Nigeria: an assessment and a strategy for development. 31 pp.

The study considers that the private sector in Nigeria has the potential to supply agricultural inputs in a cost-effective manner. However, because of the public sector monopoly in the past, these organizations and structures did not have an opportunity to develop the necessary skills needed for efficient marketing and market development.. Years of neglect and mistrust have left the private sector handicapped to perform efficiently. This study concludes that macroeconomic instability, policy inconsistency, lack of access to affordable finance and market information, and poor enforcement of quality mechanisms further discourage the active participation of the private sector in the input market development. Macroeconomic instability resulting from the depreciating exchange rate remains the single most important macropolicy factor that inhibit the growth in fertilizer use and the development of input markets.

Manyong et al. (2001) consider that agricultural research by national systems and international institutes has contributed to the increase of maize production and productivity in West and Central Africa over the last three decades.[16] Gains to consumers can be shown through the trend of the maize retailer's real price in the market. In Nigeria the real consumer price for maize did not show any significant increase over time compared to that of all other food commodities shown by the composite consumer price index.

It may be useful to end this review of a number of publications related to the opportunities for and constraints to the introduction of new maize technology with a summary of a paper by Byerlee et al. (1994) on the impact of maize research in sub-Saharan Africa.[17]

Byerlee et al. (1994) highlight that the record of technical change in maize production (in sub-Saharan Africa) is less gloomy than the widespread image of stagnating African food production would suggest. Many countries in sub-Saharan Africa have introduced improved maize technology with considerable success. Although maize yields in Africa have lagged yields in other regions, the overall gains in productivity to the scarce factor, which in much of Africa is labour, may be quite comparable to gains in other developing regions. However, the adoption of improved technology has been patchy. Often quite different results are seen in neighbouring countries, sometimes reflecting the varying availability of appropriate technology and sometimes reflecting constraints induced by institutional performance and policy. Improved varieties and hybrids are available for most areas, but appropriate crop and resource management technologies, especially for maintaining soil fertility and labour productivity, often are lacking.

The rate of adoption of improved maize varieties in 1990 as presented by Byerlee et al. (1994) is given in table 4. Two estimates are used, representing the lower and upper bounds of adoption of open pollinated varieties (OPVs). The lower bound is defined as the area sown to seed purchased in the year of the survey. The upper bound

[16] Manyong, V.M., K.O. Makinde and O. VCoulibaly. 2001. Economic gains from maize varietal research in West and central Africa. Paper presented at the Fourth West and Central Africa Regional Maize Workshop, 14-18 May 2001, IITA, Cotonou, Benin Republic.

[17] Byerlee, D., P. Anandajayasekeram, A. Diallo, Batayu Gelaw, P.W. Heisey, M. Lopez-Pereira, W. Mwangi, M. Smale, R. Tripp, and S. Waddington, 1994. Maize research in sub-Saharan Africa: an overview of past impacts and future prospects. CIMMYT Economics Working Paper 94-03. Mexico, D.F.:CIMMYT.

reflects the total area sown to improved germplasm, including seed of improved OPVs that was saved by farmers or passed from farmer to farmer. The authors note that 33-50 % of the maize area in sub-Saharan Africa was planted to improved materials or modern varieties (MVs) in 1990. And they stress that if the large developing countries with large commercial or irrigated maize sectors are excluded (China, Argentina and Brazil), progress in adoption of improved maize varieties has almost been as rapid in Africa as in Asia and Latin America. The review showed that improved seed has had a fairly extensive impact in much of the maize growing area of Africa, whereas fertilizer technology has been rather less successful.

Table 4. Area sown to improved maize varieties in Central and West African countries.

Country	**Total maize area 000 ha**	**% area sown to improved OPVs**		**% area sown to hybrids**	**% area sown to improved germplasm (MVs)**		**% of MV area with CG germ-plasm**
		Min.	Max.		Min.	Max.	
Nigeria	1,500	22	87	2	24	89	60
Cote d'Ivoire	691	14	42	4	18	46	88
Ghana	465	16	48	0	16	48	91
Benin	454	9	27	1	10	28	61
Togo	296	7	18	3	10	21	81
Burkina Faso	216	15	70	2	17	72	48
Cameroon	200	20	67	1	21	68	72
Mali	170	36	50	0	36	50	27
Senegal	117	100	100	0	100	100	100

Byerlee et al (1994) conclude that the experience with maize technology in Africa provides ample evidence that small-scale farmers, provided with well-adapted technologies and appropriate institutional support, will adopt improved seed , including hybrids, and complementary inputs as quickly and extensively as farmers in other regions. However, adoption sometimes has been patchy and the impact less than expected, in part because of deficiencies in local research and institutional support and because of inappropriate macroeconomic policies. Thus the development of improved technologies in Africa needs to place a special premium on ensuring efficient input use and maximizing returns to scarce labour and cash in the early stages of adoption. This implies a strong programme of on-farm research and extension with effective farmer participation to develop flexible and site specific recommendations.

The above examples demonstrate that various studies have been undertaken to analyse the opportunities and constraints for the introduction of improved maize technologies in West and Central Africa. They all come to similar conclusions:

(i) improved varieties can lead to significant improvements in maize production in the region,
(ii) effective government policies, in particular those related to input supplies, are essential for the development of maize production, and
(iii) more intensive maize production in West and Central Africa encounters significant sustainability problems that require innovative approaches to soil conservation and effective input use.

Regretfully for cowpea the number of such studies is much more limited. The most comprehensive study concerns Ghana and has been published by Dankyi et al., 2000.[18] They note that in the early 1980s in Ghana the top three production constraints identified were: (i) lack of improved varieties/low yield potential of local varieties, (ii) insect pest damage, and (iii) low plant populations.

These matters have been addresses under the Ghana Grains Development Project from 1980-1997. The research and extension efforts undertaken have had a very significant impact on farmers' productivity and incomes. Cowpea production in 1980 was estimated at 17,000 tonnes from about 100,000 ha; in 1997 it had increased to an estimated 80,000 – 100,000 tonnes from 140,000 to 160,000 ha. This means that the increase of production was in the first place due to increased yields from an average of some 170kg/ha to about 600kg/ha; a 250% increase over a 17 year period.

Dankyi et al. (2000) have carried out a study to (i) assess the extent of use of improved varieties and crop management technologies (insect control with insecticides and row planting to enhance plant population), (ii) find out farmers' perception of the effects of the technologies on their productivity and incomes, and (iii) examine gender roles in cowpea cultivation. It must be noted that the improved cowpea varieties were determinate and farmers were encouraged to plant them as sole crop. These were essentially new practices especially to the farmers in the Guinea Savanna zones. Five of the six improved varieties recommended originated from IITA, two were of medium maturity, one was early (originating from Ghana), and three were extra early. The yield potential of the IITA varieties ranged from 1,750 – 2,200 kg/ha, the one from Ghana had a yield potential of 1,500 kg/ha.

The survey was carried out in eight districts, in each district five villages were randomly chosen, and in each village eight farmers were again randomly selected. Thus the total sample size was 320 farmers. The adoption rates for the improved technologies were: improved varieties 69.7%, row-planting 70.7%, pre-flowering insecticides 82.8% and post-flowering insecticides 25.8%. Over half of the farmers obtained their seeds from official sources, while about 21% of them selected seeds from their own fields or obtained seed from other farmers. Nearly 28% of the farmers purchased their seed from the grain market. The recommended row planting increased

[18] Dankyi, A.A., B, Asafo Adjei, M.A. Hossain, K. Dashiell, H.K.Adu-Dapaah and V. Anchirinah. 2000. The adoption of improved cowpea technologies in Ghana. Paper presented at the World Cowpea Research Conference III, 4-7 September 2000, IITA, Ibadan, Nigeria.

dramatically the plant population by 400-600% over traditional farmers' practice (from 20,000 – 40,000 to 125,000 – 167,000 plants/ha). Farmers had difficulty in identifying the appropriate post-flowering insecticide. For most farmers the grain output, income, profit, and the quantity of product sold or stored, increased.

