Farming Systems Research in the SAFGRAD Project in West Africa

Report of OAU(STRC)/IFAD Mission to Upper Volta, Mali and Senegal

François Couprie, David Gibbon and Felix I. Nweke

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Preface

The Mission team was requested to review SAFGRAD/FSR and related activities in Upper Volta and examine the possibilities for additional FSR inputs within the Malian and Senegalese Research Systems.

In making our recommendations we have borne in mind the IFAD and OAU (STRC) wish to provide support for FSR development within national programmes and also for work that is oriented towards helping the poorer groups of farmers in the SAFGRAD countries.

We are acutely aware that the short time available for the mission has prevented thorough analysis and full exploration of alternative strategies for Mali and Senegal and also it was not possible to examine prospects for FSR in other SAFGRAD countries in West Africa. We wish to apologise for any major omissions, oversights or errors of judgement resulting from these circumstances.

Acknowledgements

The Mission members would like to acknowledge the help that they have received from many individuals and institutions in Upper Volta, Mali and Senegal during the period of travel and of study. We are particularly grateful to the Directors-General of Agricultural Research Ministries in Mali and Senegal and their staff for agreeing to see us at very short notice, for explaining their own plans and priorities and for listening to our own proposals with great courtesy.

We are also most grateful to the staff of the IITA for facilities, hospitality and support during our brief writing up period, and to a group from the FSR team for helpful comments and discussion on the preliminary proposals.

Finally, we wish to thank Professor O Williams (OAU/STRC), Dr Taye Bezuneh (Director of Research SAFGRAD) and Dr J Menyunga (International Coordinator SAFGRAD) for their help and encouragement throughout.

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Summary of findings and main recommendations

In examining farming systems research programmes in three countries in West Africa the mission team have found a variety of approaches, some of which have resulted in efficient methodologies for the identification of farmer problems. Few, however, have developed systems that are fully integrated into existing agricultural research programmes and few have managed to initiate comprehensive field research activities in whch research is conducted in a manner likely to combat the overall problems of resource base stabilisation before attempting to increase crop productivity. We are in full agreement with the findings of previous reviews that many of the alternative technologies currently under examination are not relevant to the current or medium term needs of poor farming families and they are therefore unlikely to have much impact or value.

Recommended: that SAFGRAD/FSR is strengthened in Upper Volta and that SAFGRAD/FSR programmes are begun in Mali and Senegal. All these activities to take place with the full approval of respective Directors of Agricultural Research.

With respect to each country:-

1. **Upper Volta**

   We detected several deficiencies in the current Purdue FSU approach to FSR. These include: a limited perception of the seriousness of the resource degredation problems, an excessive emphasis on the collection of data that has no immediate value, the omission of major areas of study, eg livestock and forestry, lack of communication with other important research and extension activities and the limited range of short term on-farm experimentation that was unlikely to have major impact. Though it was claimed that a "model" approach had been developed, we felt that an approach that could be used in regional training programmes was some way off.

   Of the other FSR approaches studied, ICRISAT had developed a sound reconnaisance and study approach but were also thought to be weak in the applied research programme. The IRAT approach had some useful features, particularly as it was part of the national research system and it was carried out with few personnel.

   Other, related research and extension projects provided valuable insights into the possibilities and alternatives that could be incorporated into an integrated FSR programme.

   Recommended: that three additional people are appointed, to strengthen the Voltaic research system, with specific responsibility for FSR activities in Upper Volta. These people would be; an experienced agricultural economist (team leader SAFGRAD/FSR), a livestock production scientist and a soil scientist. All three are required to work as a team in a range of agro-ecological zones relevant to the SAFGRAD Project mandate.

They are required to develop a research and development approach (which is an integral part of the agricultural research system of Upper Volta) that tackles the major problems faced by poor farmers in the short and long term.

It is also proposed that the Purdue programme be fully integrated with the national programme.

2. **Mali**

Mali already has some years experience in FSR both by national teams and by ICRISAT and ILCA. Based on this knowledge, a slow expansion of FSR activities is planned over the next 10 years. The mission team detected some scope for further FSR activity that did not conflict with existing plans and also utilised existing knowledge.

Recommended: that a two person team, consisting of an agronomist and a livestock scientist, be based at Cinzana Research Station and be required to develop an FSR approach with local staff and support. As in Upper Volta, the major task is to develop a programme that generates technologies that have relevance to poor farmer needs.

3. **Senegal**

Senegal also has a long history of research, development and extension work. The Research Division is currently planning a large expansion of FSR activity in five major areas in the country. As in Mali, the mission considered that there was still room for a modest team input in an area not currently planned for.

Recommended: that a two person team, consisting of an experienced agronomist and a livestock scientist, be based at Bambey (or an appropriate sub-station in the groundnut zone) and be required to develop an FSR approach with local staff and support. The major task would be to develop a research programme that generates technologies that stabilise the resource base and improve food security for the region's poor farmers.

It will be evident from the body of this report and annexes 2 and 3, that the mission has a number of overriding concerns in relation to the role of FSR in research systems in West Africa and also in the current trends and constraints in farming practices. We are most concerned that FSR should play an active, practical role in the development of stable farming systems and that it should not become isolated, either intentionally or not, from the problem solving tasks of applied agricultural research systems. We are also very concerned by the rate at which soil and vegetation resources are being degraded and by the possibility that many features of existing technologies, including the development of animal draught, may be contributing

to the acceleration of this decline.

Recommended:

a) that care be taken to ensure that SAFGRAD/FSR programmes are always involved in relevant research of high priority and that FSR has a continual linkage and communication function within research systems.

b) that the implications of the introduction of new technologies are fully understood before their introduction, and

c) that a serious effort is made to re-establish older or already well known fertility maintenance measures before attempting to develop more extractive and productive technologies.

It may be concluded from our study of the problems of farming in the West African semi-arid tropics that some form of mixed agro-sylvo-pastoral system may well offer the best long term solution for farmers who wish to continue to live in these areas. We consider that the development testing and evaluation of these systems is the principal task of FSR in the next 10 years.

List of abbreviations

CIEH	-	Comite Inter-African d'Etudes Hydrauliques
CILSS	-	Comite Permanent Interetats pour la lutte contre la Secheresse Au Sahel
CNRST	-	Centre National de la Recherche Scientifique et Technologique
DSC/IA	-	Direction des Services de L'Elevage et des Industries Animales
FSU	-	Farming Systems Unit (SAFGRAD - Purdue University)
ICRISAT	-	International Centre for Research in the Semi-Arid Tropics
IITA	-	International Institute of Tropical Agriculture
ILCA	-	International Livestock Centre for Africa
INSAH	-	Institute du Sahel
IRAT	-	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrieres
IRBET	-	Institut de Recherches Biologiques et d'Ecologie Tropicale
IRCT	-	Institut de Recherches sur le Coton et les Textiles
IRHO	-	Institut de Recherches sur les Huiles et les Oleagineaux
ISNAR	-	International Service for National Agricultural Research
ISP	-	Institute Superieur Polytechnique
ISRA	-	Institut Senegalais de Recherches Agricoles
IVRAZ	-	Institut Voltaique de Recherches Agronomiques et Zootechniques
MDR	-	Ministere du Developpement Rural
ME	-	Ministere de l'Equipement
MESRS	-	Ministere de l'Enseignement Superieur et de la Recherche Scientifique
MET	-	Ministere de l'Environnement et du Tourisme

ORD	-	Organisme Regional de Developpement
ORSTOM	-	Office de Recherche Scientifique et Technique d'Outre Mer
PNVD	-	Programme de Nations Unies pour le Developpement
RFA	-	Republique Federale Allemande
SAFGRAD	-	Semi-Arid Food Grain Research and Development

1. Introduction

Background to SAFGRAD/FSR Project and IFAD Project Proposal

The SAFGRAD Project was established in 1977, with support from major donor countries and institutions, with a regional mandate to engage in research and development activities designed to produce improved cereal and legume varieties and develop appropriate technologies for small or poor farmers. The project supported both research in selected countries and national extension activities to extend improved technologies to farmers. The project is implemented by the Scientific, Technical and Research Commission of the O.A.U.

The Project is partly sub-contracted to a number of international institutes (ICRISAT and IITA) and, with USAID support, to Purdue University for Farming Systems Research. Though it was intended that the FSR component of the project should be a regional activity, since 1979 all the FSU activity of Purdue has been in Upper Volta.

There is now concern that against the background of growing population densities, declining average annual rainfall and increasing resource degradation, the project is not making satisfactory progress in the semi-arid zones. Project Review Missions have recommended that activites should be reoriented towards giving greater support to national research programmes and the development of technologies that are relevant to the needs of poor farmers.

In addition, OAU/STRC and IFAD have agreed that the FSR should have a broader regional base and that both station based research scientists and all those involved in farming systems research should have a greater understanding of the nature and problems of existing farming systems. Also, the closer contact with a wider range of farmers is intended to facilitate the wider impact of any potentially suitable technology.

The consultancy team is charged with the review and further development of SAFGRAD/FSR activities in the countries of West Africa. Further elaboration of the background to the Mission is contained in the Report to IFAD by the OAU/STRC in Annex 1.

Terms of reference of consultant team to IFAD funded Farming Systems Research component of the OAU/SAFGRAD Project

The three man team is required to carry out the following on behalf of OAU/STRC and IFAD during the period January 5th to January 31st 1984:-

General

1. To advise OAU/STRC on the FSR approach in accordance with the IFAD Project

2. To prepare a plan of action for FSR in the three member countries in accordance with the Project

3. To work in close collaboration with the Director of Research and the International Coordinator to effect the above

4. To collaborate with the International Centers which have on-going activities in SAFGRAD and other institutions which are considered to be carrying out work relevant to the project

5. To visit selected countries in West Africa and assess their suitability as bases for the IFAD Project

Specifically the team is asked to:-

1. Review on-going FSR in Upper Volta carried out by Purdue University, the International Institutes, IRAT and other relevant activities, and propose, if appropriate, support for FSR in relation to national agricultural research needs

2. Propose appropriate linkages of the SAFGRAD/FSR in the Upper Volta national programme and with the regional SAFGRAD/FSR Project

3. Visit Mali and Senegal and examine the feasibility of developing IFAD funded FSR programmes in each country. If the IFAD proposal is welcomed, proposed suitable roles for the FSR teams

4. For all FSR teams, suggest disciplines, terms of reference, scheduling, activities, and expected outputs

5. Review existing SAFGRAD links, contact arrangements etc. and propose an appropriate administrative structure for the implementation of FSR in the SAFGRAD Project

Composition of mission

Three experienced agricultural research personnel made up the Mission; one with experience in farming systems research within national and international research systems (David Gibbon), a second with many years experience in agronomic research and development work in the West African region (Francois Couprie), and a third with experience in agro-socio-economic research on farms and villages in the region (Felix I Nweke).

Mission Programme

The mission began work in Upper Volta between January 6th and 13th. The three members of the team, together with the SAFGRAD Director of Research spent 5 days in Mali and 3 days in Senegal before spending a further 5 days in Nigeria (Lagos and IITA) in final discussions and writing up. Details of the itinerary are in Appendix 6.

2. **An outline of the agronomic research and extension structure in Upper Volta** (see Annex 6a)

It was evident from the team's discussions that the Voltaic authorities are aware of the necessity for coordination of agronomic research activities and the need to take effective control. The following summary gives a picture of the present situation, but this will almost certainly be modified in the next few months following two important planning meetings in February and April 1984.

Agronomic research is currently the responsibility of four ministries, the Ministry for Higher Education and Scientific Research (MESRS), the Ministry for Rural Development (MDR), the Ministry for Environment and Tourism (MET) and the Ministry of Equipment (ME).

Within MESRS the main agency for research is IVRAZ (Voltaic Institute for Agronomic and Zootechnical Research) which is one of the five institutes of the National Centre for Scientific and Technical Research (CNRST). IVRAZ is responsible for the running of four agronomic research stations which are run either directly, as at Kamboinse, or by subcontract to IRAT as at Saria Farakola or IRNO at Niabgoloko.

IVRAZ is also responsible for the coordination of various programs contracted to; IRAT for food crops, IRCT for textiles and IRHO for oil crops.

Also, MESRS is involved in the technical monitoring of research carried out by SAFGRAD/IITA, ICRISAT, ORSTOM, SAFGRAD/FSU, either directly or through IVRAZ.

The Institute for Biological Research and Tropical Ecology (IRBET), one of the five institutes of (CNRST), together with the Service des Eaux et Forets from MET, control the execution of the forestry program given to CTFT.

The Divisional Director of Higher Education (DES) through the "Institute Superior Polythecic" (ISP) coordinates the execution of various programs from Gampela Station. These programs include those of CRDI-IITA, INSAH-IITA, IRAT and IRHO projects.

The MDR, through the Directors of Agriculture (DSA) and Livestock and Animal Industries (DSE/AI), controls a number of research projects:

(a) through the DSA

1. Soil Survey - PNUD FAO
2. Plant Protection Service - CILSS, USAID, FAO, MDR
3. Fruit Program - IRFA
4. Pre-extension and experimentation among farmers - PAPEM
5. Fertilizer programme. (FAO) Rock Phosphate (RFA) and Biogas (CIEH)
6. The extension and experimentation service

(b) through the DSE/AI

1. Veterinary laboratories
2. Animal production
3. Zootechnique Research Stations at Samandeni, Banankeledega and Markoye

Also the MDR, together with the MESRS has the administrative responsibility for CRTA (Research Center on Animal Trypanosomiasis).

The Ministry of Equipment contains the Agrometeorological Service which controls the execution of the Agrohydrological Project.

All research programmes are discussed in commissions under the supervision of the CSRAZ (Special Committee for Agricultural and Zootechnical Research) committee through which are expressed the views of MESRS and MDR. However, when a broad plan has been approved, the programmes are defined by the agency of execution eg the French Institute of GERDAF, ICRISAT, SAFGRAD/IITA and Purdue/FSU. The fact that programs are defined and executed by foreign agencies, between which information circulates poorly and cooperative work is very limited, makes the task of control and coordination by the national institute very difficult.

The situation is understood by the government, and CNSRT requested help from FAO, the World Bank and ISNAR to draw up a prospective structural plan for agricultural research and proposals for its phased implementation (ISNAR/WB, 1983).

During the coming months, the proposals of this report will be considered by an internal national institutes meeting in February and a full meeting of local institutes and donor agencies in April. From these meetings it is hoped that a new structure and planning system will emerge.

3. Review of Farming Systems and on farm research in Upper Volta:

3.1 The SAFGRAD/Purdue Farming Systems Unit (FSU)

a) Objectives and Team Composition: The programme of the Farming Systems Unit (FSU) of SAFGRAD which is being implemented by a Purdue University Team, started in 1979. The goals are:-

1. to identify the principal constraints to increased food production
2. to develop and implement a multidisciplinary research method which can guide production technology and production research to address these production constraints
3. to identify the elements of that method which can be implemented in a national farming systems research programme, and
4. to train Voltaic personnel to assume increasing responsibility in the continuation of this work

The programme was supposed to be regional, covering the semi-arid region, but because of limited resources it has been concentrated in the central region of Upper Volta. The team consists of an agronomist, an economist and an anthropologist plus six assistants in each of the research villages.

b) Activities: The first three years of the programme, 1979-81, was spent developing and evaluating production strategies for the central region of Upper Volta. In 1982 the unit began actual farming systems research consisting of socio-economic data collection surveys, researcher-managed and farmer-managed agronomic trials.

These studies were based on a sample of 210 farming households selected in three villages in three rainfall zones all within the Central Plateau region. The 210 households consisted of 90 "laboratory" and 120 "control" households. Socio-economic data were collected from all 210 households but only the 90 "laboratory" households were involved in the farmer-managed agronomic trials. The Central Plateau region has the best agricultural land in Upper Volta and carries about 60% of the national population.

c) Socio-Economic Studies: The socio-economic studies involved extensive socio-economic data collection mainly from on farm labour input, risk behaviour of farmers, and the role of market in the production activity. The labour data were collected on bi-weekly basis for all activities on all cereals and for all activities on at least one field of each other crop of each of the 210 farm households.

