SENEGAL AGRICULTURAL RESEARCH II PROJECT

TRIP REPORT FOR ISRA/DRPF

AGROFORESTRY RESEARCH IN SENEGAL: PROBLEMS AND PDTENTIAL

by

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AGROFORESTRY RESEARCH IN SENEGAL

1.0 INTRODUCTION

In the context of refining and expanding its agroforestry research program, the Senegalese Agricultural Research Institute's Department of Forest Production Research (ISRA/DRPF) requested that the USAID-Michigan State University Senegal Agriculture Research Project (SARII) fund a consultant whose scope of work would include:

(1) a review of forestry and agroforestry research programs in view of ISRA/DRPF's proposed research directions and ideas on interdisciplinary collaboration;

(2) discussions with ISRA/DRPF of agroforestry research directions;

(3) identification of themes for discussion by ISRA's Scientific and Technical Committee.

This review was undertaken from September 9-24, 1988 in collaboration with the Director of the DRPF.

Given the limited duration of the visit, the author was only able to partially tap sources of agroforestry information outside of ISRA, such as projects being implemented by the Ministry of Nature Protection's Directorate of Soil Conservation and Reforestation (MPN/DCSR) and many non-governmental organization (NGO) activities.

While the comments and observations in this report may seem at times over-critical, they are made in the context of helping to strengthen what is already one of the best agroforestry research efforts in sub-Saharan Africa.

2.O HISTORICAL PERSPECTIVE

While the term agroforestry has only corne into vogue in the past decade, what could be considered to be agroforestry research in Senegal has had a long tradition. Beginning in the early to mid-1960s, much of the original research on the Acacia albida agro-silvo-pastoral system was conducted in Senegal. This is one of the best known "traditional" agroforestry systems and is widely practiced from Senegal to Eastern Sudan.

In 1966, Poulain reported that millet yields near Bambey averaged about 930 kg/ha under the crown of A. Albida and 450 kg/ha outside the crown. Other important contributions to understanding this species include; Charreau and Vidal (1969), CTFT/Senegal (1966), Gautreau (1967), IRHO/Senegal (1966), Jung (1971), Lebrun (1968), Wickens (1969), and Charreau (1970). In addition to supporting Poulain's original research, these studies also indicate that fallow requirements are greatly reduced when the species is present and that livestock carrying capacity can be doubled with a minimum density of trees.

During this same period, considerable effort was also placed on agroforestry-related methods of soil regeneration including improved fallow systems and crop rotations (CNRA/Bambey 1964, De Haut de Sigy 1962, Tourte et al. 1964) and erosion control (Charreau 1970). Much of this original work, however, was abandoned by the early 1970s due to financial and personnel constraints as well as a general shift in emphasis to mineral fertilizer research (See Dancette and Sarr 1985). According to Dancette and Sarr, agroforestry and related activities in Senegal in the 70s and early 80s were limited to: millet, bean and peanut intercropping trials with Eucalyptus SPD; soil regeneration trials with A. tortilis and Prosoois juliflora at Ndiemane; living hedges trials of 15 species in Sine Saloum; windbreak trials (between and within line spacing and orientation) at Bandia begun in 1982 but with no crop associations to determine windbreak impact on production. The results of many of these trials are either inconclusive or generally unsuccessful.

In the mid 1980s, GOS's and ISRA's attitudes to agroforestry and related research began to change. Evidence was accumulating that mineral fertilizer use on farms was generally low (Kelly 1986 and Gaye 1987) and that improving soil fertility in Senegal would depend on increased use of trees in farming systems to supply much needed organic matter and microbially-mediated nitrogen fixation. Moreover, many of ISRA's crop breeders began to recognize that improved varieties of crop seed alone may not be effective in increasing agricultural production without the improved fertility provided by agroforestry technologies.

As a result, agroforestry research has been given high priority by ISRA because of its present and potential impact on rainfed cereals production particularly with regard to improving and maintaining soil fertility. ISRA recognizes that the use of mineral fertilizers alone will not be an economically viable method for the GOS to achieve its goals in rainfed cereals production at least in the short to medium term. Because of its potential to increase soil fertility, ISRA also recognizes that agroforestry has the potential to complement varietal improvement research which to date has met with limited success due to poor soil fertility and plant-water environment.