Over 85% of the farmers said their cowpea production has been increasing following the adoption of the improved technologies. Of those farmers whose cowpea production had increased, 80% said cowpea had become more profitable than other food crops like maize and cassava, while 13% attributed the increase to the fact that it is a staple food that is widely consumed. About 7% of the farmers gave other reasons for the increase in production. For those farmers who responded that their cowpea production was decreasing (12.5%), the main reason given was high cost of inputs (insecticides). Their yields were low, because they could not afford to purchase insecticides.

Male adults carry out most of the strenuous field activities like land preparation, weeding and spraying. Females are mainly responsible for winnowing after threshing and sale of produce. The whole family is involved in planting and harvesting, while storage is done by either men or women.

In Nigeria an adoption study on the introduction of improved crop-livestock management systems has been carried out recently (Kristjanson et al., 2000).[19] The study uses georeferenced community-level data to determine the adoption of improved cowpea in northern Nigeria. One of the objectives was to find out which factors at the community or village level are significant determinants of adoption of improved dual-purpose cowpea varieties and management techniques. In the entire study area 60% of the farmers cropped their land continuously. The most important reason for the adoption of a particular cowpea variety was, first high grain yield, second adaptability to the local environment and third fodder yield.

An increase in the area planted to cowpeas was reported by 48% of the communities. Population pressure seems to influence uptake of improved dual-purpose varieties. 8% of cropland was sown to improved dual purpose cowpea within the low population density domain, whereas 15% of the total area cropped was planted to improved dual purpose varieties in the high population density domain. With good wholesale market access respondents reported increases in both area under cowpea and the uptake of improved cowpea varieties. Of all the farming households 75% use cowpea fodder to feed their livestock and to receive income from sale of fodder. Intensity of adoption was significantly and positively influenced by both the perceived importance of livestock and the number of livestock owned. Cowpea was considered very important and important in almost all locations.

Results of the study showed also that the more often the extension agents visit the farmers, the less likelihood that new cowpea varieties are being adopted. It seems that the generalist extension agent does not sufficiently understand all the diverse material

[19] Kristjanson, P. I. Okike, S. Tarawali, R. Kruska, V.M. Manyong and B.B. Singh. 2000. Evaluating adoption of new crop-livestock management technologies using georeferenced village-level data: The case of cowpea in the dry savannas of West Africa. Paper presented at workshop on "Understanding adoption processes of natural resource management practices for sustainable agricultural production in sub-Saharan Africa." ICRAF, Nairobi, July 3-6, 2000.

they are expected to extend to farmers. Consequently, the authors suggest that since traditional dissemination pathways do not appear to be working, national and international agricultural researchers need to either strengthen these institutions or explore other pathways for dissemination of their results. Another possible interpretation is that new technologies must be attractive enough to stimulate horizontal farmer-to-farmer diffusion.

Kristjanson et al. (2000) conclude that the adoption of improved dual purpose cowpea varieties appears to be a win-win situation with respect to improvements in natural resource management in these intensive integrated crop-livestock systems.

Okike et al. (2000) studied the adoption of improved cowpea varieties by different wealth groups of farmers.[20] Wealth ranking was done by members of the community, and three groups were distinguished.

1. Talakawa, poor masses, average gross farm output N76,000 or US$706 per household, average farm seize 3 ha. The total income is usually insufficient to provide food needs for the households of on average 8 persons. The Talakawa often constitute the main source for hired labour for the better endowed farmers. These people are supported by remittances from relatives and from proceeds from engagement in casual labour. This group constitutes 27% of the farmers' population.
2. Yan kiza-kiza, struggling middle class, 60% of the farmers are in this middle class. Crop harvest and sales of livestock and livestock products amounting to N110,000 (US$1,100) annually, provide enough to feed their family of nine persons all year round.
3. Mai-hali, the rich, gross income from farming on 14 ha of land averages N306,000 or US$3,060 per household of 10 persons per annum. They hardly involve members of their household in providing labour for farming, depending mostly on hired labour. People in this own many farms and produce for the market.

There was a significant increase in the adoption of improved cowpeas as wealth rank improved. Local and improved cowpea varieties contribute 11% and 12% respectively to gross farm revenue. But, improved varieties occupy only 13% of the cultivated area compared to 23% for local varieties. Thus the value of improved varieties output per unit of land is double that of local varieties. Of the respondents 45% used insecticide sprays. Farmers in the middle class invested as much as N5,500 per hectare per annum in insecticide sprays, compared to N1,300 per hectare per annum for both the poor and the rich. This study showed that the potential for adoption of improved dual-purpose varieties like IT90K-277-2 is high in all domains. The greatest potential for adoption is in the middle class, and they should get the bulk of attention.

Tarawali et al. (2000) note that the apparent popularity of cowpea, notwithstanding the low grain yields in farmers' fields, is probably related to the fact that cowpea is a legume with the potential for multiple contributions not only to the household food

[20] Okike, I., P. Kristjanson, S. Tarawali, B.B. Singh, R. Kruska and V.M. Manyong. 2000. Potential adoption and diffusion of improved cowpea in the dry savannas of Nigeria: an evaluation using a combination of participatory and structural approaches. Paper presented at the World Cowpea Research Conference. III, 4-7 September 2000, IITA, Ibadan, Nigeria.

production, but also as a cash crop (grain and fodder), livestock feed and soil ameliorant.[21] In this context they consider that cowpea is a crop that may have a wide role in contributing to food security, income generation and the maintenance of the environment for the millions of small holder farmers who grow it in the region.

The authors note that in West Africa there is and will be an increasing demand for agricultural products, both crop and livestock. One of the responses of farming systems in the region to agricultural intensification is crop-livestock integration. Fallow periods have become reduced or absent and consequently the demand for nutrient inputs is raised; manure becomes more important. At the same time, as the livestock keepers increase their animal numbers, crop residues from the crop farmers become increasingly the major feed resource because there is no longer marginal or fallow land for grazing. In the dry savannas of West and Central Africa crop livestock integration is already a common feature of the farming systems, and it will increase further.

Whilst the benefits of crop-livestock are recognized, it is apparent that the food demands of the expanding population place increased pressure on these systems to raise productivity. Such increased productivity needs to be achieved without damaging the natural resource base if they are to be sustainable. Farmers are aware of the positive role of cowpea for soil fertility as they usually rotate the legume and cereal rows in alternate years.

Feeding cowpea fodder as a supplement increases animal weight during the dry season. Indications are, that from 1 ha of improved cowpea a farmer could benefit by an extra 50 kg of meat per annum from animals being better nourished, with over 300 kg more cereal grain as a result of improved soil fertility directly from the cowpea and more/better manure from the animals. There are other potential benefits, better fed ruminants will give more milk, and better fed traction animals will work better, meaning more and timely land preparation and better crop yields. The key component in all this is improved dual purpose cowpea varieties, as discussed earlier in this report.

Whilst the analysis of the FAO statistics showed a limited increase in cowpea yields in the region over the last 40 years, the above discussed studies show nevertheless that improved cowpea varieties have been adopted quite extensively by farmers in the region. Thus, the improved technologies meet the farmers' needs to a certain extent. Improved dual purpose cowpea varieties, new planting patterns of cowpea and cereals, as well as effective crop/livestock integration will most probably play an increasingly important role in agricultural development in the dry regions of West and Central Africa in the coming years. Effective pest management is only highlighted in the study concerning Ghana, however it will stay one of the major challenges for cowpea research in the future.

[21] Tarawali, S.A., B.B. Singh, S.C. Gupta, R. Tabo, F. Harris, S.Nokoe, S. Fernandez-Rivera, A. Bationo, V.M. Mayong, K. Makinde and E.C. Odion. 2000. Cowpea as a key factor for the a new approach to integrated crop-livestock systems in the dry savannas of West Africa. Paper presented at the World Cowpea Research Conference. III, 4-7 September 2000, IITA, Ibadan, Nigeria.