The major conclusions from the socio-economic data collection studies were that: 1) labour was often a constraint during the first weeding, 2) the farmers claim to ignore price in cropping decisions, 3) continuous cropping without fallow has resulted in rapidly declining soil fertility, 4) sorghum production was restricted to relatively fertile areas which are scarce and millet was the principal crop.

90% of the time of all the interviewers and FSU research resources was devoted to the labour data collection effort. Nevertheless, the value of this data was limited. The main conclusion so far, i.e. that labour was a production constraint during the first weeding, was also reached from direct questions to the farmers on the subject of labour constraints. Secondly, the opportunity cost of the labour data collection activity appears to be high. With 90% of the enumeration resources devoted to labour, data collection on other socio-economic factors was inadequate. This probably led to certain conclusions that seem inconsistent with the behaviour of small farmers elsewhere. For example, the conclusion that the farmers "...claim to ignore price in cropping decisions..." (Lang and Cantrell 1983, p. 5) is misleading and could undermine various cropping improvement or FSR development efforts.

d) Agronomic Trials: Agronomic trials conducted in 1982 included researcher-managed and farmer-managed trials. The researcher-managed trials consisted of multilocational tests of intercrop combinations, varieties, water conservation techniques, and fertilizer trials. The aim of the trials was to evaluate the yield gap between experiment station and on-farm conditions. Standard split-plot or randomized complete block designs were employed. There were seven different experiments in all; all seven were carried out in two villages, six of the seven in one village, and two of the seven were carried out in a fourth village all at the same time.

Objective yield gaps between improved and traditional practices were adequately evaluated in these trials. Other performance indicators such as stand establishment, disease and pest problems, etc. were also adequately evaluated. Some advanced practices were judged not better than traditional practices, some needed further information from further researcher-managed trials before conclusions could be reached, two were judged superior to traditional practices and hence were ready for farmer-managed trials.

The analysis did not, however, evaluate farmers' subjective observations and suggestions on the technologies being tested. There was no evidence that such observations and suggestions were solicited. Judging a new technology as superior or inferior to a traditional technology only on the basis of objective yield measurements without consideration of farmers' subjective evaluation could, however, be misleading.

In the same year, one farmer-managed trial was carried out in each of the three villages to evaluate a combination of fertilizer and water conservation practices and to evaluate an approach for future farmer-managed trials. A randomized block design consisting of four treatments and one control was employed. The trial was carried out by each of the 90 "laboratory" households in their largest cereal fields. The average size of such fields for the 90 households was 0.75 hectare.

The FSU researchers concluded that the experimental design and the sample size which they employed were those that can be used to detect small increases in yield on farmer-managed trials. However, the bases they employed to evaluate the technologies being tested appear limited, the evaluation was based strictly on objective yield data. Other performance factors including yield determinants and above all farmers' subjective evaluation of the technologies were not considered.

The superiority or inferiority of one technology over another depends on circumstances; a technology may perform well in terms of yield or in terms of seedling establishment under certain moisture and soil fertility conditions but poorly under a different set of those conditions. To say that a technology is inferior to another in terms of yield without specifying the moisture and soil fertility conditions may not be a very useful statement for Upper Volta where soil moisture and fertility are critical constraints.

The issues of focus in the agronomic trials such as intercrop combinations, variety and fertilizer trials are short-term issues which would provide immediate answers to the kind of questions they address. However, the solution to the problem of low yield in the area may also depend on long-term issues such as soil fertility regeneration through interaction between crops and livestock or between crops and agro-forestry or both. FSU team have failed to address such issues probably because the nature of SAFGRAD contract does not encourage long range research programmes. The time perspective of SAFGRAD I is five years. In addition FSU scientists are recruited on a two-year basis only.

The failure of the FSU team to address the wider issues such as the interaction of livestock and agro-forestry with crops may also be a consequence of the composition of the FSU team which is limited to an agronomist, an economist, and an anthropologist. There are livestock, agro-forestry and soil fertility scientists in Upper Volta but the interaction with the Purdue team has been minimal so far (see Section 4 and Annex 3).

e) Training: The strength of the FSU work appears to be in its training programme. In addition to a good number who have received short-term training, by 1985 one Malian would be trained at M.S. level and three Voltaics at Ph.D. levels under the FSU training programme. This would ensure the continuity of the FSR after SAFGRAD contract is ended. Perhaps more emphasis should be placed on short-term formal training for Voltic staff at several levels. This is reported to be planned during 1984.

3.2. ICRISAT Farming Systems Research

(a) Organisation and Objectives: The farming systems programme of ICRISAT based at Kamboinse is a loose interrelationship of economics, agronomy, crop improvement and soil-water management programmes in Upper Volta. The Economics Programme is solely responsible for socio-economic surveys of farming systems and the on-farm agronomic trial component is planned in close collaboration with all programme scientists but executed by the Economics Programme. This work began in 1980. The specific objectives of the programmes are:-

1. The study of current farming systems to identify socio-economic and other constraints to production among small farmers, and to define the conditions which new technologies must satisfy for general adoption, and

2. the evaluation of new production technologies under farmers' conditions in order to assess the constraints to and consequences of adoption.

The team of the Economics Programme is made up of an agricultural economist and a social anthropologist. They work in close collaboration with agronomists, crop improvement, and the soil-water management scientists of other ICRISAT programmes in planning on-farm agronomic trials.

(b) Socio-Economic Studies: The economics programme carries out research with farmers in three agroclimatic zones of Upper Volta. Baseline studies of a socio-economic nature, with emphasis on description of production units and cropping patterns were started in 1981 in six villages in the three agroclimatic zones. Observations from these baseline studies are preliminary and are being further examined.

(c) On-Farm Tests: On-farm tests were started in 1982 in the study villages and included five researcher-managed trials on intercropping, variety, water conservation techniques and fertilizer trials. The details of the methodology and results of these trials are presented in the reports of cooperating technical programmes and are not considered here.

The on-farm tests, including four farmer-managed tests, are on sorghum varieties and one millet variety trial, were carried out in one location within 600mm rainfall zone by two different sets of farmers. The other two trials, another sorhum variety and an intercropping trial, were carried out at the same time in three locations within the 800mm and 1000mm rainfall zone. Each trial in each location was carried out by a different set of farmers. There were in all 175 farmers involved in the four trials.

The principal objectives of the trials were to determine the agronomic and economic performance under farmers' conditions of technologies which were in an advanced stage of development and to test their fit within local production systems (Matlon and Vierich, 1982).

Each farmer selected a field he considered suitable for the crops being tested. The ICRISAT staff laid out split plot design experiment covering 1000 sq.m. in the selected field. The farmers were provided at no cost with new inputs required for the test but they performed all operations. They were instructed in the new practices but they were free to modify them. No interventions were made except that field staff monitored activities including any modifications in the recommended practices through weekly interviews and frequent observations.

Observations covered included modifications in the recommended practices: seedling emergence, yield, yield distributions, determinants of yield, and farmers' subjective evaluations. Information from analyses of data on these enabled the ICRISAT farming systems scientists to show that a technology might not be superior to the alternative technology in all respects. Even in a given respect in which an improved

technology is superior it may do so only under certain environmental and/or management condition. The team was as a consequence able to establish adoption domains, environmental and management, within which technologies they considered superior should be extended for adoption.

However, ICRISAT farming systems programme has not addressed the broader and longer-term issues of the relationships between crops and livestock, between crops and agro-forestry, etc. and their consequences for soil fertility maintenance. This is in spite of the fact that ICRISAT farming systems programme is not facing short-term financing as does SAFGRAD Farming System unit. The possible explanation for ICRISAT not addressing such important issues may be the lack of livestock, agro-forestry and soil fertility scientists in their Upper Volta programmes. Or it may be because they have defined their mandate on cereals and legume crops narrowly; there is no reason why a team with such a mandate should not incorporate animal and plant organic manure to improve the soil fertility for the production of their mandate crops.

Nevertheless, the ICRISAT Economics Programme has at least developed an analytical methodology for the study of existing farming systems that could be adapted for farming systems analysis elsewhere in the Region. This methodology is summarised by Matlon (1983).

3.3 The IVRAZ-IRAT Research and Development Programme

Since 1981, IRAT is associated with IPD and the Yatanga ORD to work on farming system programme on two villages, Sabouna and Ziga. This year a programme will be started on five new villages. IPD has done the preliminary work of survey and collection of data and the actual intervention is based on the testing in the village of new technologies which has been identified as promising for the farmers; these techniques are tested on fields having the same soil characteristics as the farmers' field by IRAT personnel and on the farmers' fields by the farmers.

The first step is to verify the validity of the proposed technology perfected on research station, so that in the case of failure, the farmer does not suffer loss and the technology will be retested on station. These fields are also used for demonstration to farmers who are reluctant to try them. This action is associated with development operations such as the project on small livestock in Yatanga and the village wood programme. Therefore the farmer is offered an integrated programme which addresses many aspects of the farm system.

Test-field trials are based on the study of:

- mineral and organic fertilizers - Trials on selected varieties of sorghum and millet, introduction of new legumes, eg **Phaseolus aureus** (Amberiques) and rotations. The accent is always put on the physiological performance of the plant and the effect of tillage technology on moisture availability.

These trials have shown:

- ploughing combined with organo-mineral fertilization is water saving

- the interest in the introduction of short cycle cereal varieties (90 days) when the rainfall is in the region of 400mm

- the need to adapt fertilisation to soil types and adopt soil-water crop management practices

The study of crops in various rotations has shown the low productivity of hand labour and the time-saving effects of oxen traction. The low labour productivity is linked with environmental degradation as yields are decreasing for a given amount of work.

On-farm trials

The aim of the trials is to familiarize the farmer with long-term land improvement through the correction of soil deficiencies and to develop yield-increasing technologies. The idea is to propose to the farmer intensified cultivation on a small cereal plot which will be continuously cropped. Other interventions have been the introduction of a few sorghum varieties and the making of compost.

This work is achieved by one expatriate and two national assistants with a very small operational budget (12,000 US $).

4. Review of some development activities which are relevant to farming systems research

4.1 FAO/CLSS

Purpose: developing forage and soil improving crops in the Soundan-Sahelian zone

Most of this programme is carried out in the Dori region in the North East of Upper Volta with a rainfall in the 300-400mm range.

Most of the work is based on the selection and testing of local and imported grains or legumes. Some plants have been found very promising and can contribute to soil fertility restoration.

4.2 FED

Small livestock and poultry project in the Yatanga ORD

The project is based on the improvement of animal health, the decrease of mortality rate by the supply of appropriate vaccines and drugs, training of animal health assistants, the improvement of pastures, the fattening of animals with cotton seed, straw enriched with urea, and the making of manure pits. It has involved 55 villages and promising results have lead to a second phase programme.

4.3 MET

Village wood programme

This programme aims at the production of firewood and construction timber. According to the fertility level of the soil, plantations will be established in a pure stand on the poorest soil, but they can be associated with crops during the establishment period, or with pasture when the trees are fully grown wherever the soil has an acceptable level of fertility. On cultivated soil, planting of leguminous trees can be envisaged, particularly **Acacia albida, Parkia biglobosa** (Nere) and **Tamarindus indica** which, in addition to their soil restorative value, are all associated with human or animal food. There is also a programme on fruit trees and forage trees or bushes which can be used for hedges or anti erosion measures.

4.4 ORSTOM

Though this institute has recently started a socio-biological study of farming systems in the North West Region, it has already conducted various studies of agro-sylvo-pastoral systems at different times in the past 20 years. These studies should be a valuable source of information for any researcher in farming systems as they

show that not so long ago farmers had a comprehensive farming system which included the association with pastoralists and the integration of trees, arable crops and fertility maintaining technologies (Kohler, 1971).

The decline of these, older systems has occured at a rapid rate in recent years and most "modern" technologies that have been introduced seem to have contributed to this decline.

4.5 IITA SAFGRAD Research Programme

IITA activity in Upper Volta commenced in 1977 with the posting of a cowpea breeder, with IDRC support, to strengthen the national grain legume improvement programme. In 1978 IITA joined the SAFGRAD project to develop improved varieties of maize and legume crops and cultural practices which were compatible with semi-arid farming systems. For this purpose IITA posted a maize breeder, a maize agronomist, a cowpea agronomist and an entomologist in addition to the cowpea breeder already in Upper Volta.

These scientists work at four stations in Upper Volta representing four different agroecological conditions in the semi-arid tropics. The bulk of their work is on the following problems (IITA/SAFGRAD Progress Report and Future Plans. JP 31. SAFGRAD):

1. Maize Breeding: emphasis on earliness and drought tolerance. Two varieties have been tested and released in Upper Volta.

2. Maize Agronomy: emphasis is on soil fertility, water and crop management. Major agronomic constraints to maize production in the 700-900mm rainfall belt and agronomic practices are promising in solving some of the constraints that have been identified.

3. Maize Entomology: The major insects of economic importance that have been identified are termites and millipedes. The entomologist has concentrated his effort on cowpea for which insect damage is more critical than for maize.

4. Cowpea Breeding: emphasis has been to screen improved lines developed by IITA Ibadan and to develop high yielding varieties adapted to different ecological zones of SAT and two varieties have been released in Upper Volta. In addition efforts are being made to combine high yield with resistance to insect pests and acceptable seed quality, to collect and evaluate local varieties and to screen early varieties.

5. Cowpea Agronomy: emphasis has been on identifying factors limiting growth and yield of cowpea and assessing response to various management factors. Progress has been made in defining and recommending the management practices for maize-cowpea relay cropping systems.

6. Cowpea Entomology: the major thrust has been on working with the cowpea breeder in identifying sources of major resistance to major insect pests and in incorporating such resistance into promising varieties. Progress has been made in developing the screening technique and in screening some progenies for resistance to some of the insects.

In addition to these research efforts IITA organizes annual workshops, monitoring tours, short courses and training at degree levels for young scientists from SAFGRAD national programmes.

4.6 ICRISAT Research Programme in Upper Volta

(ICRISAT, 1979 and ICRISAT, 1983)

ICRISAT work in Upper Volta was initiated in 1975 with the posting of a sorghum breeder in Ouagadougou. By 1982 there were six ICRISAT scientists including sorghum breeder, millet entomologist, Striga physiologist, soil management agronomist, an economist, and an anthropologist.

The research emphasis is centered in the rainfall zones ranging from 400-800mm and the major activities of the programme are an extension of the activities of the Centre. These include sorghum breeding and testing, millet breeding and testing, germplasm collection, striga research, sorghum and pearl millet agronomy, soil and water management, and socio-economic studies.

5. Agricultural Research in Mali

5.1 Structure and responsibilities (see Annex 6b)

Agricultural research in Mali is the responsibility of two Ministries, the Ministry of Agriculture (MA) and the Ministry of Rural Development (MDR). Under the Ministry of Agriculture is the Institute for Rural Economy (IER) which is divided into six divisions, among which are the Division for Agronomic Research and the Division for Farming Systems Research whose budgets are allocated in proportions of 4:1.

Agronomic research is divided into various commodity sections on:- food crops, oil crops, textiles, fruits and vegetables, tobacco and new plants and selected seeds. The programmes of these sections are carried out in appropriate ecological zones using research station bases.

The Farming Systems Division is based at Sikasso as this was the base for the first FSR Programme in the country. The Division works closely with the DRA and the INRZFH and is involved in the evolution and testing of alternative technologies among rural communities.