3.0 ISRA'S CURRENT AGROFORESTRY RESEARCH PROGRAM

3.1 Projet de Recherche - Développement sur le Rôle de l'Arbre en Exploitation Agricole

This activity, designed to support research on the role of trees in farming systems, is currently the main component of ISRA/DRPF's agroforestry program. The project, funded by FAC at a level of 150,000,000cfa began in March 1987 and is scheduled to terminate in December 1988. The objectives of this project are to:

(1) Initiate village level agroforestry activities in Senegal in order to :

-reintroduce trees in Senegalese farming systems.

-determine the biological, social and economic importance of trees in these systems.

(2) Reinforce individual and collective agroforestry actions by a program of complementary on-station and on-farm research.

(3) Assure farmer participation in project activities.

ISRA and FAC initially chose to work in three agroecological zones each with its distinctive set of natural resource and production problems; the Northwest Peanut Basin, the Southern Sine Saloum region, and the Lower Casamance Region. These regions also benefit from a fairly extensive ISRA forestry and agriculture research presence as ISRA research stations are located in all three regions. It was hoped that the presence of these stations as well as personnel from ISRA's other divisions (DSAEA, Animal Production) would facilitate program implementation. The project's two primary modes of action are:

(1) to conduct diagnostic surveys to describe the rural milieu, to identify problems and determine with the farmers what agroforestry techniques are most appropriate;

(2) to develop a research development component comprising three types of actions:
- on-station research
- on-farm research
- development/extension of technologies;

According to the FAC project paper, ISRA/DRPF was to collaborate with ISRA's DSAEA and Animal Production Departments, with ORSTOM and with the Directorate of Soil Conservation and Reforestation under the Ministry of Nature Protection (MPN/DCSR).

Technical assistance to the project is provided by CTFT and includes the project coordinator and one researcher. ISRA/DRPF has assigned four researchers (including two "stagiares"), one Agent Technique des Eaux et Forets and four "encadreurs/observateurs" to the project.

The following section describes in detail the project's actions in each region along with some observations and suggestions for program improvement.

3.1.1 The Northwest Peanut Basin (Thienaba)

3.1.1.1 Agroecological Zone Description

This region is characterized by poor sandy soils, with organic matter content between 0 and 3%. Intensive millet-peanut culture in the area has had a severe. impact on soil fertility. Moreover, this is the Acacia albida-millet zone, but natural regeneration of A. albida has decreased substantially over the past several years. Most ISRA/DRPF researchers attribute this decline to increased use of animal traction in the area and increased demographic pressure, although these hypotheses have not been substantiated. However, older trees are systematically being harvested for fuelwood and/or lopped for fodder in the dry season. Rainfall appears to be

declining; the average for 1931-1960 was 670mm compared to 395mm for 1986-87.

3.1.1.2 On-Station Research (Thienaba)

Past and present on-station species trials and protocols at Thienaba are presented in Annex 1. In 1985, this station also initiated alley cropping/line planting trials. Five species (Acacia albida, Acacia tortilis, A. nilotica, A. senesal and Prosopis juliflora); and four treatments (with and without rhizobium inoculation, with and without nematocides) in 4 repetitions. Tree lines were originally spaced at 5m but light competition forced ISRA to eliminate one line of 2 for a final 10m spacing. Within line tree spacing was 2.50m.

Crops for the intercropping component are based on the traditional system of rotation; cowpeas (year 1), peanuts (year 2) and millet (year 3). While these trials are still on-going, preliminary results indicate that: in years one and two, when the lines were expanded to 10m, there was a slight decrease in crop yield. Nematode treatment appeared to have the biggest positive influence in crop yield. However, there was some interaction between nematode treatment and rhizobium particularly with peanuts (decrease in production). In terms of tree species, it is too early to determine species performance although A. tortilis, and A. senesal appear promising. The results in A. albida are inconclusive as the provenance used may not be adapted to Thienaba conditions.

3.1.1.3 On-Farm Research (Khayes)

This is the only one of the three agroforestry sites in which the diagnosis was conducted independent of ISRA/DSAEA. Apparently, ISRA/DSAEA did not consider this area to be a priority in terms of its program. As an alternative approach, ISRA took advantage of its "memoire de confirmation" process to use an ISRA/DRPF stagiare to examine physical and socio-economic conditions in a village (Khayes) near the station in view of establishing an eventual agroforestry management plan. This study was conducted in early 1988 by Samba Ndiaye and is entitled "Etude des Facteurs Physiques et Socio-economiques Utiles a l'Etablissement d'un Plan d'Amenagement Agroforestier" (Ndiaye 1988). While Mr. Ndiaye would have undoubtedly benefitted from participation in an inter-disciplinary systems team, his study nevertheless makes an important contribution to understanding the rural milieu from a natural resource perspective rather than from the more traditional ISRA/DSAEA cropping systems perspective.