5. Non-formal technology transfer

Given the lack of effectively functioning formal technology distribution systems in many countries in the region, opportunities for the transfer of technologies through non-formal channels merit to be exploited. Direct involvement of farmers in technology distribution will be a key element for future development in the region. At least as long as the private sector is not adequately organized to meet the farmers' demands in a reliable and economically acceptable manner. In the following, three examples of farmer to farmer seed production and distribution are presented. They show that excellent results can be achieved with this approach.

A good example of farmer to farmer seed distribution is the spread of improved cowpea varieties in Kano State, Nigeria. In Northern Nigeria cowpea is an important multi-purpose crop as shown earlier in this report. However the private seed industry is relatively poorly organized and has shown little interest in the marketing of improved cowpea varieties. Farmer to farmer distribution was considered as a possible option to introduce improved cowpea materials.

A project was initiated in 1997 jointly by IITA and the Kano State Agriculture and Rural Development Authority (KNARDA) to promote farmer production and distribution of improved seeds. Each selected farmer was given 3kg breeder seed of the improved cowpea cultivar IT90K-277-2, on credit to be recovered after harvest. Following farmer selection of improved cowpea materials IT90K-277-2 had been identified as one of the most promising new varieties. A total of 36 farmers (primary farmers) participated in 1997 in the project and produced 6,786 kg of seed. They sold most of the seeds to 262 farmers (secondary farmers) who had approached them on their own. This group of farmers in turn sold seeds of the improved varieties to the so-called tertiary farmers. Each year the primary farmers are provided anew with breeders seeds produced by IITA to ensure that the varietal purity is maintained. The details are presented in the following table 5. It should be noted that the contact with the farmers was maintained by a well experienced extension officer who has been detached from KNARDA to IITA.

Table 5. Farmer to farmer production and distribution of seed if the improved cowpea variety IT90K-277-2.

Year	Primary farmers (nb.)	Seed produced (kg)	Secondary farmers (nb.)	Seed produced (kg)	Seed produced by tertiary farmers (kg)	Total Seed Produced (kg)
1997	36	6,786				6,786
1998	51	6,224	262	11,800		18,024
1999	48	18,347	2,458	16,375	64,757	99,479
2000	100	46,250	6,916	173,133	34,847	254,240
2001	140	52,320	8,758	175,160	57,660	285,140

Some 30 kg of cowpea seeds are needed to plant one hectare. The 36 farmers were provided in 1997 with a total of 108 kg of seeds from which 3.5 ha could be grown. The total amount of improved seeds produced in 2001 can cover 285,140/30 = 9,500 ha. This represents a 3000 fold increase over four years and demonstrates clearly that a new variety that is well adapted to the farmers' needs, can be spread very effectively through farmer to farmer seed distribution.

The above example is based on traditional cowpea production during the rainy season. However, over the last decade there has been an increased interest by farmers in Northern Nigeria to grow cowpeas during the dry season under limited irrigation and on the flood recession areas. During the dry season cowpea suffers less from insect pressure and provides better returns than wheat produced in the irrigated areas. An improved cowpea variety (IT89KD-288) well adapted to the growing conditions in the dry season and meeting farmers' interests became available in early 1990s. In 1993 some 200 gram of breeder seed was given to one farmer, who multiplied it and sold it to other farmers. By 2000 over 10,000 farmers have planted this variety during the dry season and they produced over 4,000 ton of cowpea seed. This shows again that a new variety can be rapidly introduced by farmers. The yields during the dry season are in the range of 1-2 ton/ha and, consequently, the introduction of this new variety has brought the farmers substantial benefits. Traditional yields are generally well below 400 kg/ha.

Another example of farmer to farmer distribution of new varieties is the introduction of downy mildew resistant maize varieties in Ogbomoso in southwest Nigeria (S. Ajala et al. 2001).[22] The objectives of the exercise were to (i) rapidly disseminate downy mildew resistant varieties of maize in the area, (ii) develop a model that can be used directly or modified for similar deployment exercises elsewhere, and (iii) develop the capacity of farmers themselves to implement and maintain the intervention.

Nine villages were selected in 1997. Three farmers from each village were chosen and supported with seed, fertilizers, and guidance on how to produce seed. In the following season, each farmer backstopped in a different village three new farmers and another farmer in his own village with seeds and technical know-how imbibed from the earlier training. The following year, the number of villages participating in the exercise had increased to 25 and the number of farmers to 111. By the third year, 625 farmers in 159 villages were producing seed of resistant varieties and all had been trained on how to produce a healthy maize crop. Average yields increased by 50% from 1846kg/ha for non-participating farmers to 2763 kg/ha for participating farmers in 1998/99.

The end of survey conducted to obtain farmers perceptions of the project impact indicated that farmers observed a drastic reduction in the incidence of downy mildew within two years. This resulted in a yield increase for over 90 percent of the participating farmers. There was a significant increase in proportion of income attributable to downy mildew resistant maize. Further analysis revealed that the

[22] Ajala, S.O., V.M. Manyong, V. Adenle, K.O. Makinde, A. Akintunde, J. Olufowote, M. Balaji and B. Bolayi. An approach to rapid development of agricultural technologies – The case of downy mildew resistant maize in Ogbomoso, southwest Nigeria.. Paper presented at Forth Biennial West and Central Africa regional Miaze Workshop, 14-18 May 2001, IITA, Cotonou, Benin.

additional income enabled farmers to finance children education, pay hired labour and expand farm sizes among others.

6. Introduction of improved maize and cowpea technologies in West Africa by Sasakawa Global 2000.

Introduction of improved maize technologies into West Africa has been undertaken since 1996 by Sasakawa Global 2000. Sasakawa Global 2000 encourages farmers to set up so-called management training plots of 0.25 ha each, and provides credit for the provision of inputs, i.e. seeds of improved crop varieties, fertilizers and pesticides. For maize the recommended amount of fertilizer to be used per hectare is a total of 135 kg of N, 45 kg of P, and 45 kg of K. About two third of the total N and all P and K is given as a basal dose, followed by a top dressing of 50 kg of N. These rates may vary somewhat from farmer to farmer. On cowpea the use of 100 kg NKP (15-15-15) per hectare is recommended, as well as two insecticide sprays. These inputs need to be repaid at the end of the cropping season. In Nigeria the programme was so successful that after three years there was no need anymore to provide credit at the beginning of the season.

A summary of the results obtained in Burkina Faso, Ghana, Guinea and Burkina Faso is presented in table 6. Very detailed data were received from the programme in Nigeria in particular with respect to production costs and net income per hectare for each of the participating farmers. A summary of these data is presented in tables 7, 8 and 9.

The data for maize in Burkina Faso, Ghana, Guinea and Mali show that the use of improved varieties and fertilizers increased the yields two to three fold compared to those obtained with traditional production practices. The data for cowpea are more limited but show also significant improvements in yield.

The data for Nigeria show without exception that excellent maize yields can be obtained in northern Nigeria, and that through the use of improved technologies average net income per hectare can be quite substantial. Maximum yields of some farmers were more than 8 tonnes/ha. These data clearly show that excellent yields can be realized with the available technologies, but to achieve this, farmers have to be assured that they will have access to the necessary production inputs. Traditional maize yields are in the order of 1200-1500 kg/ha, which means that farmers' gross income is normally less than $300/ha. The data for cowpea also show that farmers can benefit substantially from improved technologies. Gross income of farmers using traditional cowpea production practices is usually below $100/ha.

Table 6. Sasakawa Global 2000: introduction of improved maize and cowpea technologies in Burkina Faso, Ghana, Guinea and Mali.