Under the Ministry of Rural Development is the Institute of Forestry, Livestock and Fisheries (INRFZH) which carries out research in these three areas. Rural development programmes are organised by the ORD (Rural Development Office) which has implemented a range of operations. The most important of these are:

ODIPAC	-	Office de developpement integre pour les productions arachidiere et cerealieres
ODIK	-	Operation de developpement integre de Kartaa (Millet)
CMDT	-	Campagnie Malienne de Textiles-Operation Mali-Sud
OHV	-	Operation Haute Vallee in the Central Region
Office du Niger	-	Cannea sucre et riz
Operation Mopti	-	sur mil et sur riz

5.2 Farming Systems Research - The Sikasso based study

The initial study in the Sikasso Region was designed to characterise the principal farming types and groups of farming families with varying access to resources and with varying objectives.

The analysis of the relationship between resources and farming objectives of each farming system was considered to be essential in order to classify constraints and factors from which alternative technologies could develop.

The method used to identify these typologies was simple so it could be used by other development agencies. Five criteria were selected, three related to resources and two to objectives. These were:-

1. **Numbers of pairs of traction animals**

Low	-	0 - 0.5 pairs/farm
Medium	-	1 - 1.5 pairs/farm
High	-	2 or more/farm

2. **Livestock ownership** (expressed in UBT - Tropical Livestock Unit)

N.B. One head of cattle = 0.7 UBT
One goat or sheep = 0.12 UBT

Three levels:	Negligible	<5
	Average	5-10
	High	>10

3. **Number of active farm workers** - those between the ages of 7-60

Three levels:	Small	<3
	Average	3-8
	High	>9

The criteria of availability of land was not selected as this was not considered to be a limiting factor.

Under production objectives of farmers the two criteria were:

4. **Cereal production per head**

The determination of this permits the study team to make an estimation of the degree of food self-sufficiency for farmers.

5. **Cotton production**

This information makes possible the classification of farmers according to their technology levels. Those having:

no cotton	=	low level of technology
yields $\leq$ 1 ton/ha	=	medium level of technology
yields > 1 ton/ha	=	good level of technology

These categories correspond to traditional, intermediate and intensive cultivation systems. The combination and interaction of these criteria permitted a detailed examination of poor (not, or marginally self sufficient) and better off (self sufficient and adequate cash income) groups of farming families. It is interesting to note that **all** the farms practising intensive cultivation are self sufficient, 65% of the intermediate group are self sufficient and only 20% of those with 'traditional' cultivation systems are self sufficient.

The research team examined a range of technical alternatives appropriate to each group of farmers. For the poorest farmers the CMDT programme for cereal improvement was proposed, for the intermediate farms more intensive cultivation of cotton and cereals was proposed and for the high income group, fodder, erosion control measures and water management technologies were explored. The effectiveness of this approach was then evaluated at the end of each season.

The approach does result in the definition of farming systems and the relative importance of different groups of farming households. It is therefore possible to determine the extent and seriousness of the major problems facing farmers and to focus on those areas and systems where there is the greatest need for stabilising and more productive technologies.

The Mission feels that this approach has a number of very valuable features that could be usefully incorporated into other FSR programmes.

5.3 The ICRISAT Research programme

ICRISAT has had a small team in Mali since 1978. The team has consisted of a plant breeder and an agronomist together with Malian staff. They have studied and selected a range of crops and varieties that may be suitable for the conditions in the central and northern cereal belts and also are examining a range of technologies (animal draught intercropping and soil and water management) at a range of sites including Sotuba and Cinzana stations.

5.4 The expansion of FSR activity in Mali

Following the FSR experience in Sikasso, the IER plan is to expand FSR activities to two more regions with the help of a USAID project worth US $16 over a period of ten years. This project will commence activities in Bamako Region in 1984 and a second region in 1988. It is currently scheduled to last ten years. An important feature of the approach will be the setting up of large, multidisciplinary teams in each

region. It is clear that with this projected rate of expansion of the programme, many areas of the country will not have active FSR activities for many years to come. There is also a need for the consolidation of the work and experience in Sikasso. During the past 6 years, ICLA have made a major study of climatic, biological, physical, human and livestock resources and pastoral and agro-pastoral systems in the Segou and Mopti Regions and there is a wealth of information and material available that will be invaluable to any future FSR team working in those areas.

6. Agricultural Research in Senegal (see Annex 6c)

6.1 Structure

Agricultural research comes under the Ministry for Science and Technical Research and is carried out by ISRA (Senegalese Institute for Agronomic Research) which covers all the national activities in this field; all technical assistance from bilateral or international agencies is integrated within ISRA.

ISRA has three divisions:

1) Administration and Finance
2) Research departments in which the research programmes are coordinated
3) Research Centres and substations where research is carried out.

The Departments for research are:

1) Farming systems and adaptation to the rural environment
2) Plant production
3) Animal production
4) Forestry
5) Fisheries and Oceanography
6) Assistance to research

The research programmes are executed at six agronomic stations, two livestock stations, one forestry station, one oceanographic station and one veterinary laboratory.

6.2 The Farming Systems approach to research in Senegal

Senegal has had a long history of research and substantial amount of experience in research, extension and development. The current plans for farming system research involve the setting up of five multidisciplinary teams each of which includes, an agronomist, economist, anthropologist, animal scientist and soil scientist. Wherever necessary the team will be complemented by specialists such as foresters or fisheries scientists.

At present only one team is fully operational in the Sine-Saloun region (in the southern part of the groundnut area). During 1984 two more teams will become operational, one in the Lower Casamance Region and another in the Senegal River Basin. Next year, two further teams which have yet to be recruited, will start work in the Eastern Casamance area and in the mainly pastoral area of the Louga and Fleuve Regions.

The Farming Systems research programme is based on the collection and analysis of soci-economic data on major production systems, the identification of priority problems, the evaluation of new technologies and studies of the socio-economic constraints to their adoption and the development of effective linkages between research and development agencies and programmes.

This work is supported by specialist research services in bioclimatology, soil fertilisation and conservation, mechanisation and post harvest technology and hydrlogical studies.

Despite this extensive coverage of several agroclimatic zones in the country, there remain areas where resource degradation and management problems are acute and where additional farming systems inputs within the national programme may be appropriate. One such area is the northern groundnut zone where tree removal and soil degradation is already at an advanced stage.

7. Proposals and Plans for FSR in Upper Volta, Mali and Senegal[1]

7.1 Upper Volta

Introduction:

In reviewing FSR activities in Upper Volta we have found a number of valuable positive features but also a number of gaps and imbalances in the overall research programmes that have seriously inhibited the development of any widely applicable, relevant technologies that could contribute towards the development of stable and more productive farming systems.

The proposals that follow take into account these weaknesses and also the proposition that Upper Volta should act as the coordinating centre for the Project's FSR activities. We have also borne in mind the current plans for restructuring research in Upper Volta and the need to integrate any new research activity into the national programme. Consequently, any proposals that we now make must be reconsidered in the coming planning meetings in February and April 1984.

Objectives of FSR

1. To evolve sustained systems of production in the semi-arid zone for small or poor farmers whose systems have major cereal (maize, sorghum, millet) and/or grain legume (cowpeas) components.

2. To develop an effective communication system between farmers, extension workers, research scientists and others, to ensure that agricultural research is relevant to the short and long term needs of poor farmers.

Programme

1. The monitoring of the major resource management systems of the Sahel-Soudan Zone.

2. The identification and prioritising of problems and research activities.

3. The investigation, testing and demonstration of alternative systems and components of systems at appropriate locations - station, sub-site, farm.

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1 For an overview of FSR for West Africa semi-arid tropics and a detailed discussion of the need for soil fertility restoration and maintenance, see Annexes 2 and 3.

4. The training of local and regional research and extension staff in short formal sessions, seasonal seminars and through regular, informal contact.

Personnel, Location and Job Descriptions:

It is proposed that all FSR personnel should be based at Kamboinse station but operate throughout the Soudan zone. All should be fluent in French and have a working knowledge of English.

1. **Purdue team**

Agronomist)
Agricultural Economist) currently in-post

2. **Agricultural Economist**

Experience:

10-15 years; training and/or experience in natural and social science research and development, and of relevant farming or farming systems research. Minimum 3 year contract. To be recruited as soon as possible.

Job description:

- Overall responsibility for SAFGRAD FSR
- Coordinate SAFGRAD/FSR activities in Upper Volta, Mali and Senegal national programmes
- Summarize and make available existing knowledge on farming systems and methods of studying them. Develop training materials for local and regional staff.
- Initiate greatly expanded applied research activities that link on-farm, sub-site and station research. (To include cropping systems, agro-forestry and agro-livestock work)

3. **Livestock Production Scientist**

Experience:

5-8 years, knowledge of agro-pastoral systems and applied research.

Job description:

- Examine the feasibility of increasing the animal production component (both small and large stock) of farming systems. Animals as generators of food, draught, wealth and partial restorers of fertility.

- Contribute to **all** FSR programmes where there is currently no or minimal livestock research activities and link relevant station and off station work.

4. **Soil Scientist/Agronomist**

Experience:

5-8 years, knowledge of semi-arid tropical soil/crop/tree inter-relationships, soil fertility maintenance using renewable resources.

Job description:

- Monitoring rate of soil fertility change in major semi-arid zones.

- Active programme of research on amelioration measures using trees, pastures and arable crop combinations. Focus on on-farm and sub-site activities in all villages which FSR teams are operating.

All three of the new personnel should be appointed as soon as possible and work as an integrated team of advisers and researchers operating as far as possible through their Voltaic counterpart staff.

Activities

The activities of the FSR programme will be partly evident from the above job descriptions but may be summarized (including the Purdue activities) as follows:-

1. Continue the monitoring of climatic, biological and socio-economic data at a much reduced level, but in more villages representing distinctive agro-ecological zones, or socio-economic groups of farmers, **and** in clusters of villages around them. Methods should involve regular and specific topic data collection.

2. Develop a much more active programme of resource management systems studies which involve; trees, livestock, crops and other inputs in as many locations as possible (including sites in Mali and Senegal if appropriate). This includes some station based systems work, the setting up of researcher managed sub-sites or plots in appropriate villages and, if possible, using groups of farmers within villages to cooperate in major on-farm systems studies. The focus should be on building up fertility on a proportion of available land, not extending the cultivated area.

3. In the coming reorganisation of research the FSR team should make a major contribution to the establishment of a linked series of research activities which include breeding, agronomy, crop production, cropping systems, crop/livestock/tree systems carried out in collaboration with station and off-station based scientists.

4. Develop training materials and methods for informal training and professional staff, short formal courses for local and regional staff and organise bi-annual seminar for all staff and related project personnel. The team should identify suitable locations for short term attachments for staff, eg on other regional or national FSR programmes. Also, together with the Director of Research, suitable priority topics for research by local graduate students should be identified and appropriate local supervision arranged.

5. Develop a close working relationship with extension staff and other institutional staff involved in rural development activities that have relevance to the development of sustained farming systems.

Outputs

1. The establishment of an effective programme that can be managed by Voltaic staff for the identification of farming system production problems.

2. Methods of carrying out research into these problems or means of communicating problems that cannot be directly studied to appropriate individuals or institutions who can.

3. The generation and testing of a range of alternative measures and technologies that give greater stability to farming systems in the area and greater food security for the majority of poor producers.

4. A training system based on local and regional resources that will result in the full localisation of all key posts within a period of four years.

5. A formal system of communicating research results and of agreements on research priorities and methods developed in cooperation with IVRAZ.

7.2 Mali

Introduction

It is proposed that SAFGRAD/FSR activities in other countries should consist of two person teams working very closely with the national agricultural research programmes. We are confident that this modest approach, which is in contrast to the large, multidisciplinary team approach of USAID in Mali and Senegal, can be effective provided the SAFGRAD teams have adequate back up from their operating research stations and that they make full use of other institutions and personnel who are already involved in applied research and development activities. They should also have support from SAFGRAD/FSU in Upper Volta, particularly in social sciences and training.

Programme

1. Continue the monitoring of the existing agro-livestock systems in a range of agro-climatic zones in the Segou Region.

2. Use the information already available from earlier (particularly ICLA and ICRISAT work) and existing studies (ILCA and 1. above) to initiate an active farm, sub-site and station based experimental programme on components, sub-systems agro-livestock systems that will present a range of alternatives for poor farmers of the region.

3. Develop working relationships between station based researchers, extension staff and farmers.

4. Train local research and extension staff through regular, informal contact, short formal sessions, workshops and attachments to relevant FSR projects in the Region.

Personnel, Location and Job Descriptions

It is proposed that all personnel should be based at Cinzana station and operate in a broad series of agro-ecological zones in Segou Region.

1. Agronomist/Agriculturalist

Experience:

Minimum 8 years. Interdisciplinary research and development work. Minimum 3 year contract. To start as soon as possible. Experience with arable and tree crops preferable.

Job description:

- Responsibility for developing modest, workable approach to FSR and Development in one region of Mali.

- Utilise and apply existing knowledge of farming and agro-pastoral systems research methods.

- Initiate active applied research programme that provides viable linkages between station, sub-site and on-farm research activities.

- Local staff training at all levels.

2. **Livestock Production Scientist**

Experience:

Minimum 5 years. Working knowledge of semi-arid, agro-pastoral systems and applied research work.

Job description

- Participate in village and household studies of systems in the Segou Region.

- Examine a wide range of alternative technologies that develop the contribution made by livestock in the farm system, particularly those that lead to the stabilisation of the resource base.

- Monitor and evaluate existing systems and produce appropriate recording and training materials that can be handled by local staff.

Both team members are to be working directly within the Malian national research programme and will be immediately responsible to the regional research director and the direct of FSR. Both these personnel should begin work as soon as possible and develop a research approach that fully utilises the range of skills and expertise in the country, in research, in extension, in development institutes and among the farming community.

Activities The team is required to:

1. Develop a method of initial and continuous monitoring of existing farming and agro-pastoral systems together with Malian staff and advice from the SAFGRAD/FSR team leader as necessary. The methods should include both regular and specific data collection on the characteristics and major problems of farming systems.

2. Establish in each major zone or for each distinctive farming group (excluding the wealthier groups), a research-controlled sub-site that can be used for developing a range of system alternatives. Linked research activities should be initiated at an early stage, at all appropriate locations including the main regional research site. Some of the trials activities should be linked to similar SAFGRAD work in Upper Volta and Senegal.

3. Develop training courses and materials for informal and formal training of Malian professional and technical staff. Identify suitable candidates for further training in the Region or outside.

4. Develop linkages and involvement of research and extension staff in the application of farming systems research approaches.

Outputs

1. The establishment of a modest but effective farming system research approach that fulfils the need in regional research programmes for greater relevance in agricultural research.

2. The generation and testing of a range of alternative measures and technologies that give stability to existing farming systems and greater food security for the majority of poor producers.

3. A training system that can serve at a local, national and regional base for scientists in farming systems research.

7.3 Senegal

Introduction

Of the three countries visited, Senegal clearly has the longest history and experience in farming systems research. ISRA is also at an advanced stage of preparation in the setting up of 5 major farming systems teams that will cover most of the major agro-ecological zones in the country.

However, the programme has phased starting dates and there still appears to be at least one area where there are now acute problems of degradation and where the modest input proposed by the IFAD mission could play a useful role.

Programme The two man team is required to:

1. Begin a wide ranging survey and study of the farming systems in the northern part of the groundnut area of Senegal, focussing on the areas severely hit by drought in the last few years.

2. Utilise this information, and the considerable information available from previous development programmes and from the main research station at Bambey, to initiate an active on-farm, sub-site and station based experimental programme. This programme should be primarily aimed at the rehabilitation of the agricultural ecosystem and the development of reliable food outputs from the system.

3. Develop effective working relationships between station-based researchers, extension staff and farmers.

4. Train local research and extension staff in the principles and practice of farming systems research.

Personnel, Location and Job Descriptions

It is proposed that all personnel should be based at Bambey station or an appropriate sub-station located in the northern groundnut-zone. They should operate in as wide an agroecological zone band as practicable.

1. **Agronomist/Agriculturalist**

   Experience:

   Minimum 8-10 years. Interdisciplinary research and development work. Minimum 3 year contract. To start as soon as possible. Experience with agro-forestry or agro-pastoral systems preferable.