In particular, the study documents the decline of Acacia albida in the area and suggests that the increased use of animal and traction may be responsible for this decline. The study also identifies certain regions where regeneration of A. albida has been maintained or increased implying that farmer perception and cultural practices have an important role in maintaining the A. albida - millet system. Mr. Ndiaye was also able to identify five distinct vegetation zones in the study area (Borassus aethiooium, Adansonia digitata, Parinari macroohvlla, Detarium microcaroum and Prosoois africana) which interestingly enough, correspond neither to

soil type nor rainfall. Again, this would imply that predominant vegetation in the study area is again a factor of cultural practices and farmer perception. In short, Mr. Ndiaye has identified areas which merit additional research and would obviously benefit from a systems approach.

Based on Mr. Ndiaye's study, ISRA/DRPF has begun a small on-farm research - development program in Khayes which to date has focused on:

> natural regeneration of Acacia albida - (painting seedlings a bright orange in order that farmers can see them and plow around them). ISRA/DRPF intends to measure crop yields around these trees based on age class.
>
> establishment of a village forest and fruit tree nursery and a village (community) fruit orchard with mangos, lemons, oranges, guavas. ISRA loaned the village sufficient fencing to establish a lha fruit orchard in a "bas fond" donated by the village. Hedgerow trials are located inside the fence using single species and/or combinations resulting from the on-station research. ISRA also assisted the village in establishing a well within the orchard. Villagers paid for fruit tree seedlings while hedgerow seedlings were provided free of charge. The village supplied all labor for fencing, tree establishment and well digging but will return the fencing to ISRA when the living fence is sufficiently established to deter animals.

3.1.1.4 COMMENTS/OBSERVATIONS:

On-farm-on station linkages: Unfortunately, the on-station trials were established prior to Mr. Ndiaye's study. The result is essentially a top-down research program. For example, the station researchers are pushing the Australian Acacia spp. as a "good" hedgerow/windbreak species because of their relatively fast growth and coppicing characteristics. However, initial farmer experience with the species in the area indicates that they are not compatible with crops. A closely related species, Acacia mangium, is known to have allelopathic characteristics and it may be that the Australian species being tested on the station may also be allelopathic. Moreover, the form of these acacias (relatively open on the bottom) may not be the best for crop protection either from animals or desiccating winds.

The on-station-on-farm linkage problem is further compounded by the fact that there appears to be little communication between the Senegalese and the expatriate researcher. Mr. Ndiaye apparently has little input into decisions made on-station.

There is also a question on the ability of farmers to replicate some of the technologies currently being tested on-station. It is extremely doubtful whether farmers in the area will be able to purchase nematocides or anti-desiccants, particularly considering their difficulty in purchasing other, more common inputs such as fertilizer. A system of research priorities needs to be established at the station based on Mr. Ndiaye's

study and research obtained on station to date. This issue will be discussed in detail in a later section.

Additional species: While there has been considerable attention paid to local species, some indigenous species which appear to have good hedgerow characteristics have been overlooked. For example, Guere senegalensis (sp.) is a shrub common to the area appearing as part of the fallow system. Farmers note that crops planted where the species was removed tend to grow better than other areas. This would indicate a nutrient rich litterfall. The species also has a good hedgerow form with dense foliage all the way to ground level and coppices well. However, the species is usually never allowed to reach its maximum height as it is continuously being cut for firewood and other uses (baskets). Given this shrub's characteristics, it would appear to be worthwhile to include it in any hedgerow research protocol.