Maize

Country	Total ha	Yield (tonne/ha)	Range (tonne/ha)	Trad. yield (tonne/ha
Burkina Faso				
1996	77.5	3.258		0.970
1997	170.25	2,293		1.181
1998	423.75	2.898		1.220
1999	485.5	2.601		1.115
2000	346,25	2.221		1.131
Ghana				
1997	223.75	3.65		1.53
1998	403.75	3.34		1.45
1999	228.50	3.90		1.45
2000	284.75	4.80		
Guinea				
1999	217	2.983		1.300
2000	273.5	2.62	4.5-1.0	1.600
Mali				
1998	250.25	2.434		1.175
1999	798.91	3.155	4.9-1.2	1.723
2000	84.50	2.725	6.4-1.3	1.952

Cowpea

Country	Total ha	Yield (tonne/ha)	Range (tonne/ha)	Trad. yield (tonne/ha)
Burkina Faso				
1998	14.5	0.778		0.541
1999	30	0.899		0.549
Ghana				
1997	67.25	1.56		0.62
1999	14.50	1.00		0.60
2000	41.25	1.58		

Table 7. Results of Sasakawa Global 2000 Maize Nigeria 1997 and 1998.

7.1 Sasakawa Global 2000 Maize Nigeria 1997

State/Zone	Area/zone (ha)	Yield range tonne/ha	Av. yield tonne/ha	Av. prod. cost/ha	Av. net income/ha
Kaduna					
Lere	155.45	9.3-2.3	5.6	$452.42	$690.19
Maigana	21.25	8.5-2.6	5.5	$422.62	$712.58
NAERLS	37.25	7.4-1.8	4.2	$297.30	$561.80
Samaru	15,00	6.9-1.7	4.1	$352.09	$492.38
Birnin Gwari	21.25	6.7-28	4.7	$408.29	$552.31
Kano	80.75	7.9-2.0	4.7	$374.46	$622.93
Jigawa	62.50	9.2-2.1	4.4	$409.88	$487.53
Katsina	7.50	7.2-1.6	4.3	$437.76	$429.23
Bauchi	0,75	5.4-3.8	4.8	$307.82	$680.76

Cost of 1 kg of maize in the market $ 0.20

7.2 Sasakawa Global 2000 Maize Nigeria 1998

State/Zone	Area/zone (ha)	Yield range tonne/ha	Av. yield tonne/ha	Av. prod. cost/ha	Av. net income/ha
Kaduna					
Lere	191.25	9.0-3,.3	6.1	$405.11	$741.23
Maigana	22.50	n.a.	6.2	$426.82	$327.76
Kano	108.75	8.2-2.2	5.2	$386.69	$599.47
Jigawa	61.00	6.4-2.9	4.7	$383.59	$499.40
Katsina	55.25	7.6-2.2	5.4	$355.36	$652.95
Bauchi	10.25	7.1-1.9	4.8	$302.40	$609.20
Gombe	24.75	6.0-3.3	4.3	$383.75	$419.39

Cost of 1 kg of maize in the market $ 0.19

Table 8. Results of Sasakawa Global 2000 Maize Nigeria 1999 and 2000

8.1 Sasakawa Global 2000 Maize Nigeria 1999

State/Zone	Area/zone (ha)	Yield range tonne/ha	Av. yield tonne/ha	Av. prod. cost/ha	Av. net income/ha
Kaduna					
Lere	201.25	8.2-4.0	6.0	$376.10	$264.27
Birnin Gwari	24.75	6.6-3.7	5.6	$328.15	$269.48
Samaru	13.00	6.3-3.9	5.0	$339.88	$200.62
Maigana	22.50	8.7-3.9	6.2	$374.02	$287.21
Kano	150.25	8.0-2.4	4.6	$274.66	$222.28
Jigawa	46.75	9.5-2.4	4.4	$315.44	$160.48
Katsina	116.75	12.6-1.6	5.5	$330.57	$275.60
Bauchi	56.55	9.4-3.5	4.7	$285.12	$217.15
Gombe	49,00	9.2-2.4	4.1	$305.09	$131.50

Cost of 1 kg of maize in the market $ 0.11

8.2 Sasakawa Global 2000 Maize Nigeria 2000

State/Zone	Area/zone (ha)	Yield range tonne/ha	Av. yield tonne/ha	Av. prod. cost/ha	Av. net income/ha
Kaduna					
Lere	214.25	13.9-4.3	6.5	$393.54	$377.84
Birnin Gwari	50.25	6.6-3.4	5.4	$388.23	$252.53
Maigana	33.00	8.0-2.4	5.3	$322.21	$309.37
Kano	150.00	7.4-2.4	4.9	$308.00	$465.89
Jigawa	68.25	7.2-1.6	4.7	$353.66	$387.30
Katsina	137.00	14.6-2.4	6.1	$290.12	$437.42
Bauchi	37.25	6.2-3.2	4.5	$275.29	$352.86
Gombe	44.75	6.0-2.8	4.1	$323.91	$227.71

Cost of 1 kg of maize in the market $ 0.12 in Kaduna and Katsina, $0.13 in Gombe, $0.14 in Bauchi, and $ 0.16 in Kano and Jigawa.

Table 9. Results of Sasakawa Global 2000 Cowpea Nigeria 1999, 2000 and 2001.

9.1 Sasakawa Global 2000 Cowpea Nigeria 1999

State	State (ha)	Yield range (tonne/ha)	Av. yield (tonne/ha)	Av. prod. cost/ha	Av. net income per ha
Kano	6.25	1.9-0.7	1.26	$106.23	$221.40
Jigawa	3.25	1.7-0.8	1.37	$147.74	$208.50
Bauchi	3.00	2.0-1.1	1.60	$120.32	$295.68

Fertilizer 100 kg NPK(15-15-15)/ha. Up to 2 insecticide sprays depending on pest infestation. Price of cowpea $0.26/kg

9.2 Sasakawa Global 2000 Cowpea Nigeria 2000

State	State (ha)	Yield range (tonne/ha)	Av. yield (tonne/ha)	Av. prod. cost/ha	Av. net income per ha
Kano	15.10	2.6-0.8	1.86	$123.10	$319.17
Jigawa	10.00	2.8-1.3	1.82	$150.10	$319.27
Bauchi	6.00	2.0-0.7	1.73	$136.37	$205.81

Price of cowpea per kg $0.20 at Bauchi, $0.24 at Kano and $0.26 at Jigawa

9.3 Sasakawa Global 2000 Cowpea Nigeria 2001

State	State (ha)	Yield range (ton/ha)	Av. yield (ton/ha)	Av. prod. cost/ha	Av. net income per ha
Kano	24.50	2.4-0.8	1.55	$118.73	$382.32
Jigawa	11.75	1.9-0.8	1.42	$155.66	$252.05
Gombe	5.75	1.4-1.1	1.21	$73.53	$253.75

Price of cowpea per kg $0.32 at Kano, $0.29 at Jigawa, and $0.27 at Gombe. At Gombe pesticides were not used.

7. Discussion and conclusions

It is evident, that the West and Central African region has its own international agricultural research requirements, because of its typical and varied agroecological and socio-economic conditions, and also because of the limited capacity of the national agricultural research systems. Four issues had to be addressed in this report. The first concerned the appropriateness of currently available technologies given the agroecological and socio-economic conditions in the region.

The review of relevant literature indicates that both maize and cowpea technologies have been adopted quite extensively by farmers in West and Central Africa. Maize research seems to have been most successful in this respect, and currently all the area planted to maize in the region is either occupied by improved varieties or by materials derived from them. The results obtained by farmers clearly show that the available improved maize and cowpea varieties can produce excellent yields, provided farmers have access in a timely manner to the necessary production inputs. Over the past 40 years maize has evolved from a subsistence crop to a food and cash crop. Originally maize was mainly grown in the humid forest zone, but the availability of well adapted germplasm has allowed it to become a major crop in the savannah zones, where growing conditions are more favourable for maize production. Consequently, the new maize technologies have affected in particular agriculture in these agroecological zones.