   Job description:

   - Responsibility for developing a modest, workable approach to FSR and development in one region of Senegal.

   - Utilise and apply knowledge, from all sources, on farming, agro-forestry and agro-pastoral research methods.

   - Initiate active applied research programme that provides station, sub-site and on-farm links.

- Local staff training and development.

2. **Livestock Production Scientist**

Experience:

Minimum 6-8 years. Working knowledge of semi-arid agro-pastoral systems and applied research work.

Job description

- Participate in village and household studies of systems in the groundnut region.

- Examine a wide range of alternative technologies that develop the contribution made by livestock to the farm system, particularly those that lead to the re-stabilisation of the resource base.

- Monitor and evaluate existing systems and produce appropriate recording and training materials that can be handled by local staff.

Both team members will work directly within the Malian national research system and will be immediately responsible to the regional research director.

Activities The team is required to:

1. Develop a method of initial and continuous monitoring of existing farming systems, using the knowledge and methods already gained from previous work. (Some liaison with the SAFGRAD/FSR tean leader and other social scientists in the Senegal system will be necessary at the outset).

2. Establish suitable researcher controlled bases, in each distinctive agro-ecological zone, for the examination and testing of a range of system and system component alternatives. Some of this activity should be at the main regional station and as much as possible should also be on farm lands.

3. Develop training courses for informal and formal training of Senegalese staff in the principles of farming systems research in the context of resource poor environments.

4. Develop linkages between research and extension staff and promote the integration of farming systems research into the Senegalese national agricultural research system.

Outputs

1. The establishment of a modest but effective farming systems research approach that fulfils the current objectives of the Senegalese national research programme.

2. The generation and testing of a range of alternative measures and technologies that give greater stability to existing farming systems and ultimately greater food security for the majority of poor rural households.

3. A training system that can contribute to the national plan of greater competence and understanding of farming systems research.

7.4 General matters covering all three countries activities

Responsibilities, administration and coordination

The overall aim of the Project is to strengthen national research capability in farming systems research. It is vital, therefore, that all staff are clear that their primary responsibility is to their immediate (in-country) regional research director in their respective countries. However, as SAFGRAD is a Regional project, it is proposed that there will be benefits from an effective linkage between the three su-bprojects and between these and other FSR projects. The team leader in Ouagadougou has the task of coordinating these activities and should be responsible for bi-annual meetings, workshops, travelling seminars and overall planning guidance. It is well understood that detailed planning of FSR in Mali and Senegal is at an advanced stage and we would not wish to suggest anything that interferes with these plans. The team leader will only operate with the full approval of the Directors of Agricultural Research in each country.

In Upper Volta the task is equally delicate as the research system is in the middle of a major restructuring. It is important that all the SAFGRAD activities are seen as supportive, not competitive in any way.

The SAFGRAD/FSR teams are in turn also responsible to the Director of Research, SAFGRAD and to the International Coordinator. It is proposed that each team should be allowed to operate as independently as possible within the objectives of their respective national agricultural research systems. Technical support should be sought from personnel and institutions within a country as far as possible before requesting external help. The senior member of the team, in each case, will be responsible for local administration and liaison in each country and between FSR projects.

Monitoring and Evaluation

The project should be subject to regular review, both by staff within SAFGRAD (Director of FSR, Director of Research and International Coordinator) and by external assessors.

Internal reviews should take place at 6 monthly intervals and performance carefully measured against the overall project objectives stated earlier. They should also be assessed against individual in-country planning objectives. In particular, it is important to examine outputs in relation to the poverty focus of the project and in relation to the urgent need to develop long term stabilising rather than short term extractive technologies for poor farmers.

An annual workshop should be held at which all research results are presented and discussed with project scientists, station-based commodity scientists and representatives of other institutions engaged in related work. This meeting should agree on research proposals for the following season and for longer term planning and submit them to the SAFGRAD TAC meeting immediately afterwards.

The external assessment should involve a three person team of experienced FSR scientists who would examine all FSR activities and also use the same criteria, as above, for assessment. In addition, they should be charged with examining the role of a regional FSR project, in the light of expanding national plans for FSR, and determine whether the project should expand to other countries of the region and elsewhere in the SAFGRAD region.

This external team should consist of, at least, one national from the region, at least two persons who are fluent French speakers, and at least two who are familiar with all current farming systems approaches. At least one should be a social scientist.

Training

The training that can be carried out by the FSR teams in the next phase of the Project will be limited, but it must, at least, include regular formal and informal on-site training and the facility to send trainees to suitable FSR projects in other countries in the region wherever appropriate. Both Mali and Senegal already have experience in FSR that could be utilised for this purpose.

If training includes graduate work, it must include the use of relevant case study material collected within the Project or in work relevant to the work of the Project.

Conclusions

The mission team consider that there is scope for an expansion of FSR in each of the countries visited. Clearly the needs and the form that the SAFGRAD project should take differs in each country, but we feel that the addition of small teams of personnel, supported by modest but adequate resources, is an appropriate strategy for all countries at the present time.

There does appear to be a strong case for the addition of three people in the Upper Volta system, to fill identified disciplinary gaps, to initiate much needed coordination, and to consolidate the knowledge already gained from a variety of activities. In Mali and Senegal the case for additional FSR teams would, at first sight, appear weaker but the mission team feels strongly that there is merit in using a much more modest team approach (than the large team approach planned in some areas) and utilising knowledge, personnel and institutions already involved in research and development work. The evaluation of both these approaches will give useful indicators for the future expansion of the SAFGRAD/FSR activities and may give guidance to future planning of FSR in each country. The key to the success of the small team approach is the identification and recruitment of experienced personnel who are familiar with the environment, the language, and with small farmer problems in the semi-arid tropics.

Annex 1

REPORT AND RECOMMENDATION OF THE PRESIDENT TO THE EXECUTIVE BOARD ON A PROPOSED TECHNICAL ASSITANCE GRANT FOR RESEARCH AND DEVELOPMENT FOR FOOD GRAINS IN SEMI-ARID REGIONS OF AFRICA BY THE SCIENTIFIC, TECHNICAL AND RESEARCH COMMISSION OF THE ORGANIZATION OF AFRICAN UNITY (OAU/STRC)

BACKGROUND

1. Within the semi-arid regions of Central and West Africa maize, millet and sorghum represent the basic food staples of the population and occupy the greater part of the cultivated area. In these regions over 80% of the population is engaged in agriculture. Since the early 1970s the 25 African countries now participating in the Organization of African Unity's SAFGRAD (Semi-Arid Food Grain Research and Development) project (see Map) have experienced such rates of population growth that, having outstripped food production increases, they are increasingly dependent on food imports. Sustained periods of drought have contributed to make the achievement of even limited food self-sufficiency and food security more dramatic and uncertain. The small production increases which have been achieved in the past are primarily due to the expansion of cultivated areas on to marginal land. However, this practice has set in motion a long term trend of soil erosion and degradation of the regional physical environment with consequent reduction of crop yields and grazing potentials. In order to reverse this trend improved technologies are being sought through research being carried out by international, regional and national agencies throughout the regions.

2. In the Sahel, as well as in many other developing regions, experience has shown that technologies developed on research stations - as a result of research designed only by biological scientists - have performed poorly when transferred to small farm conditions. This is due to the fact that objectives and aims of in-station research have often lacked relevance for the vast majority of those farmers who are characterized by a limited resource base.

3. Throughout the 1970s, it became evident that improved biological research was not per se a sufficient condition for increased farmer yields. It also became evident that physical, biological and social scientists should collaborate - as a Farming Systems Unit - in the ex-ante design of the food research programmes and in the ex-post evaluation of the impact of this research on the day-to-day life of the individual farmer. Although basically aimed at improving soil-water-plan relations, this research should also take into consideration the characteristics of the prevailing climatological, social and economic environments in which the

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production process takes place.

4. Therefore, the development of applied, locally tested, improved technologies implies the characterization of the physical environment, an interdisciplinary design of the research, the generation of the new technology under a controlled environment (in-station research), and its testing under farmers' field conditions. Therefore, farming systems approach to research places equal emphasis on :

- the generation of locally adapted technologies;
- the capacity of the individual farmer to adopt and manage this technology; and
- the capacity of private and public institutions to sustain this improved level of farm production.

5. The SAFGRAD project was created in 1977 with US, UK, French, Netherlands, Canadian, EEC, UNDP and host governments' financing (US $21.4 million over five years), to assist in improving the production of staple food grains in the regions. The purpose of the project is to develop improved cereal varieties (millet, sorghum maize) and grain legumes (cowpeas, groundnuts) under agronomic practices which are compatible with small farm, semi-arid farming systems. Project activities are classified into two broad areas: firstly, regionally coordinated research on food crops at three selected African research centres (Nigeria, Upper Volta and Senegal) secondly, support to national research and field trials to further develop and extend improved technologies to farmers. The project is being implemented by the Scientific, Technical and Research Commission of the Organization of African Unity (OAU/STRC).

6. Parts of the SAFGRAD project are contracted to IITA (for the improvement of maize and cowpeas), to ICRISAT (for sorghum and millet) and from 1979 to Purdue University (Indiana, US) for the establishment of a Farming Systems Unit (FSU). This FSU is based in Ouagadougou, Upper Volta, and the team includes an agronomist, an economist and an anthropologist. Although the original mandate of the FSU was to initiate regional activities in a number of countries, de facto its activities have been limited to Upper Volta. As a result of the project as a whole, national and international research organizations have developed a wide range of station-based research and identified a number of improved technologies which are potentially relevant for improving and stabilizing food production.

7. The adoption of these improved technologies by the individual farmer of the SAFGRAD project region has not gained as much momentum as was originally expected. This is due to a series of reasons which it was possible to identify only on the base of the experience gained after the project was initiated. Firstly, most of these farmers, especially those which represent the IFAD target group, are not perfectly integrated into the market system. This situation has important consequenc for the procurement of inputs on which the improved technologies are based, for the allocation of the output which is mostly home-consumed, and for the definition of farm management criteria which are commonly addressed to maximize family food securi

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rather than farm profits. A second very important factor is the extreme variability of the environment in which production is taking place. The result is that it has not yet been possible to test the proposed improved technologies in the different socio-economic and agro-climatological environments under which the farmers operate. The third important factor is that national institutions which should foster the spread of technological progress and provide farmers with research and extension services are weak and have not been able adequately to fulfil their institutional mandate.

8. In 1981 a review of the activities of the SAFGRAD project was carried out. This review pointed out that, though good results had been achieved in the more humid areas of the project, far less progress had been achieved in the arid zones, where the negative impact of environmental constraints on production is more important.

9. The same review recommended that:

(a) the project should place greater emphasis on the coordination of national and regional research efforts and less on direct research at regional level;

(b) Farming Systems Research (FSR) work should develop regional networks among national research programmes with the objective of contributing to the identification of production constraints and to the improvement of research design; and

(c) the project's Accelerated Crop Production Officers (ACPOs) should be assigned to national FSR programmes and leave the responsibility for carrying out research trials to national research organizations.

10. The OAU/STRC has now requested a technical assistance grant from IFAD to assist the SAFGRAD project in developing the FSR approach at national levels and also to strengthen the coordination of SAFGRAD research generallly with national research programmes.

RATIONALE FOR IFAD PARTICIPATION

11. The mid-term review has provided a practical basis for the consolidation and expansion of work under the project. USAID will be continuing its support 1/ but additional funding is required to ensure that the farming systems which research is intended to benefit are more fully understood

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1/ USAID contributions to the SAFGRAD project have been extended to cover the period until September 1984.

and that the farmer will benefit more rapidly and directly from the results of such research.

THE IFAD PROJECT

12. IFAD's financing would be provided for:

(a) strengthening national FSR in three SAFGRAD countries and contributing to the development of FSR methods which would serve as regional models, by funding:

- three senior two-man advisory teams, including an agronomist and agricultural economist, based in three SAFGRAD countries. Services of team members would be provided through contract with experienced agencies, such as IITA or ICRISAT. These teams would:

  - assist local institutions to plan and organize national farming systems units (FSUs);

  - provide direction in the training of national scientists and technicians in FSR methods;

  - develop together with national scientists FSR methods appropriate to national needs and resources; and

  - help execute FSR on a national level within three years of project initiation.

- travel for the advisory teams and their counterparts from each of the three countries, to visit ongoing FSR projects in Africa in order to gain in-depth familiarity with the accumulated FSR experience;

- annual workshops to present results of the three teams and refine programme development; and

- capital and operational costs (excluding salaries of national scientists and technicians) required to support and execute FSR field work in each country;

(b) improvement of research coordination by funding:

- a Director of Research who, working administratively under the SAFGRAD project's international coordinator and reporting to the Project Management Committee (para. 13) on technical matters, would be responsible for reviewing and advising on the research being financed under the IFAD-financed project and the SAFGRAD project and for making international and regional research programmes familiar to national research organizations.

IFAD would review the job description and the terms and conditions of employment applicable to the position prior to the advertisement of the vacancy and the appointment would be subject to IFAD's approval.

- Research workshops designed specifically for scientists working inside national research organizations or similar programmes, with possible inputs from IITA and ICRISAT scientists:

(c) a soil fertility specialist based at Kamboinse Research Station to work with ICRISAT, IITA, FSU, and national scientists on problems of long-term soil fertility maintenance: and

(d) a financial controller based at SAFGRAD headquarters, Ouagadougou, who would be responsible for controlling the disbursement of IFAD funds and maintaining project accounts.

IFAD's financing would also cover the detailed elaboration of the work programme (para. 14).

PROJECT MANAGEMENT COMMITTEE

13. OAU/STRC would set up a Project Management Committee, under terms of reference approved by IFAD, comprising representatives of the donor agencies to the SAFGRAD project, the implementing agencies, representatives from each of the three participating FSR countries and IFAD, as well as the SAFGRAD project's international coordinator and the director of research. The committee would be responsible to OAU/STRC for technical and administrative review of the programme and would meet not less frequently than every six months.

FSR WORK PROGRAMME

14. Details of the FSR work programme would be elaborated by a three-man team of internationally recognized FSR scientists, in consultation with OAU/STRC, ICRISAT, IITA, USAID and IFAD, in the first three months of the project period. The team would also prepare, for the approval of OAU/STRC and IFAD, a definition of the precise responsibilities and authority of the director of research and his relationships with the international coordinator of the project.

15. Activities of the FSR component of the IFAD project would be approximately sequenced according to the following schedule:

(a) year one

- recruitment and installation of three two-man advisory teams in each of the three selected countries;

- elaboration of the institutional structure of national FSUs;

- identification by the competent national officials of counterparts from national research and/or extension organizations who would ultimately head the national FSUs;

- reconnaissance surveys to develop familiarity with the major farming systems of each country and to select sites for pilot studies to be initiated in year 2;

- visits to each ongoing FSR project in Africa judged to have experience relevant to the present FSUs;

- end-of-year workshop bringing together all FSUs to review experiences and to present and refine provisional four-year work plans;

(b) year two

- identification and training of field staff;

- initiation of pilot activities within each country in order to further develop FSR methods appropriate to local conditions, to develop collaborative working arrangements with scientists and extension agent and to provide training and practical field experience to field staff;

- end-of-year workshop to compare lessons learned and to present final plans for the remaining period of the project. This workshop would also take into account the conclusions of a USAID review of the SAFGRAD project, which is planned to be undertaken in the second half of 1984.

(c) year three

- expansion of the programme to a national scale within each country.

RELATIONSHIPS OF FSUs WITH OTHER INSTITUTIONS AND PROJECTS

16. The FSUs would be expected to develop working relationships, as judged relevant to each national programme, with other SAFGRAD scientists as well as with scientists in ICRISAT, IITA, ILCA, IFDC, CILSS, and the various French institutes. The IFAD project would make full use of the training and information facilities on FSR available through these institutions, as well as with the opportunities offered through the IRAT/IITA/ICRISAT/GTZ West African Farming Systems network.

17. As the most experienced SAFGRAD team in the area of FSR, the USAID-financed Purdue University FSU based in Upper Volta would play a central role in training and backstopping the national FSUs. Support activities would include:

- a two-week orientation workshop to farming systems approaches during year one;

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- subsequent visits of national staff to the Purdue University FSU as required for staff development of the national FSUs;

- sponsoring the first end-of-year workshop; and

- technical backstopping as requested by each national FSU throughout the life of the project.

COUNTRY LOCATIONS

18. The three countries in which FSR would be supported under the project would be selected by OAU/STRC upon the recommendation of the Project Management Committee after consideration of requests from interested countries. Criteria for selection would include:

- the presence of an ACPO;

- a demonstrated commitment on the part of the government to the development of national FSR capacity;

- agro-climatic differences among the three countries, to enable wider regionalization of results and approaches to other SAFGRAD countries; and

- absence of similar projects already in place.

COST ESTIMATES

19. IFAD's funding would be utilized for:

	Year 1	Year 2	Year 3
	-----US $ '000 ----		
(i) STAFF			
International			
Director of Research	95	95	95
Agronomist (3) x 80	240	240	240
Economist (3) x 80	240	240	240
Soil Fertility Specialist	80	80	80
Financial Controller	85	85	85
Local			
Secretariat Staff (3) x 6	15	18	18
Drivers (6) x 2	10	12	12

		Year 1	Year 2	Year 3
		---- US $'000 ---		
(ii)	TRAVEL			
	Director of Research	30	30	30
	Advisory Team			
	Air tickets	24	18	18
	Per diem	20	20	20
	Counterparts			
	Air tickets	10	9	9
	Per diem	5	5	5
	Soil Fertility Specialist			
	Air tickets	4	4	4
	Per diem	2	2	2
(iii)	CO-ORDINATION MEETINGS			
	Research Co-ordination (2)	20	40	40
	FSR Co-ordination	10	15	15
(iv)	TRAINING			
	Scholarships for FSR Staff	30	30	45
(v)	CONSULTANTS	20	10	10
(vi)	EQUIPMENT			
	Vehicles	30	95	-
	Motorcycles	-	12	18
	Microcomputers (3) x 8	-	24	-
	Office Equipment	10	20	10
(vii)	OPERATIONAL EXPENSES			
	Vehicle Fuel and Maintenance	30	85	110
	Field expenses	15	45	60
	Sub-total	995	1234	1166
	Physical contingency 1/	5	16	10
	Price contingency (10%)	-	120	244
	TOTAL	1000	1370	1420

1/ 5% on items (vi) and (vii)

Annex 2

The farming systems approach to research: an overview in the context of the West African semi-arid tropics

The farming systems approach to research does not contain any major innovations that could not be found in older, integrated research and development systems, despite the voluminous recent literature that would claim otherwise.

What the approach is attempting to do is to reinforce or rejuvenate areas and linkages that have become weak or ineffective within many agricultural research systems so that more relevant research can be undertaken. The reasons for these weaknesses are many, but they include institutional separation and weak linkages between them, the move away from solving problems faced by farmers to more specialised disciplinary and sometimes esoteric research on stations and the increasing specialisation into various scientific disciplines of most research scientists.

The addition of farming systems research teams to existing national research structures has presented an opportunity to correct these deficiencies. It should now be possible for scientists, extension workers and farmers to evolve more stable systems of production which will provide food security and income for the majority of poor households.

However, there is a danger that the introduction of FSR has raised expectations of spectacular early results in the same way the Green Revolution technology packages did 20 years ago. FSR can only work effectively as part of a broader research, extension and rural development system and any technology that is devised has to be an integral part of this system.

It is also important to note that the semi-arid tropics of West Africa are facing a number of circumstances that will have a major influence on future farming systems. These include:- increasing rural population density, decreasing annual rainfall, amounts and the increasing dependence of individual producers on external (to the village) aid and support. It would now appear that there is a need to make substantial changes to the methods of extraction of surpluses from these systems and also into methods of maintaining stability through the renewable resources if these ecosystems, and the people who depend upon them, are to survive.

We therefore consider that FSR has a number of important functions in operating within national agricultural research and development systems in the semi-arid tropics of West Africa, which are:

1. The development of an understanding of the total farm environment, the farm and the household system and the purpose and objectives of farming.

2. The facilitating of effective linkages between farmers, extension workers, research scientists and other institutions and individuals involved in natural resource management and development.

3. The utilisation of farmer knowledge of environment and resources, both from the past and present, and knowledge from analogous situations, to evolve solutions to long and short term problems faced by farmers.

4. The early and continuing involvement in active, applied research work on farms and at sub-sites in each agroecological zone. This work should be designed to examine, test, and demonstrate a range of stable, productive systems that offer the largest groups of poor farmers attractive alternatives to existing practices.

5. The identification of priorities, and sequencing of problem solving in the long term development of farming systems. These may be superficially technical, such as the arresting of fertility decline but they may also have important policy dimensions which would involve additional intervention. FSR therefore has an important role in bringing to the attention of policy makers and planners, matters that require modifications in policy at national or regional levels (eg pricing, land tenure, taxation, marketing access to inputs, group activities).

We consider that if any one of these important functions is absent or neglected, the FSR program may be partially or wholely ineffective.

In addition to these functions, we think that FSR teams should consist of people who can work in an inter-disciplinary framework. Large teams consisting of many disciplines are not necessarily more effective than small teams containing people with strong interdisciplinary backgrounds. Also, large teams may only be able to operate in a relatively limited area whereas a number of small teams can often cover a wider geographical area and interact with a large number of farming groups.

Annex 3

Farming Systems Research: the need for soil fertility restoration and maintenance in the semi-arid areas of West Africa

Decreasing soil fertility in the semi-arid regions following the shortening of the fallow period and the extension of the cultivated area is undoubtedly the most important problem[1] that farmers will face in the next few years, particularly in areas where population density is already very high. In the long term, migration from these areas is inevitable if current practices continue. Mineral fertilizer use cannot build up or maintain soil fertility without the addition of more organic materials.

On Saria research station a 25-year experiment was conducted by IRAT on alternative ways of mantaining fertility. Various mineral fertilizers were used with and without organic manures. This work showed that by itself high mineral fertilizer use cannot maintain fertility as it raised soil acidity that had to be corrected by regular doses of lime. A small amount of manure (2.5 - 5 tonnes/ha) together with a small amount of mineral fertilizer was sufficient to maintain and stabilise soil fertility and also sustain an acceptable yield level.

Whenever the possibility of extending the cultivated area is limited, an increase in cereal production necessary to obtain food self-sufficiency can only be obtained by increasing yield following the rehabilitation of soil using a range of techniques designed to maintain soil fertility and improve the economy of water use.

At the current levels of production from most farm lands, the introduction of high yielding varieties of millet or sorghum can only be justified on the best soils which are very limited in area. In the present situation where limited organic manuring is carried out, all techniques designed to increase production through the use of new varieties and mineral fertilizer, even if they produce some promising results in the short run, will, in the long run, contribute to the further deterioration of soil fertility. It is surprising that, though most researchers recognise the seriousness of soil fertility decline, most agronomic field research still concentrates on variety and fertilizer trials, and animal traction technologies that encourage farm area expansion. The IVRAZ-IRAT programme is exceptional in that manuring is an important component of the research and development programme. In Yatanga ORD (Upper Volta) all the amelioration techniques generated by a range of small projects, such as the use of small stock, fruit trees, forestry and fodder crops, are presented as a range of alternatives or alternative combinations for the farmers of the region.

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1 That is, apart from rainfall amount and variability which clearly sets the limits on permanent arable cropping.

In a major ORSTOM study made in 1966-1967 in the Yako region, 180km W-NW of Ouagadougou, most of the fertility maintenance techniques outlined below were integrated into farming systems, even though some were carried out on a very limited scale (Kohler, 1971).

It is fully accepted that one farmer cannot adopt all the techniques discussed but it would seem to be a matter of extreme urgency that at least a range are tested and farmers are given the choice and support needed to implement those they consider feasible for their circumstances.

Acacia albida as a permanent tree intercrop and fertility restorer.

This is the first measure to be introduced as, in all the locations in which it has been planted, even though its growth is slow, it is one of the most promising trees for the semi-arid zones. Its chances of adoption by farmers would be greatly enhanced given appropriate government support. The tree is found in all the Sahel-Soudan zones and it would appear to have originated from southern Africa. Its abnormal season growth indicates that it has not originated in the countries where it is currently growing. They may also indicate that man has had an active role in its distribution and that it has been of importance in the past. In the Zinder Kingdom of Niger a man who cut down one **Acacia albida** tree (Gao) without permission was beheaded.

The tree is found in areas where sandy or sandy-clay soils are present and where the water table is not too deep as it requires water during the dry season to develop full leaf canopy.

Despite this limitation, the areas where the tree could be planted are immense, and many authors confirm that with a full **Acacia albida** stand permanent cropping is possible without any decline in soil fertility. The tree clearly can contribute to the improvement of both physical and chemical properties of the soil. Also, the pods have a high feeding value for animals and the attraction of the trees in providing shade in the dry season results in concentrations of animal dung. The sometimes stated 'problem' that the presence of the tree inhibits animal traction is fallacious as the tree has few surface roots and can be planted in rows 20m apart.

It is suggested that the introduction of **Acacia albida** and other, well adapted trees, should be a major priority wherever possible in the Sahel-Soudan zones.

Restorative fallows

Due to demographic pressure and to the expansion of farm areas cultivated using animal traction, fallows are decreasing in proportion to cropped area both in surface area and in time. However, where organic manuring is limited, fallowing is the only effective way to restore fertility on cropped land. Any method which could speed up the restoration process is worth examining and testing. Some leguminous fodder crops such as **Dolicos lablab**, Siratro or Pigeon pea or grasses such as **Andropogon guyanus** and **Pennisetum penicelatum**

(local) or **Cenchrus ciliaris** (introduced) can either be grazed by cattle and dung dropped in situ, or made into hay for dry season feeding in enclosed areas where manure can be collected for distribution later.

Intercropping of cereals with leguminous plants such as Dolicos lablab, Siratro or Niebe

Even though intercropping is very limited in the dry zones, it can be envisaged on land that has been cropped and is now moving into a fallow phase because of declining fertility and low yield. Millet may be sown at very low density (maybe 5,000 - 10,000 hills/ha) and intercropped with a legume. The small return from the millet could generate interest in the companion fodder crop.

Green manuring

Though this technique may only be appropriate where animal traction is present, some plants with rapid growth such as **Macroptilium latheroides** can be sown as a preliminary to the installation of a pasture crop or even as a second crop following a short duration in adequate rainfall seasons.

Compost

All available remnants of crops, weeds and domestic refuse should, whenever available, be used for composting. This is much the best way of recycling straw which, if ploughed in, will utilise additional nitrogen on decomposition. The objection to this technique is that it requires additional water for the effective decomposition of the organic matter. This could be overcome by having two pits so that the build up of compost can continue through the rainy season.

Mulching

This is an effective method of increasing soil fertility and reducing evaporative loss and erosion but requires a large amount of hand labour and also considerable quantities of material to be effective. As fallows decrease in size so does the available biomass also. However, whenever grass is available, it is a technique worth investigating.

Manure

All farmers are aware of the value of animal dung and many will collect dung for application on small areas or encourage the temporary stay of cattle on fields in rotation. However, the quantities of dung contributed by these methods is erratic and often inadequate. It may be necessary to concentrate the collection of manure at night by provision of enclosures or stalls and supplementary food. The rotation of small stock on small areas using temporary fences may also be possible.

Animal care and health

The high mortality rate (30 - 40%), for small stock in the area visited by the Mission, could be drastically reduced by the widespread use of vaccination and anti-parasitic drugs for all classes of livestock. This would increase the number of animals and, provided there is sufficient feed available, increase the quantity of manure produced. It may also encourage the growing of fodder crops, and the contribution to household income from livestock sales could be raised substantially.

Animal traction

In a number of programmes, animal traction using donkeys has been favourably compared (economically) to ox traction. However, this approach is limited as work with donkeys is almost always confined to simple weeding operations, whereas some form of ploughing is an important cultural method which increases water retention capacity on many soils. Also the introduction of oxen to farms on which there are none will familiarize the farm household with cattle which are an essential step in the gradual improvement of the farm system. With cows as draught animals, it would be possible to breed stock over a relatively short period. Buying young animals and selling 2-3 years later when they are heavier is a method of increasing household income. This is the current practice in the Sine-Saloun region of Senegal. Oxen will also produce significant amounts of manure whereas donkeys will not generate much unless there are large numbers.

One of the main current objections to ploughing in Upper Volta is that under conditions of a short rainy season, the farmer is always anxious to sow rapidly with the first rains and ploughing may well delay the operation. This argument is only valid if the farmer was intending to plant all his land as the rains commence. This paper suggests that the farmer should concentrate on a relatively limited area (his better soils) and improve this land with manuring, ploughing in early and tree planting so that cereals can be planted on this land as, or just before, the rains commence.

Hedges

Hedges are useful for protection from wind and to provide shade and fodder. They are difficult to establish where farmers practice extensive cultivation but could be practicable in a more intensive system with small fields, protected in sequence. A hedged field of leguminous shrubs could provide some fodder and also contain cattle at night during the dry season.

Village wood lots

Most of the cereal straw is currently used as a fuel (or as housing material) but it may be more usefully utilised as a fodder (with or without the addition of urea) or for composting. The planting of village wood lots provide firewood and building materials and it is recommended that tree planting for these purposes is included in any programme of environmental improvement at village level.

Mineral fertilizer use

Mineral fertilizer, in the form of rock phosphate, may only be of value where soil organic matter is at a reasonable level and where moisture supply is reliable. In this case crop yield response is likely to be substantial and the phosphate will also have useful residual effects. Nitrogen fertilizer is only likely to be of value where yield potential is high and consistent. The increasing cost of mineral fertilizer makes its use unlikely over much of the semi-arid zones unless the true cost is subsidised.

Improved varieties of crops

Improved varieties of crops, that are adapted to better than average conditions, are unlikely to have more that a very limited value or impact (i.e. only on the better soils in good rainfall years) in situations where farmers are facing increasing deterioration of their soils. Many farmers already have a wide selection of locally selected cultivars that are adapted to a range of climatic and soil conditions to combat the extreme riskiness of their environment. This strategy may be an important one for crop improvement scientists to bear in mind.

Water management

Soil management techniques such as tied ridging are only likely to result in greater responses on an improved soil that has a good moisture retention capacity. On soils with very poor structure, ridges are difficult to maintain and plants grown on ridges may also be more susceptible to drought at early growth stages. Some form of local water conservation is obviously desirable on most semi-arid soils but there has not, so far, been any wide adoption of tied ridging among farmers of the semi-arid tropics despite more than thirty years of research into this technique. It may well be the high labour demand of the technique not only for construction but also for maintenance at a time when weeding is a major priority that makes it unattractive.

Conclusions

It is obvious that all of these techniques cannot be adopted by all farmers but at least most of them should be examined and tested in as wide a range of agroecological zones as possible as an integral part of farming systems research programmes.

In all farming systems research budgets, some provision should be made for financing the introduction of some of these measures. Support may also be possible from Forestry Divisions of the appropriate community development Ministry. It would seem to be important that farmers are intimately involved in the planting and maintenance of seedlings of **Acacia albida** fruit trees, wood lots, hedges, forage legumes or grasses, and should have access to drugs or vaccines for livestock, but the initial cost of introduction should not be passed on to the farmer.

The amount of money needed for this kind of action is small in relation to the size of current FSR budgets.

Our knowledge of these environments more than one hundred years ago and of their quality in the recent past indicates that there is now an exponential rate of deterioration taking place and many areas have reached an irreversible state. In many areas of the region, arable soils without any kind of protection are exposed to sun and wind for 6-8 months of the year. The reversal of this process cannot take place without a concerted series of actions that will rehabilitate and maintain the environment. The protection of the soil and the return of increasing amounts of organic matter through a variety of measures are essential elements in this process. The long term improvement of farm production systems and food security may only be possible through the improvement and integration of the livestock component of the system and the planting and management of trees and tree crops. The current orientation of agriculture involving the extension of the cultivated area through the use of animal draught mitigates against this as trees and stumps are removed for ease of ploughing and grazing areas reduced.