However, in the region as a whole maize and cowpea yields are still very low. The main reason for this seems to be the insufficient use of the necessary production inputs, in particular fertilizers. This affects very strongly agricultural productivity in this region where soil fertility is generally low and where pest pressure, especially for cowpea is high. There are a variety of causes for the very limited input use including inconsistent government policies, inadequate infrastructure, insufficient private sector development, and high costs of inputs. The harsh reality in West and Central Africa is that farmers must not only cope with difficult crop production conditions, but also with mostly ineffective government policies and actions, and very poor support services. Notwithstanding this almost total lack of support, farmers have adopted to a very significant extent improved varieties, especially in the case of maize. A significant benefit is that currently all maize grown in the region is resistant to the major diseases, and as such the introduction of the new materials has significantly increased production security.

The efficiency of the present technology transfer mechanisms in widely reaching the producers was the second issue to be addressed. The performance of technology transfer mechanisms in the region has been quite variable in effectiveness over time. The rapid spread of improved maize varieties in Nigeria in the 1980s was due to the successful operations of the Agricultural Development Projects. Adesina et al. (1997) discuss the positive role of the cotton development agencies in introducing improved maize production technologies in the dry savannas in francophone countries. Excellent examples are also available from other countries in the region. But, at present in West and Central Africa the agricultural extension systems are under-funded and often lack well motivated staff. Kristjanson et al. (2000) did not see a positive effect of extension staff visits on farmers' adoption of new technologies. It must be concluded that currently the traditional technology transfer mechanisms are

not widely reaching the farmers. In this region also NGOs try to fill the vacuum, but with the exception of Sasakawa Global 2000 and a small number of in particular church related groups, it is too early to judge the overall benefits of their actions.

The third issue referred to the bottlenecks (technical, institutional, organizational and cultural) that restrain the generation, dissemination and adoption of improved technologies. In order for a technology to be of interest to farmers it has to fit well into his/her production practices. As mentioned in the report international agricultural research in West and Central Africa originally followed the green revolution approach. In a sense that is surprising because of the lack of a number of essential conditions required for the success of that approach. These include a favourable production environment, in particular through irrigation, and effective access to technical information and production inputs.

Much more progress might have been made if from the start of international agricultural research in the region, critical production constraints had been analyzed, and if solutions to address them had been undertaken in a more pragmatic manner. This would have meant that from the beginning of the establishment of IITA in the region more on-farm, applied research on effective production practices should have been undertaken, and less fundamental research on matters such as soil physical and chemical properties and plant physiology. But an applied approach to international agricultural research was for a long time not considered very positively within the CG system. It was felt that this type of research was the domain of the national agricultural research systems. This is fine for the CGIAR as a whole, but it did not take into consideration in an adequate manner the specific conditions and needs of agricultural research and development in West and Central Africa.

A more pragmatic approach might have led to a situation where the availability of more sustainable production technologies would have been more advanced than is currently the case. However, the fact remains that the unfavourable socio-economic circumstances in the region would still have impacted in a negative manner on agricultural productivity.

The institutional problems are well known in the West and Central African region. National agricultural research and extension structures, in almost all countries are severely under-funded. There is a significant number of well qualified staff but they lack adequate operational funds to carry out their work effectively. From an organizational point of view it will be important to further strengthen the ongoing collaboration between international and national agricultural research institutions. The national systems can, for example, draw significant benefits from collaborative projects through which they can complement their limited resources. At the same time, international research will be able to better focus on matters of direct interest to national systems.

Cultural differences in the region do not seem to have a marked effect on farmers' interest and capabilities to adopt new technologies. Provided that it can be clearly proven that a new technology fits into farmers' production practices and brings substantial benefits, without increasing production risks, it will usually be considered with interest by the farmers.

Opinions will most probably differ significantly on the implications for agricultural research of (i) agricultural developments over the last 40 years, and (ii) current socio-economic conditions in West and Central Africa (the forth issue to be addressed). Without doubt there will continue to be a strong need for research aimed at increasing crop productivity and ensuring that natural resources and production inputs can be used most effectively. Research on sustainable production systems will remain a key element in this. This will require close collaboration between plant breeders and natural resource management specialists. Natural resources must be considered in the broad sense, i.e. it must also involve extensive pest management research. Labour productivity must be increased to reduce production costs and augment production efficiency. It might be worthwhile to analyze the type of research needed to try to overcome the shortcomings of insufficient government support. This might lead to the conclusion that more efforts should be undertaken to strengthen farmer organizations.

A critical problem is also the remuneration that farmers receive for their products and this will require further research on effective farm product storage, transformation, and commercialization. As noted earlier all these issues need to be addressed in a pragmatic manner by working closely with farmers in order to fully understand their needs. In the current situation in West and Central Africa this does not require a great deal of fundamental research. The agricultural development problems are of a very practical nature and need solutions accordingly. It has sometimes been argued that the more applied agricultural research should be undertaken by the national systems. Research must be undertaken in effective partnership with the national colleagues, and this means that both should be working on the full range of research problems.

Poverty as defined by the international development community is very widespread among the rural population of West and Central Africa. Reduction of poverty is a major goal of the CGIAR. The data presented in this report in relation to the activities promoted by Sasakawa Global 2000, show that farmers can earn a net income from improved maize production in the order of $200 to $600 per hectare per year. About similar incomes might be generated by effective cowpea production. These results are obtained by maize farmers that produce 4 to 6 tonnes of maize per hectare. These are good maize yields given the overall production circumstances in the region.

In West Africa the amount of arable land available per capita of the rural population is about 0.4 hectares, or some 4 hectares per family. It might therefore be speculated that the average farmer, when using effective maize production practices, could earn between $800 to $2400 per year. This would have been a very decent income in a country like the Netherlands some 50 years ago. But if the average family size is eight persons and the poverty level is one dollar per person per day, than the average family must have a minimum annual income of $2920. Thus, given the current socio-economic conditions in West and Central Africa, there is little hope that significant numbers of farmers will be able to raise their income above the poverty line in the near future.

The one dollar a day figure might not be applicable in the same manner to all regions. In the study of Okike et al. (2000) farmers were considered rich by their own community if they had a gross annual income from farming of $3,060 per household of ten. Nevertheless, it can be concluded that farming will have to be diversified and farm size will have to be increased to become a remunerative activity in the region.

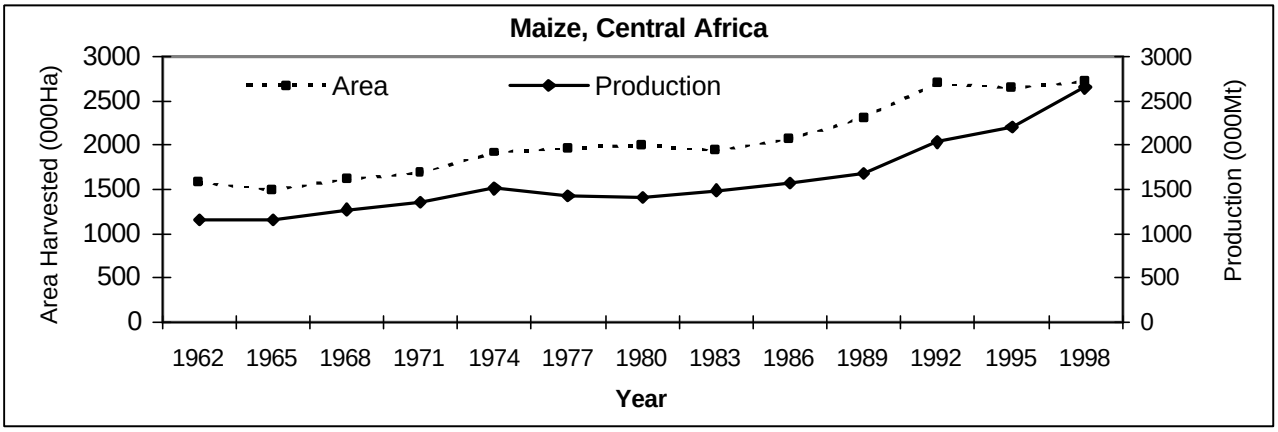
Annex I. Land use, population and production data for West and central Africa according to FAOSTAT Production Statistics 2002.

Figure 1. Land use and population development in Central Africa (three year averages).

Central Africa	Land use		Population		Area harvested to annual crops (1000 ha)
Year	Arab&perm crops (1000ha)	Arable land (1000ha)	Total (1000)	Agr. pop. (1000)	
1962	20,933.67	19,069.67	33,240.33	27,248.00	8,369.76
1965	21,348.33	19,328.33	35,600.33	28,749.67	8,320.52
1968	21,796.67	19,661.33	38,336.00	30,492.33	8,825.23
1971	22,184.67	19,919.67	41,232.33	32,230.67	9,368.97
1974	22,703.67	20,166.00	44,274.67	33,858.00	9,875.94
1977	23,422.00	20,627.00	47,909.67	35,818.00	10,190.03
1980	23,916.33	20,991.67	52,206.00	38,172.67	9,803.35
1983	24,187.33	21,047.33	57,084.33	41,018.00	9,689.90
1986	24,526.00	21,176.00	62,438.67	44,110.00	10,164.96
1989	24,627.00	21,258.67	68,380.66	47,470.67	10,906.16
1992	24,852.00	21,488.67	75,756.66	51,404.00	12,179.10
1995	24,997.67	21,628.67	83,674.34	55,311.33	12,529.86
1998	25,087.00	21,733.00	90,611.66	58,276.00	12,868.87

Figure 2. Maize production Central Africa (3-year averages).

Year	Maize, Central Africa		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	1583	733	1161
1965	1499	773	1159
1968	1616	791	1279
1971	1689	807	1362
1974	1919	791	1517
1977	1971	724	1428
1980	2001	707	1415
1983	1944	767	1490
1986	2064	763	1575
1989	2311	726	1678
1992	2702	753	2035
1995	2642	833	2200
1998	2720	974	2650



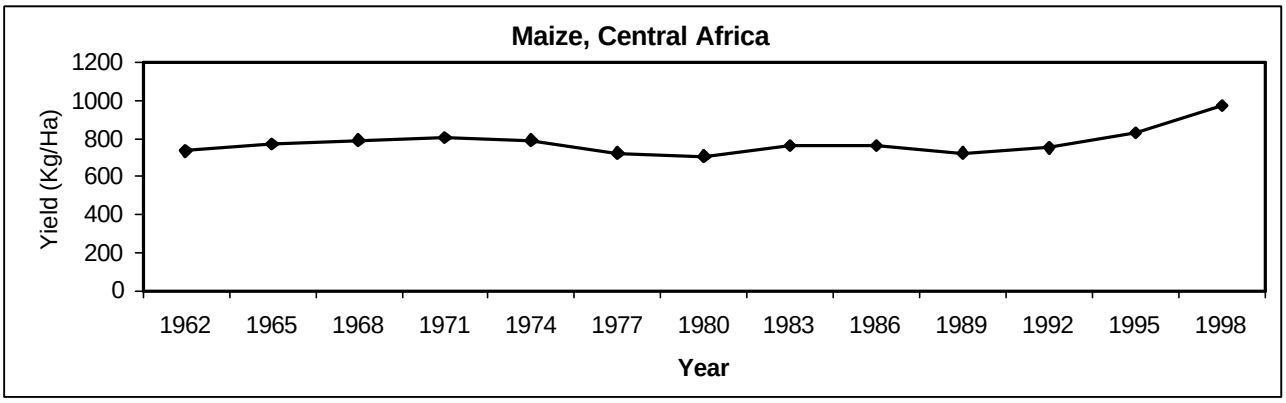
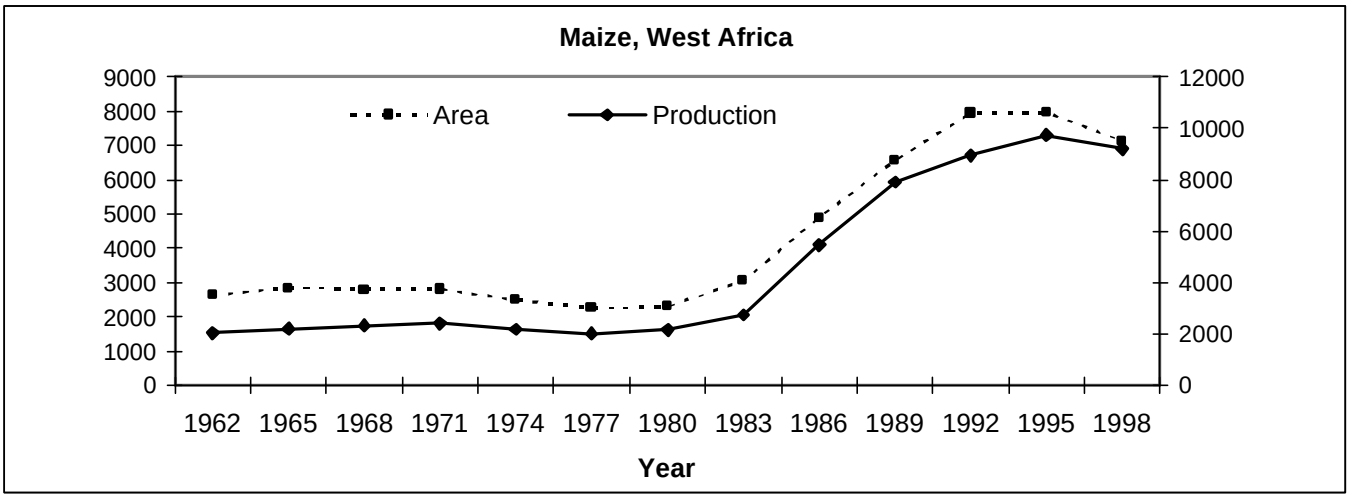


Figure 3. Land use and population development in West Africa (three year averages).

West Africa	Land use		Population		Area harvested to annual crops (1000ha)
Year	Arab&perm crops (1000Ha)	Arable land (1000Ha)	Total (1000)	Agr. pop. (1000)	
1962	48,820.00	42,767.33	79,137.34	61,692.67	32,202.93
1965	49,547.67	43,228.67	85,143.00	65,693.00	35,045.08
1968	50,339.33	43,882.67	91,769.34	70,095.34	38,345.87
1971	51,358.00	44,743.33	99,081.34	74,114.00	37,753.66
1974	51,759.33	44,877.00	107,273.70	76,864.66	36,584.66
1977	53,877.67	46,521.67	116,852.30	80,006.00	32,640.29
1980	55,243.67	47,640.67	127,739.00	83,496.66	30,879.70
1983	56,655.67	48,821.33	139,586.30	88,065.34	32,944.24
1986	58,429.33	50,287.67	152,481.30	92,922.00	39,895.63
1989	60,461.67	51,880.00	166,387.30	97,794.00	47,344.21
1992	62,340.67	53,447.33	180,946.70	102,397.00	57,168.34
1995	65,706.66	56,109.33	196,252.00	106,780.00	61,884.61
1998	66,406.34	56,478.33	212,611.00	111,127.30	66,184.85

Figure 4. Maize production in West Africa (three year averages).