Annex 4
Documents studied - Upper Volta, Mali and Senegal

L'Autorite de Developpement Integre de la Region du Liptako-Gourma (1983). Fiche d'Information.

Bois et Forét des Tropiques (1964). Possibilite de reboisement en **Acacia albida** au Senegal.

Bois et Forét des Tropiques (1977). Le role de la forestrie dans la lutte contre la desertification et sa contribution au developpement.

Bonkian, A. (1982). Les Structures de Marche et Le Prix des Cereales dans Deux Villages du Centre de la Haute-Volta. Rapport No. 8, ICRISAT, Ouagadougou.

Bouake, I. (1979). Les problemes techniques et ecologiques que posent les assolements actuellement practiques.

Bouake, I. (1979). Assolement propose par la recherche, techniques, culturales, equilibre mineral et organique, probleme de la jachere et de l'association avec l'elevage.

Burzat (1982). Rapport Final.Projet petit elevage region Yatanga

Charreau, C. (1980). Some controversial aspects of farming systems in Semi-Arid West Africa: 1.

CILSS (1983). Project Developpement des Cultures Fourrageres et Ameliorantes en Zone Soudano Shaelienne. Haute Volta, Mali, Niger, GCP RAF 098 SW1.

CNRA (1982). Rapport Agrometeorologique. 1981-2.

Colomb, J. (1982). Evaluation du Project Actuel et Preparation d'une Deuxieme Phase. Project de Developpement de l'Elevage des Petits Ruminants du Yatenga.

Document. Quelques applications possibles de l'Agro Foretrie in Haute Volta (1983). Seminair sur l'Agro Foretrie Niamey.

Dugue, P. (1983). Rapport analytique 1982. Programme d'Agronomie Vol. I. Resultats des Tests Paysans et Enquetes Agronomiques.

Elliot, H. (1977). Farming Systems Research in Francophone Africa. Methods and Results. Ford Foundation Seminar, Tunis, 1977.

FAO (1983). Note de Synthese sur le "Programme de Developpement de l'Elevage dans la Region du Liptako - Gourma, Ouagadougou, ADIRL - G.

FED (1982). Project Petits Ruminants, Aviculture. Rapport Final. ORD - Yatenga. Ouahigouya.

FSU/SAFGRAD (1984). Report to SAFGRAD TAC Meeting 9-11 January 1984. H. Ohm and M. Lang.

FSU/SAFGRAD (1981). Major Cropping Patterns. SAFGRAD Countries. Upper Volta. Facts and Observations Relevant to FSR. Ram. D. Singh. Purdue Team.

FSU/SAFGRAD (1981). Field Trial Research Program. 1980. P. Christenson and R. Swanson. Purdue Team. July 1981.

FSU/SAFGRAD (1981). Rock Phosphate Fertilizer in Upper Volta: Policy Implications of Cereal Yield Response Characteristics. P. Christenson.

FSU/SAFGRAD (1980). Pour Une Exploitation des Materiaux d'Enquete. A Bruyer.

FSU/SAFGRAD (1983). Annual Report of Purdue FSU. 1982.

FSU/SAFGRAD (1981). Household Composition, Rainfall, etc. Observations and Recommendations on Methodology and 1980 Results. R. Swanson.

Giffard (1964). Les possibilities de reboisement en Accacia albida au Senegal. Revue Bois et Foret des Tropiques n 95 1964.

ICRISAT (1983). **Annual Report** 1982, International Crops Research Institute for Semi-Arid Tropics, ICRISAT Patancheru, P.O. Andra Pradesh 502 324, India.

ICRISAT (1979). **Annual Report** 1979, Dept. of Agricultural Services, Ministry of Rural Development, Republic of Upper Volta.

ICRISAT/SAFGRAD. Eastern and Soutern African Sorghum and Millet Program - current activities and projected plans. Brhare Gebrekidan.

IEMVT L'Hoste. L'approache de l'elevage dans les systemes agro-pastoraux en Afrique.

IEMVT L'Hoste. Developpement de la traction animale et evolution des systemes pastoraux dans le Sine Saloum.

IER (1978). Pour un Programme de Rechereche sur les systemes de Production Agricole.

IER (1980). Rapport sur la Typologie Prelimminaire des Unites de Production dans les Village de Gladie, Monzondougou et Sakaro.

IER (1982). Rapport Annuel Institut d'Economie Rurale.

IER (1983). Etude Socio-Economique aux Environs de la Station de Recherche Agronomique de Cinzana. par. O.N. Coulibaly et Mme. C.A. Gologo.

IER (1984). Synthese des Resultats 1982/3 et Programmes 1983/4. Commission Technique Specialisee des Systemes de Production Rurale (Bamako. 29-31 Mai, 1983).

IITA/SAFGRAD (1981). Maize and Cowpea Improvement in Semi-Arid Africa.

IITA/SAFGRAD Report 1982. Including IDRC Upper Volta Cowpea Project.

IITA/SAFGRAD Progress Report and Future Plans. JP. 31. SAFGRAD. 1984.

IPD/AOS/IVRAZ/IRAT (1983). Programme D'Agronomie au Yatenga, Vol. III - Resultats de travaux d'experimentations. P. Dugue. (IRAT).

IRAT (1983). Rapport de Synthese. 1982.

ISNAR/W.B. (1983). La Echerche Agronomique et Zootechnique. Haute-Volta. Minor Report.

ISRA (1984). Publicity brochure. Organisation and activities of ISRA in Senegal. Dakar.

Jaeger, W.K. (1983). Animal Traction and Resource Productivity: Evidence from Upper Volta. Mimeo.

Kabore, P.D., Lebene, Y. et P.J. Matlon (1983). Models dans Trois Zones Agroclimatiques de Haute-Volta. Rapport No. 9, ICRISAT, Ouagadougou.

Kohler, J.M. (1971). Activites Agricoles et Changements Sociaux dans L'Ouest-Mossi (Haute-Volta). OSTOM 70-74 route d'Aulnay 93-Bondy, France.

Lang, M.G. and Cantrell, R.P. (1983). Accenting the Farmer's Role in Farming Systems Research: Alternative Approaches by the Purdue FSU.

Lang, M., Cantrell, R., and Saundes, J. (1983). Identifying Farm Level Constraints and Evaluating New Technology in the Purdue Farming Systems Project in Upper Volta. FSR Symposium, Kansas State University, October 1983.

Les Editions j.a. (1980). Les Atlas Jeune Afrique: Mali.

Les Editions j.a. (19800. Les Atlas Jeune Afrique: Senegal.

Martin, D.G. and H. Vierich (1983). Les Regimes. Fonciers dans Trois Zones Agro-Climatiques de Haute-Volta. Rapport No. 10, ICRISAT, Ouagadougou.

Matlon, P. and Vierich, H. (1982). Annual Report of ICRISAT/Upper Volta Economics Program. 1982.

Matlon, P.J. (1983). Farmer participation in Technology Evaluation: Five Case Studies from ICRISAT/West Africa.

McIntire, J. (1983). Budgets de Production Agricole dans deux Villager du Centre de la Haute-Volta. ICRISAT Rapport No. 4.

McIntire, J. (1982). Sondage de Reconnaisance au Nord et a L'Ouest de la Haute-Volta. ICRISAT Rep. No. 3.

Ministere des Transports, de L'Environnment et du Tourisme (1983). Quelques Applications Possibles de L'Agro-Foresterie en Haute-Volta. Seminaire sur L'Agro-Foresterie, Niamey, 23/5 - 11/6/83.

Morris, W.H.M (1982). The Development of Agriculture in Sahelian Africa 1960-1980. Dept. Aric. Econ. Purdue University.

Norman, D.W., Newman, M.D. and Ouedraogo, I. (1981). Farm and Village Production Systems in the Semi-Arid Tropics of West Africa. ICRISAT Res. Bull. No. 4. Vol. 1.

OAU/STRC (1984). Report and Recommendation of the President to the Executive Board on Proposed Technical Assistance Grant for Research and Development of Food Grains in the Semi-Arid Regions of Africa.

Perrier, E.R. (1984). The Soil-Water Management Programme of Upper Volta.

SAFGRAD (1983). Projet Safgrad au Mali. Rapport de la Campagne 1982.

S.N.V.A. (1984). History, objectives and priorities, structure, organisation and roles of sections (brochure of Service National de Vulgarisation Agricole.

USAID/MALI (1983). Farming Systems Research and Development Projects. PID.

Vierich, H. (1983). Participation or accommodation: Communication Problems in Farming Systems Research. ICRISAT. "Farmers Participation" Workshop, Ougadougou, September 1983.

Working Papers from: OAU/SAFGRAD 3rd Tech. Advisory Committee Meeting, 9-11 January, 1984.

- Tech. Res. Information
- Training
- Coordination
- SAFGRAD II

Activities du RPAA - SAFGRAD/MALI
Project Management Committee of SAFGRAD - Working Paper 12/1/84.

Annex 5

Itinerary of IFAD Mission

Friday January 6th		Travel to Ougadougou (Couprie and Gibbon). Meeting with SAFGRAD Director of Research, Dr. Bezuneh.
Saturday January 7th		Study of FSU Purdue reports and documents.
Sunday January 8th		Further study of FSU Purdue documents and documents for SAFGRAD/TAC Meeting. Arrival of Nweke and meeting with Prof. Williams (OAU/STRC) and Dr. Kesseba (IFAD) and Bob Clay (USAID).
Monday January 9th,	a.m.	Attended opening session of SAFGRAD meeting. Meeting with Prof. Williams, Kesseba, Couprie, Nweke, Gibbon, Bezuneh to discuss terms of reference of mission and work programme. Agreement to visit Mali and Senegal.
	p.m.	Purdue FSU presentation at SAFGRAD meeting Drs Ohm and Lang. Discussion.
Tuesday January 10th	a.m.	Visit to Purdue FSU office. Discussion with M. Lang on Purdue work and plans.
	p.m.	Visit to Nedago village with Mr. Seyo, Robert and Francois. Discussion on FSU work with village Chief, Mr. Berema and other farmers.
Wednesday January 11th	a.m.	Ministry of Rural Development and Extension. Miss Sanwidi. Discussion on reorganisation of extension and problems of coordination and communication. Visit to Kamboinse Research Station (IVRAZ) Dr. Patanayah, Head ICRISAT Team - ICRISAT Regional Plans. Deputy Director of Kamboinse Station Dr. P. Matlon, ICRISAT Economist - Farming Systems Programme.
	p.m.	Dr. Perrier, Soil Scientist - soil and water management work and animal traction training. SAFGRAD office, Ouagadougou.

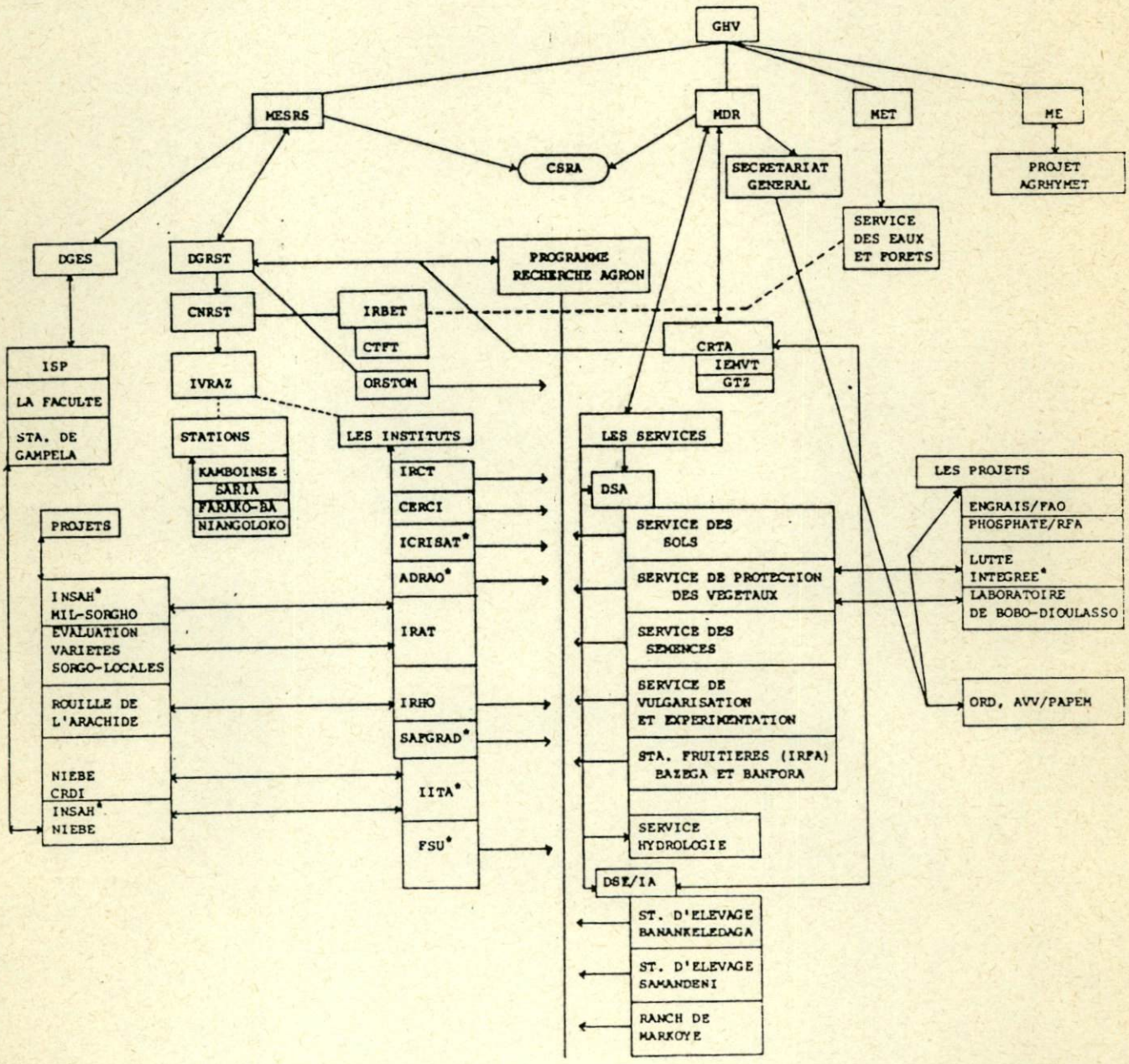
Thursday January 12th	a.m.	IRAT office. Mr Nicou and Mr. P. Dugue. Discussion of IRAT work - U.V., including study and experimentation in Yatanga and in 3 other villages in North. FAO office - Dr. C. Hoste - responsible for regional project on control of livestock and human diseases and improvement of trypanotolerant breeds of livestock. EDF office Mr. Raadr, livestock specialist.
	p.m.	CILSS Poject. Mr Diack - plant protection. Mr. Dialo, Deputy Director of Projects and Programmes. Discussion of major problems in integration of crops and livestock. Mr. Dalebroux - forage and restorative activities in Northern Zone. ORSTOM - Agronomist - Library.
Friday January 13th	a.m.	Purdue/FSU office. Head of Team, Dr. H. Ohm. Discussion of Project history and problems, progress and future plans and priorities. IVRAZ office Dr. N'Guetta-Bosso. Discussion of review of research structure and organisation in progress following ISNAR Report. Plans for workshop in March and further planning meeting in April. Visit to Vet. Department. Visit to Village Tree Planting Project (Department of Forestry), Ouchiaogo Abdusselum, Mr. Samyu. Discussion of programme and plans for workshop on agrosylvopastoral system.
	p.m.	John Becker Project offices for SAFGRAD in USAID office, and Roger Bloom, New Project manager for SAFGRAD. Discussion of support for FSR activities and of IFAD proposals. Also of contributions from Florida FSR Support Group.