Year	Maize, West Africa		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	2638	777	2049
1965	2844	774	2200
1968	2803	830	2325
1971	2808	862	2419
1974	2497	878	2191
1977	2253	892	2010
1980	2304	933	2150
1983	3045	901	2743
1986	4900	1117	5474
1989	6561	1208	7923
1992	7951	1125	8948
1995	7953	1224	9736
1998	7122	1292	9199



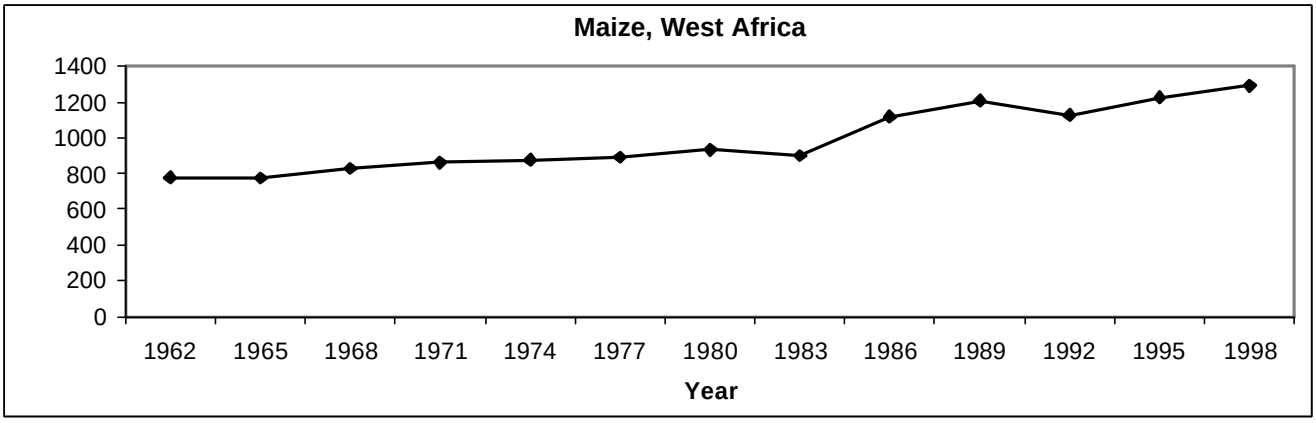
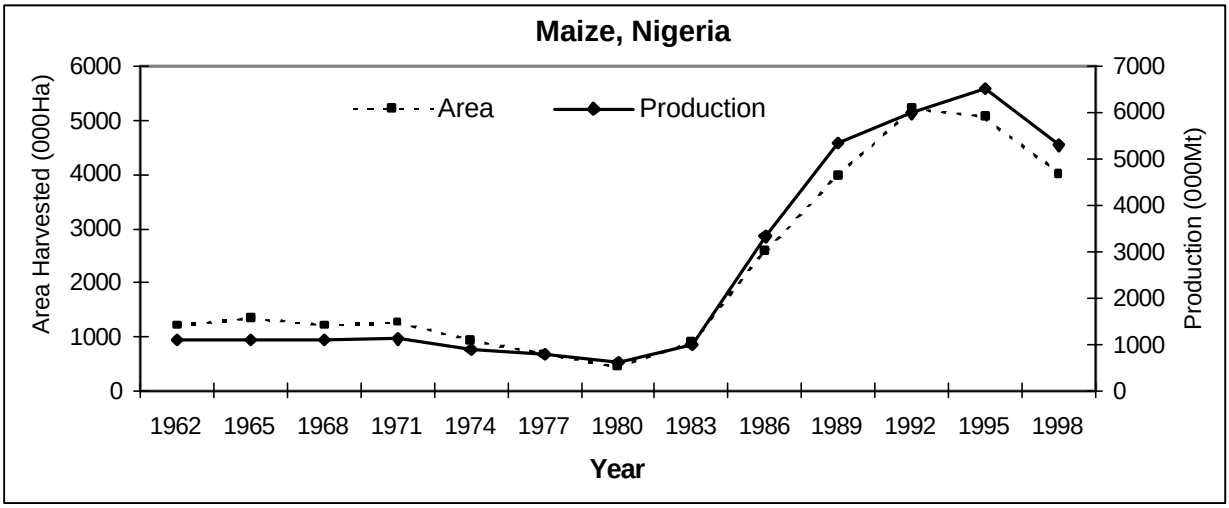


Figure 5. Maize production Nigeria (three year averages).

Year	Maize, Nigeria		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	1212	898	1088
1965	1340	809	1084
1968	1210	918	1110
1971	1261	887	1119
1974	932	954	889
1977	674	1176	792
1980	443	1370	607
1983	888	1122	996
1986	2588	1286	3329
1989	3969	1348	5348
1992	5225	1145	5980
1995	5057	1285	6500
1998	4016	1316	5286



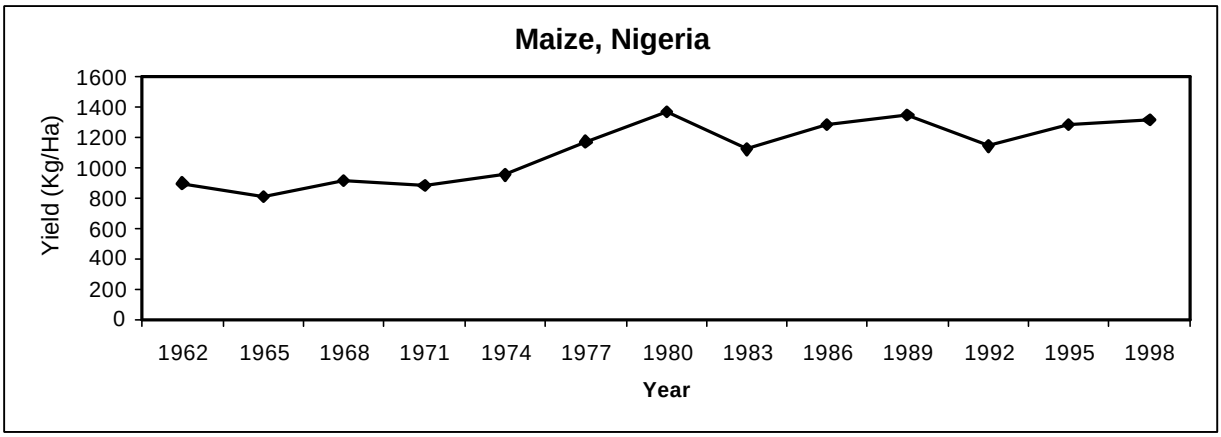
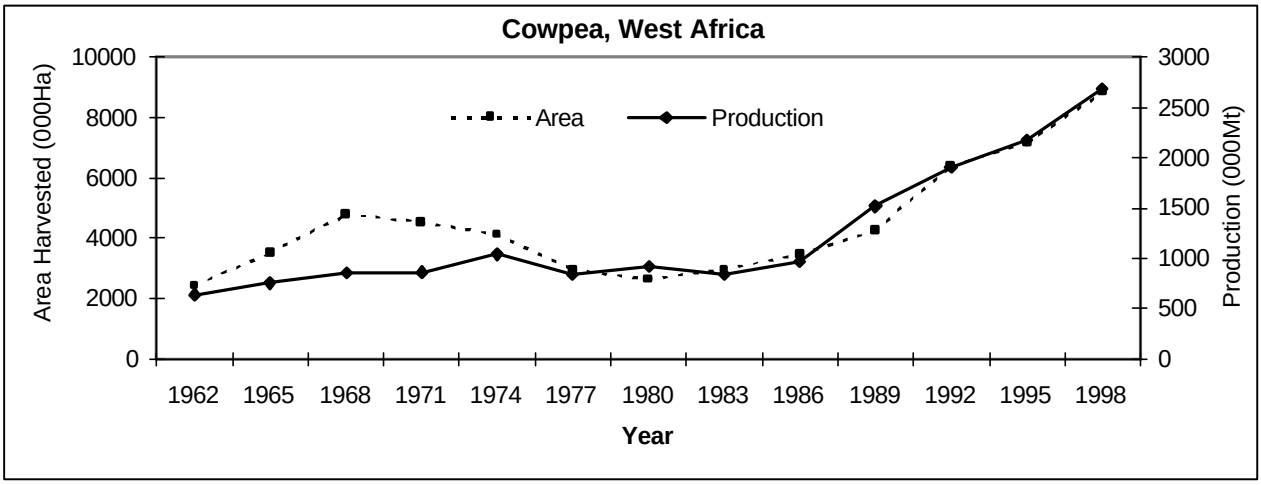


Figure 6. Cowpea production West Africa (three year averages).