Saturday January 14th		Flight Ouagadougou to Bamako (Mali) with L. Traore (ACPO) and T. Bezuneh (Director of Research SAFGRAD). Visited Sotuba Research Station. Met: Mr. Dolo Panaganigou, Head of Station - introductory talk, Dr. John Scheuring, ICRISAT Plant Breeder - discussion of farming systems and current research problems. IRAT - Mr Martinet, Malian - Mr Bagayoko, soil fertility research staff. Dr. Tiecoradie Diana - Director of Farming Systems Research Division, Sikasso - discussion of current FSR work and future plans. Also IFAD proposal.
Sunday January 15th		Discussion and writing - Grand Hotel.
Monday January 16th	a.m.	Visited Dr. Zanasonego - Director of Agronomic Research.
	p.m.	Dr. Reddy USAID Technical Director FSR - plans and proposed expansion over next ten years.
Tuesday January 17th	a.m.	ILCA project office, Bamako. Mark Haywood - Team Leader, P. Hiernaux - Pasture Ecologist. Discussion of ILCA programme over last six years and present plans.
	p.m.	Mr. Mamadou Fatogoma Traore - Director of Agricultural Research. Discussion of Mali plans for development of FSR in Mali and possible SAFGRAD FSR input in Sikasso or alternative in Northern Region.
Wednesday January 18th		Left Bamako at 12 noon on train for Dakar 1400 km in 37 hours via Keyes, Tambaconda and Sine Saloun Region. Noted extreme degradation of groundnut region in N. Centre of country. Few trees, no organic matter or residues from groundnuts, millet and cotton.
Friday January 20th		1.30 a.m. Arrived Dakar - Savana Hotel.
	a.m.	Meeting with Dr. Papa Ibrahim a Thiongane - Director General ISRA - Discussion of ISRA plans for FSR development and SAFGRAD proposal.
	p.m.	Dr. Francois Faye - Agronomist, Farming Systems Programme. Discussion of ISRA plans for FSR expansion and scheduling.

Saturday January 21st	Public Holiday Dakar. Report writing.
Sunday January 22nd	Travel to Lagos.
Monday January 23rd	Travel to IITA, Ibadan.
January 23 - 27th	Report writing.
Thursday January 26th	Discussion of preliminary proposals with IITA/FSR Group.

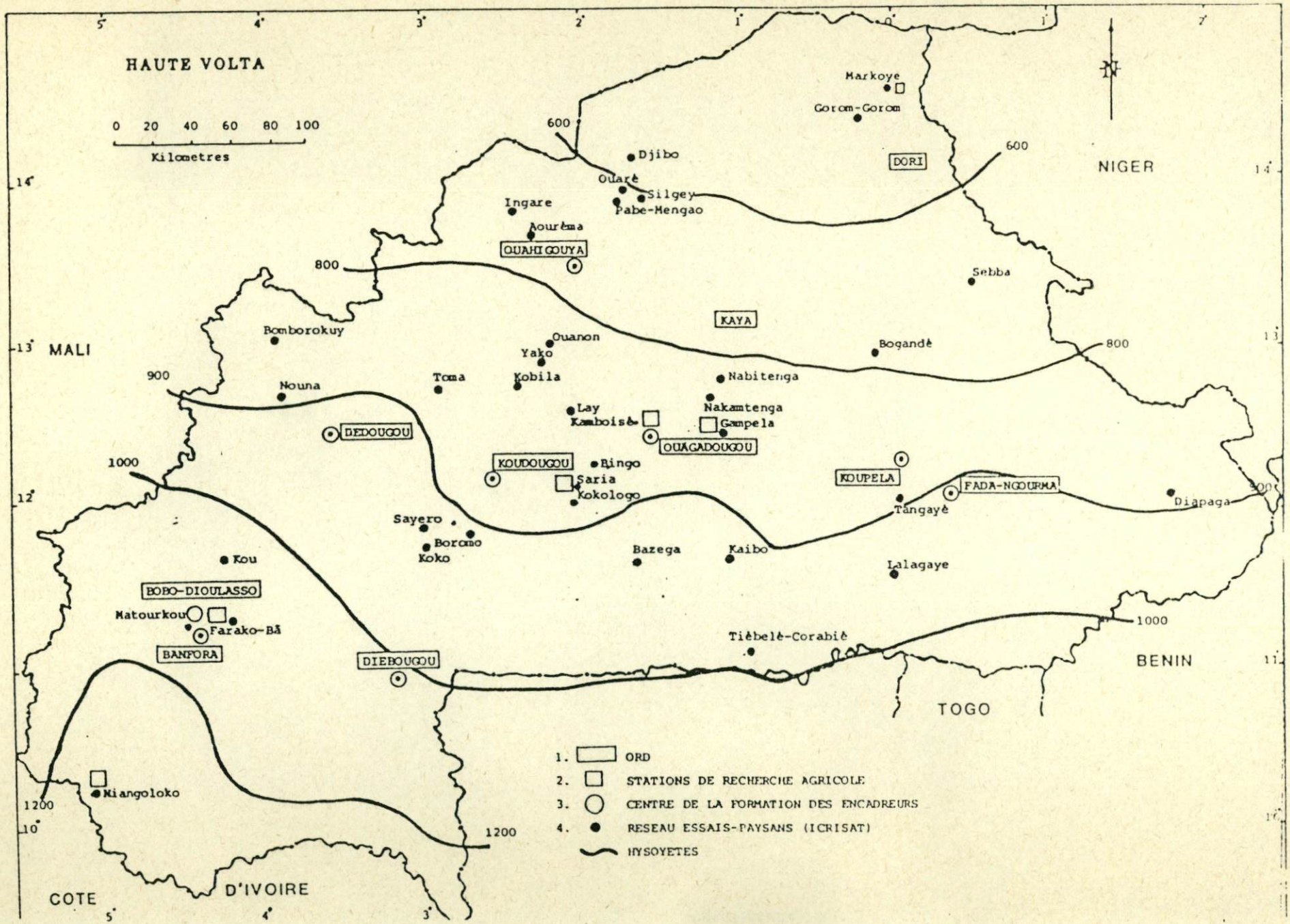
Annex 6a

SCHEMA 1 ETAT ACTUEL DE L'ORGANISATION ET DE PROGRAMMATION DE LA RECHERCHE AGRONOMIQUE ET ZOOTECHNIQUE EN HAUTE-VOLTA



* STRUCTURES A CARACTERE INTERNATIONAL ET/OU REGIONAL

N.B. VOIR LISTE DES ABBREVIATIONS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Djibo
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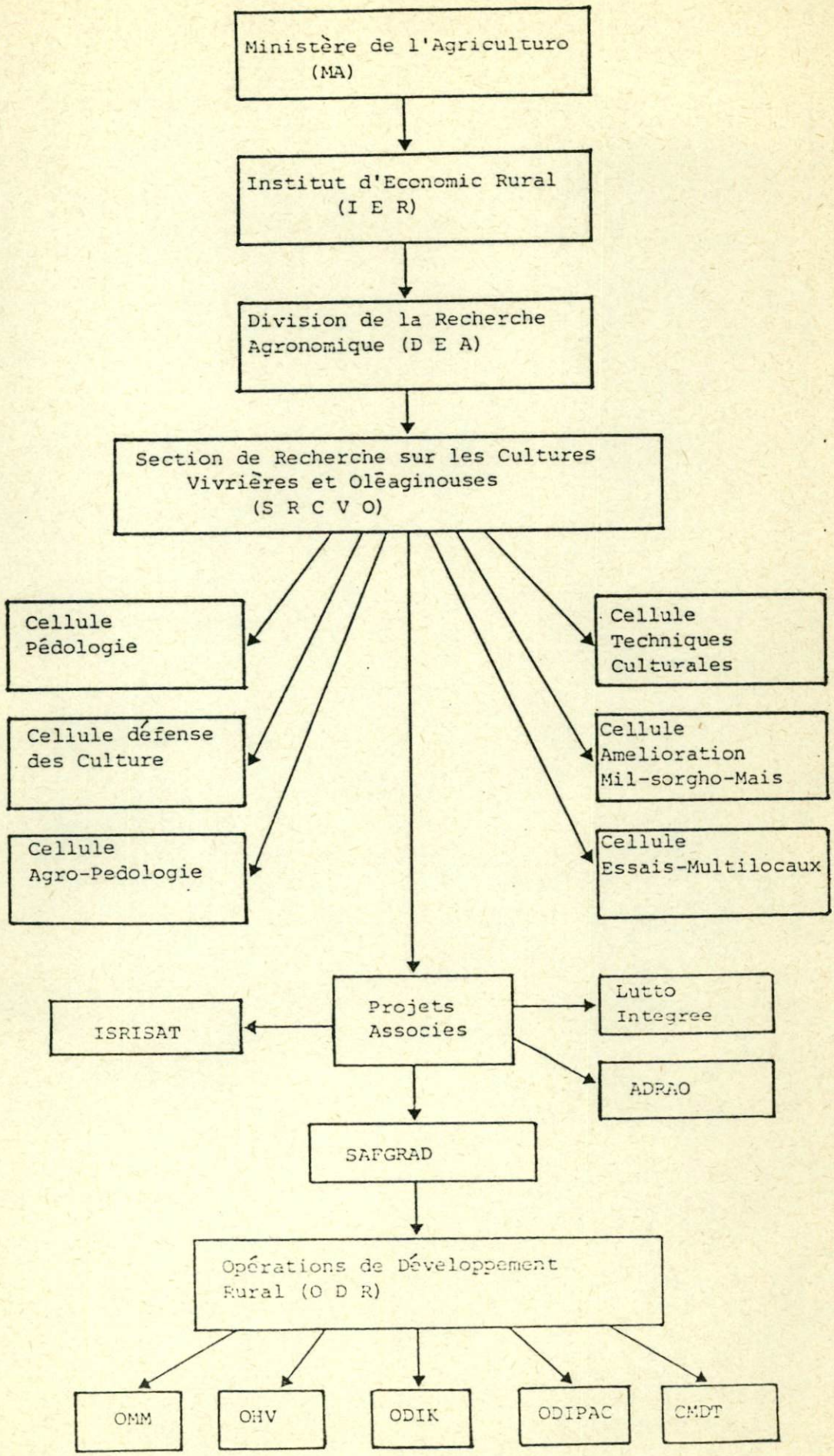
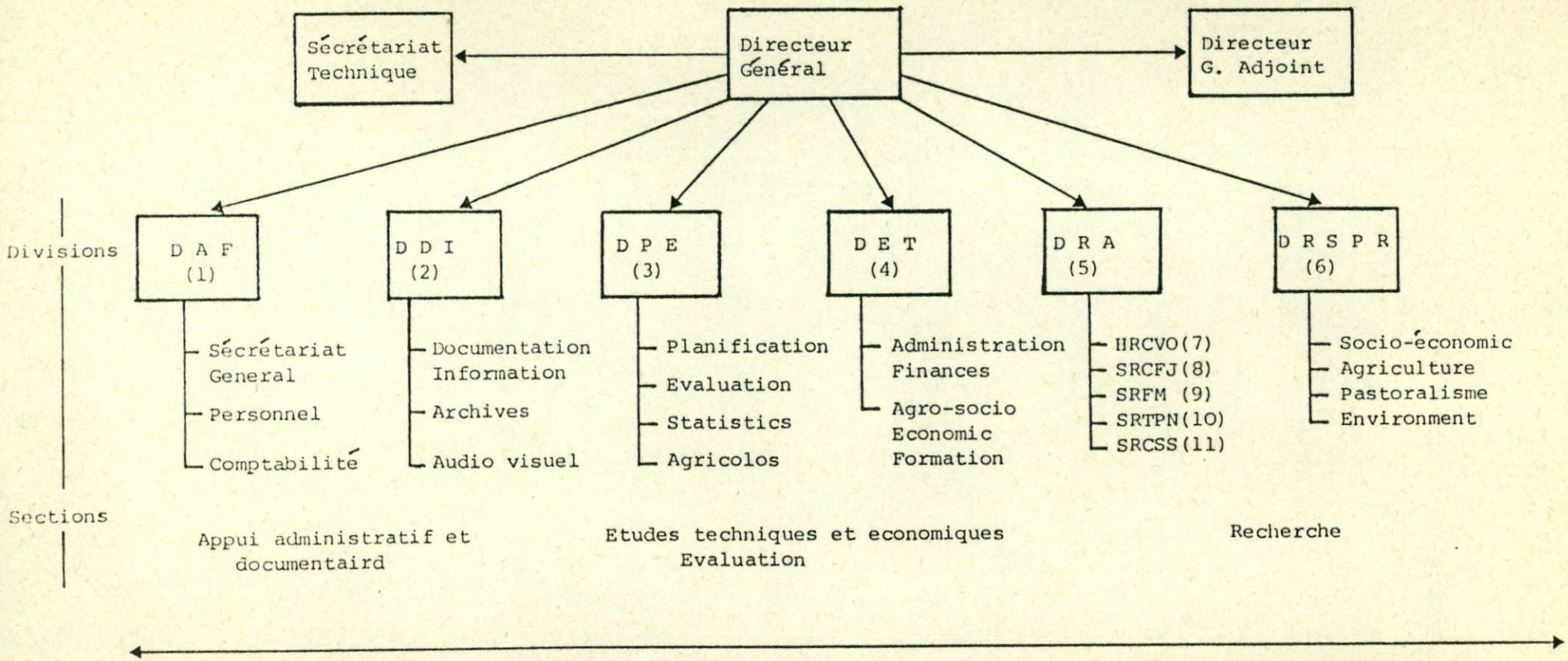
Pabe-Mengao
Ingare
Aourèma
OUAHIGOUYA
Sebba
KAYA
Bomborokuy
MALI
Ouanon
Yako
Kobila
Bogandè
Toma
Nouna
Nabitenga
Lay
Kamboisè
Nakamtenga
Gampela
DEDOUGOU
OUAGADOUGOU
KOUDOUGOU
Bingo
Saria
Kokologo
KOUPELA
FADA-NGOURMA
Tangayè
Diapaga
Sayero
Boromo
Koko
Bazega
Kaibo
Lalagaye
Kou
BOBO-DIOULASSO
Matourkou
Farako-Bâ
BANFORA
DIEBOUGOU
Tièbelè-Corabiè
BENIN
TOGO
Niangoloko
COTE D'IVOIRE
600
800
900
1000
1200
1. ORD
2. STATIONS DE RECHERCHE AGRICOLE
3. CENTRE DE LA FORMATION DES ENCADREURS
4. RESEAU ESSAIS-PAYSANS (ICRISAT)
ISOYETES

Annex 6b

MALI



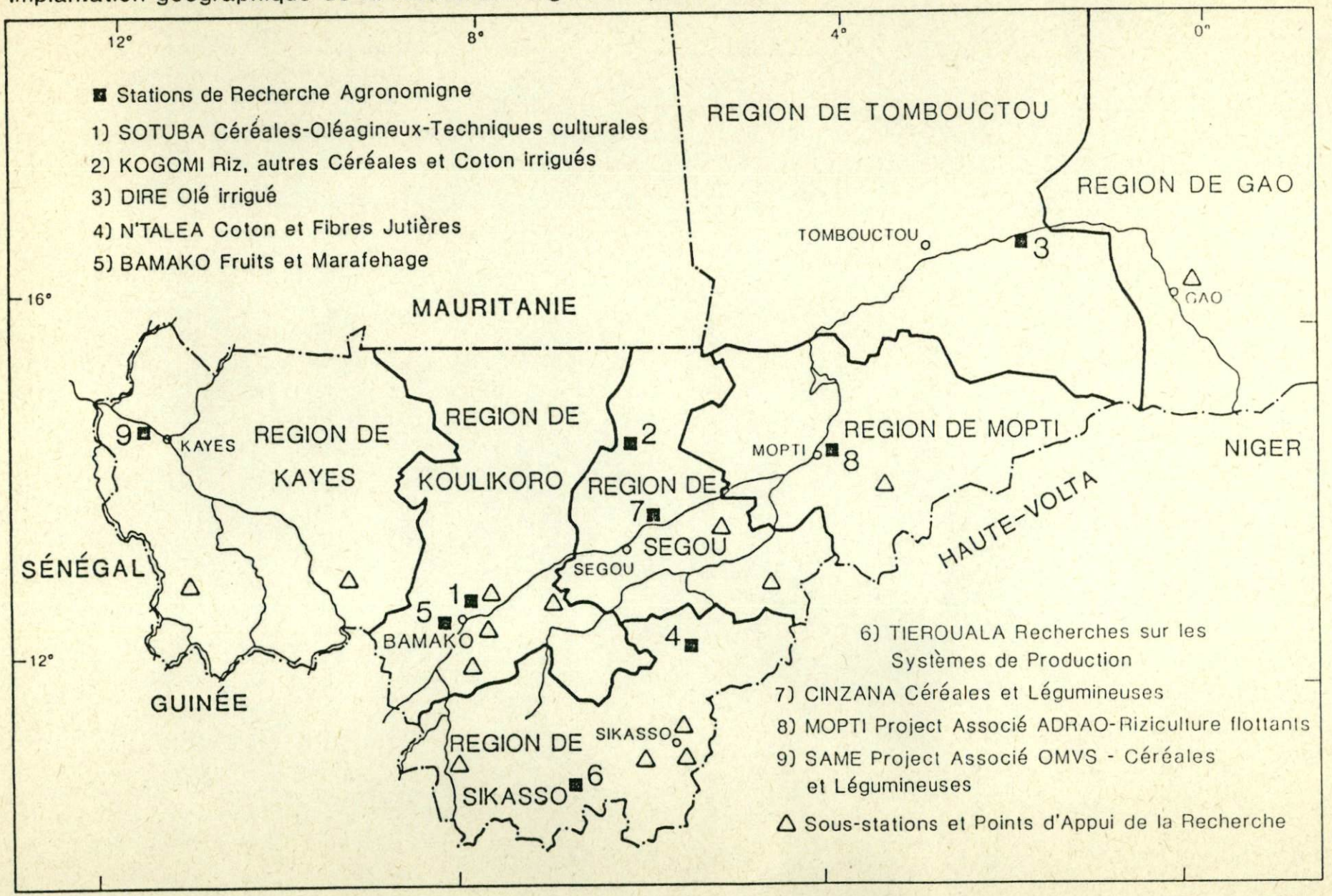
8°) Organigramme de l'INSTITUT D'ECONOMIE RURALE (Reorganisation août 1980)



(1) Division Administrative et financière
(2) Division de la documentation et de l'information
(3) Division de la planification et de l'évaluation
(4) Division de études Techniques
(5) Division de la recherche agronomique
(6) Division de la Recherche sur les systèmes de production rurale
(7) Section des cultures vivrières et eléagineuses
(8) Section de recherches cotonières et fibres jutières
(9) Section de recherches fruitieres et maraîchères
(10) Section de recherches tabacoles et des plantes nouvelles
(11) Section de recherches sur le contrôle des semenoes selectionees

Annex 6b

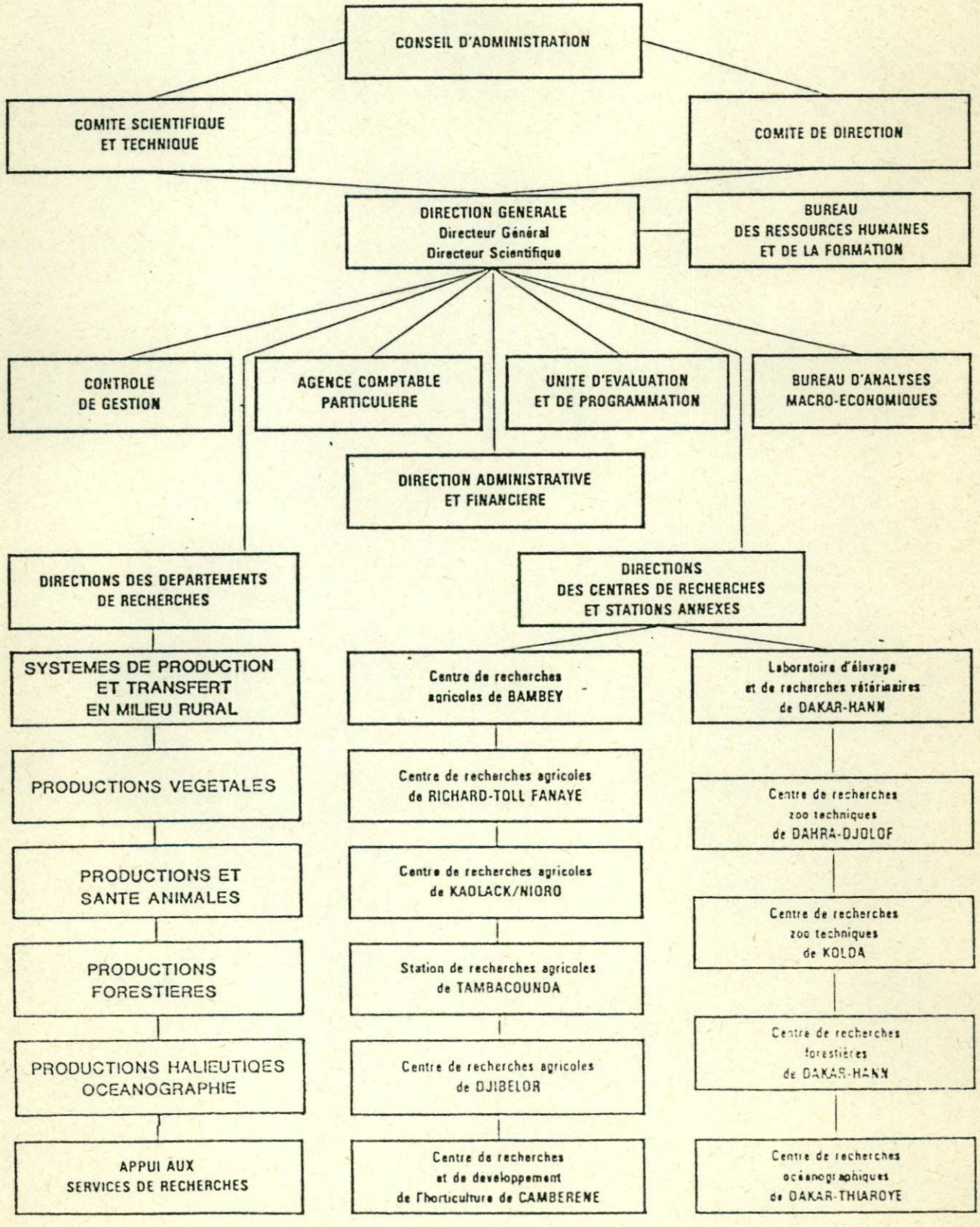
Implantation géographique de la Recherche Agronomique au Mali



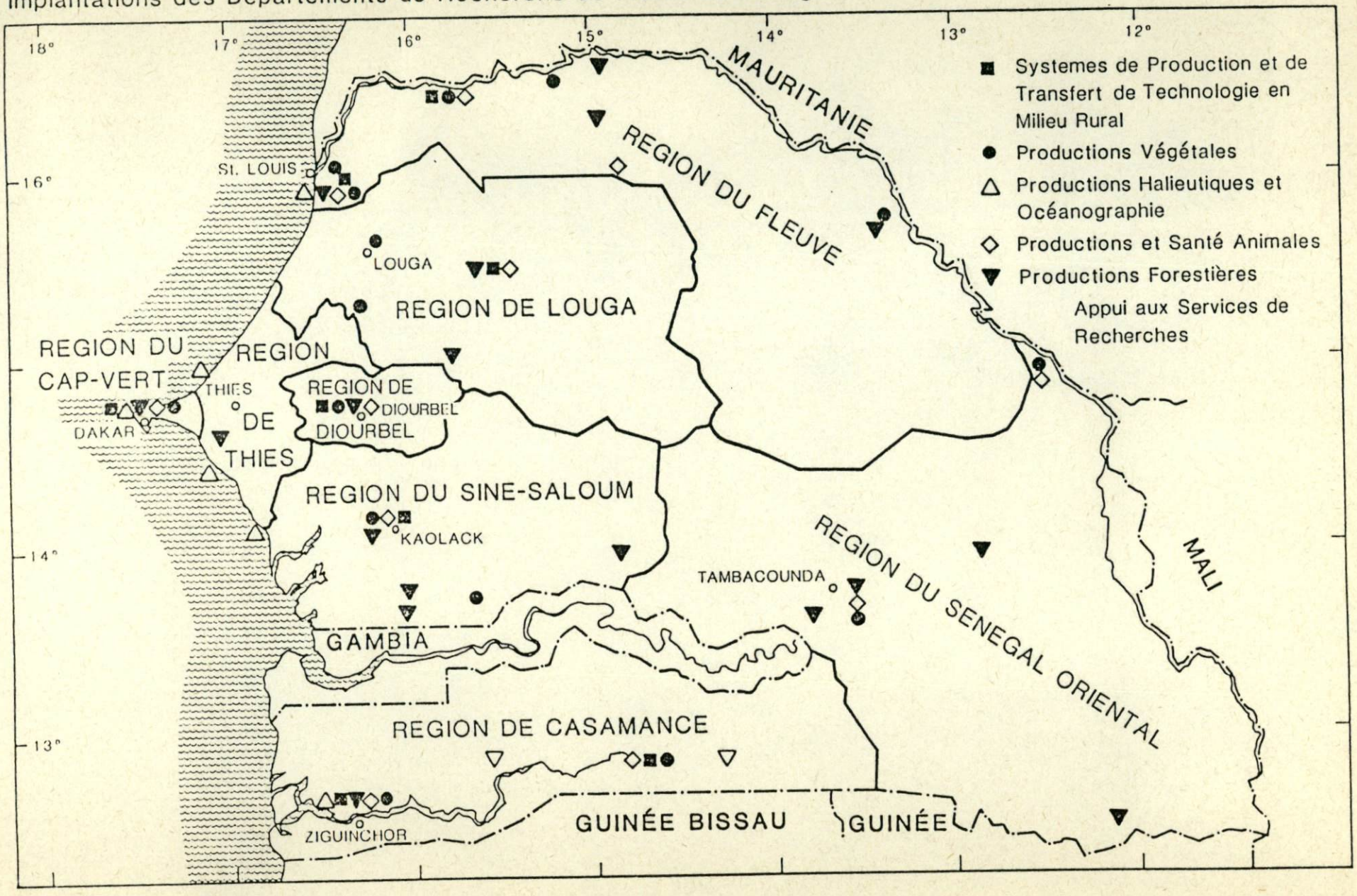
Annex 6c

REPUBLIQUE DU SENEGAL

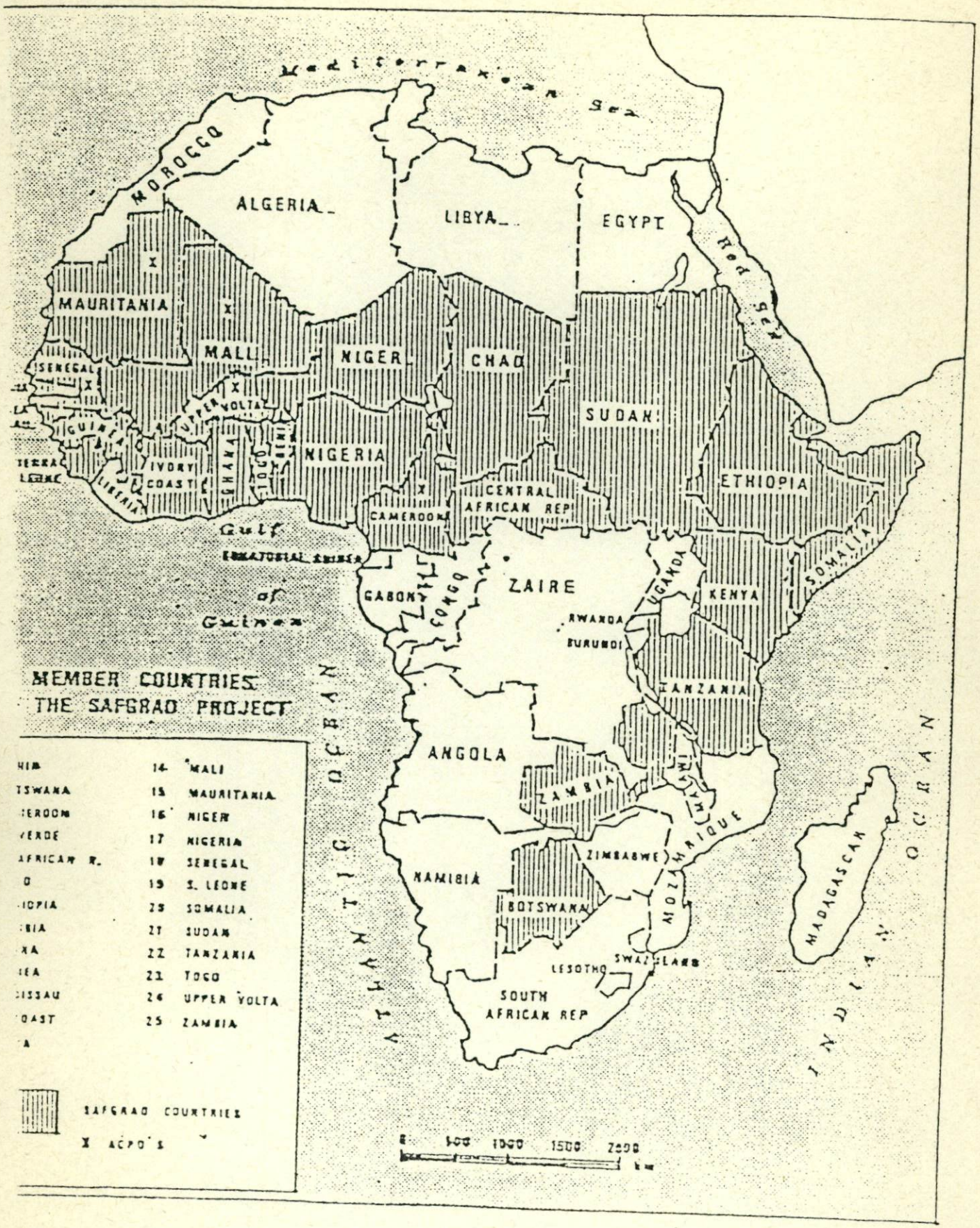
MINISTERE DE LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE



Implantations des Départements de Recherche de l'ISRA au Sénégal



Annex 6c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ALGERIA
LIBYA
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CHAD
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GUINEA
SUDAN
NIGERIA
IVORY COAST
GHANA
TOGO
BENIN
LIBERIA
ETHIOPIA
CENTRAL AFRICAN REP
CAMEROON
Gulf of Guinea
EQUATORIAL GUINEA
ZAIRE
GABON
CONGO
UGANDA
KENYA
SOMALIA
RWANDA
BURUNDI
TANZANIA
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
ZIMBABWE
NAMIBIA
BOTSWANA
LESOTHO
SWAZILAND
SOUTH AFRICAN REP
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ATLANTIC OCEAN
INDIAN OCEAN
MEMBER COUNTRIES
THE SAFGRAD PROJECT
14 MALI
15 MAURITANIA
16 NIGER
17 NIGERIA
18 SENEGAL
19 S. LEONE
20 SOMALIA
21 SUDAN
22 TANZANIA
23 TOGO
24 UPPER VOLTA
25 ZAMBIA
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1984-01

Report of OAU(STRC)/IFAD Mission to Upper Voita, Mali and Senegal

Couprie, Francois

AU-SAFGRAD