Year	Cowpea, West Africa		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	2433	264	642
1965	3515	214	754
1968	4810	179	860
1971	4544	190	863
1974	4132	252	1040
1977	2957	285	842
1980	2645	348	921
1983	2972	286	848
1986	3469	281	974
1989	4269	357	1522
1992	6397	298	1907
1995	7168	303	2172
1998	8851	304	2688



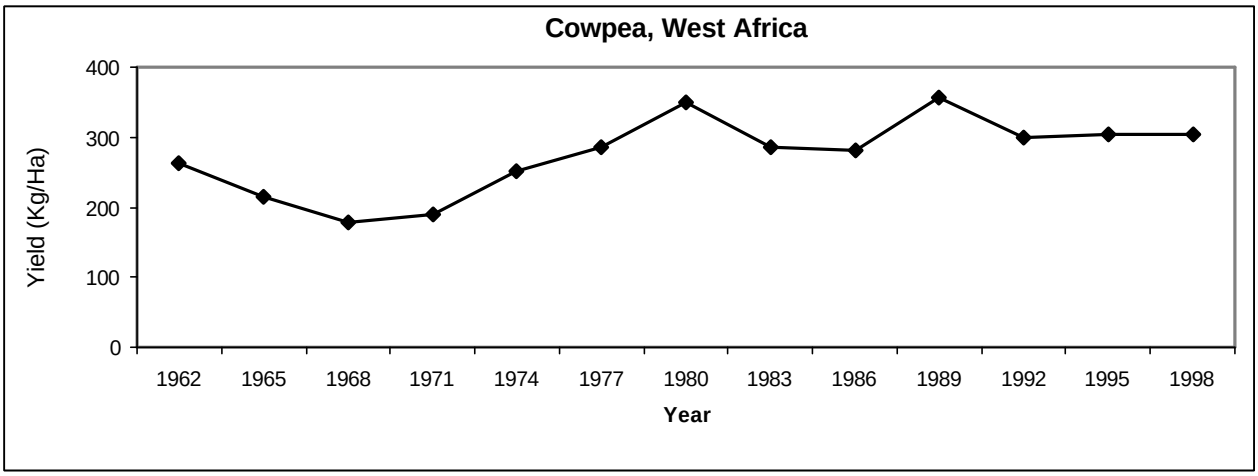
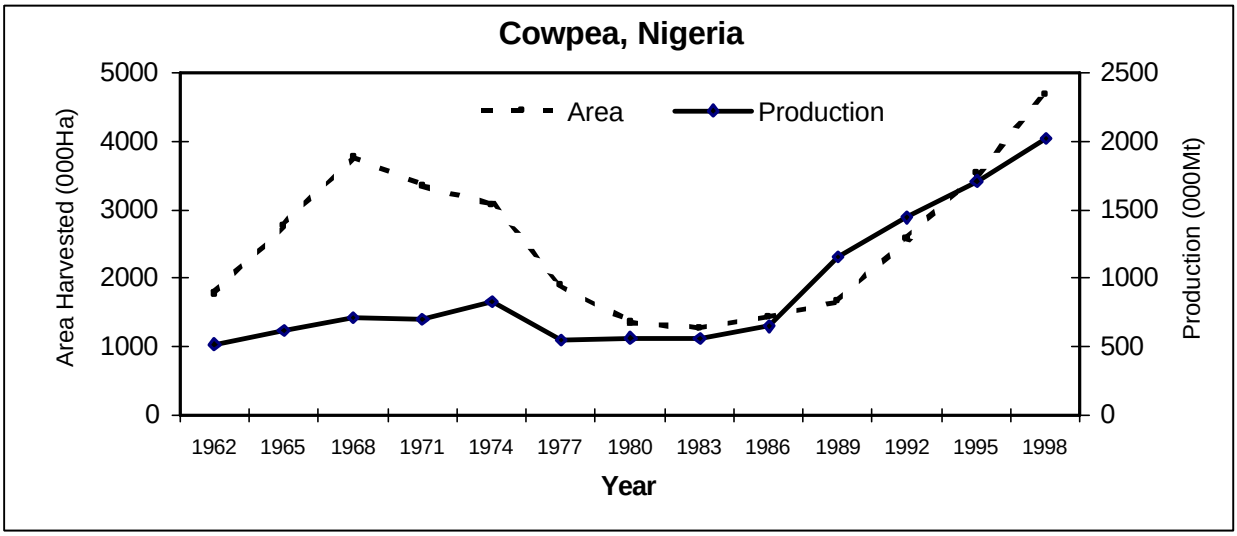


Figure 7. Cowpea production Nigeria (three year averages).

Year	Cowpea, Nigeria		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	1776	291	517
1965	2772	221	614
1968	3783	188	710
1971	3358	208	698
1974	3075	269	828
1977	1893	288	544
1980	1347	419	565
1983	1270	440	559
1986	1435	451	647
1989	1663	696	1158
1992	2581	560	1446
1995	3538	485	1714
1998	4695	431	2024



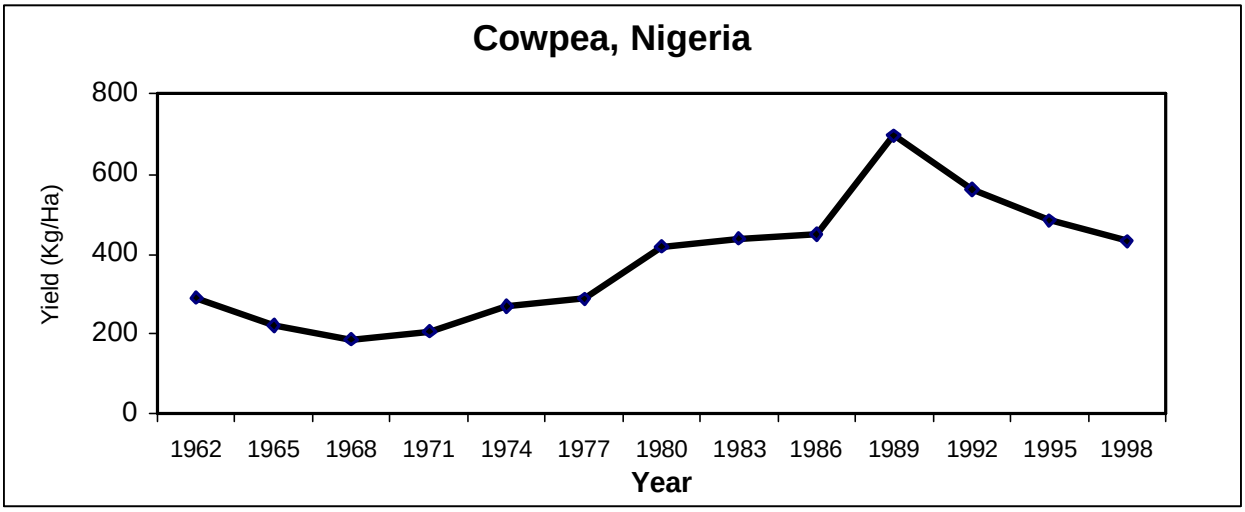


Figure 8. Cowpea production Niger (three year averages).

Year	Cowpea, Niger		
	Area Harvested (000Ha)	Yield (Kg/Ha)	Production (000Mt)
1962	469	145	68
1965	532	144	77
1968	801	98	78
1971	967	104	100
1974	863	171	148
1977	851	272	231
1980	1088	259	282
1983	1478	154	227
1986	1649	122	202
1989	2237	125	280
1992	3259	97	317
1995	3153	106	335
1998	3621	131	474