The Acacia albida-millet system: The peanut basin continues to be the prime traditional area for the Acacia albida-millet agroforestry system, but little research is being done on this important system. This is even more surprising considering that the general consensus among natural resource professionals in Senegal indicates that the use of the system is declining. Thus, there appears to be a need for compromise between research on the introduction of new agroforestry systems and species, and study or refinement of viable, old systems. Questions that ISRA/DRPF could address on the A. albida system include:

> Why is the system declining in some areas and being maintained or increased in others? Are there lessons to be learned (socio-economic, cultural or biological) from areas where the system is being maintained which can be applied to other areas?
>
> What are the best methods for replicating/maintaining the system on-farm; natural or artificial regeneration? If artificial, by what means? How many trees can be maintained per ha without interfering with crop production?
>
> What are the constraints on extension and maintenance of the system?
>
> To what extent has animal traction contributed to the decline of the system? Are farmers willing to plow around naturally seeded seedlings or is it better to establish them in line plantings? Are there any other factors which are contributing to the species decline?
>
> A nationwide, if not rangewide, provenance test of A. albida appears to be warranted. This could perhaps be done in collaboration with an IARC such as ILCA or ICRAF.

Experimental design: The experimental designs at the Thienaba station are extremely complex. Agroforestry research complex, but when it

is compounded with numerous species, rhizobium and nematocide trials, the analysis of variance and determination of statistical significance of the various species and treatments become extremely difficult. (In fact, none of the published results of the trials gives the statistical significance and level of confidence.)

The general rules of thumb for agroforestry research design are: (i) simplicity (no more than 2 species * 2 treatments); (ii) repetition (at least three); (iii) randomization; (iv) control; and (v) to "block" for differences in soil type and for slope whenever possible[1]. On-station trials should be simplified into smaller units rather than one large trial which attempts to address everything.

Considerably more attention should be given to within and between row spacing in terms of the alley cropping trials, and in diagonal planting of the hedgerow associate species trials. There will of necessity be a compromise between the number of trees a farmer can plant in his field (due to labor and time constraints, etc.) and the number required to maximize crop production. In the trials, parallel planting takes considerably more space out of production than diagonal planting. Hedgerow "yield" and effect may not be influenced by diagonal planting and may even be enhanced.

Research vs. Develooment: The majority of on-farm activities conducted by ISRA/DRPF have a distinctly development inclination. Very little on-farm research (other than the diagnostic study) has been conducted to date. Development actions are necessary to gain farmer confidence, but the DRPF should begin to move some of the more promising species and trials on-farm as soon as possible. In this regard, Thienaba is somewhat behind the other two stations.

3.1.2. Sine Saloum

3.1.2.1 Agroecological Zone Description

This area is currently experiencing a rapid population increase, with reports indicating that population has doubled over the last 10 years. Soils are variable but generally poor with low organic matter content. The population pressure has increased pressure on the natural resource base to the extent that traditional farming systems are beginning to break down. Soil erosion and decreased fallow periods are becoming more of a problem and are major contributing factors to declines in agricultural productivity. Overgrazing has also recently become a problem and also contributes to the decline in forest cover. Rainfall has declined in the area from an average of 927mm between 1931-60, to an average of 640 in recent years with a slight increase to 850 mm during 1986-87.

[1]The Thienaba station has different soil types whose effect could have been removed by blocking.

3.1.2.2 On-Station Research (Nioro du Rip)

Research on this station has primarily focussed on living fence trials and species and protocols are found in Annex 1. There are no intercropping trials at this station.

3.1.2.3 On-Farm Research

As part of his "memoire de confirmation", M. Diatta, an ISRA/DRPF research trainee, is currently studying:

- the correlation between vegetation and soil types in the region (soil evolution/regeneration);
- the influence of the different vegetation types on run off/erosion in collaboration with ISRA's Soil Conservation Program and ORSTOM;

Results of this study are expected by the end of 1988.

The Sine Saloum ISRA/DPRF team is also conducting research on the effect of woody species on crop yields. In the area, four species are commonly found in farmers' fields: A. albida, Cordyla pinnata, Prosopis africana and Lannea acida. The objective of this experiment is to measure crop yields under the crowns of these species in order to determine optimum tree density/ha. Additionally, factors such as litterfall as a function of tree size, quality of litterfall/forage, and fruit production per diameter class will be examined.

Two villages were selected during the course of the diagnostic survey (with the Kaolack Agrarian Systems Team) for research-development type actions: Ndimb Taba and Sinthiou Kahel[2]. ISRA/DRPF research - development activities in Sinthiou Kahel include: the establishment of a village nursery and training of a nursery technician; the establishment of live fences on farmer's fields (using preliminary results from the on-station trials), and planting fences along contours whenever possible to help stem soil erosion).

Hedges are also being established to control animal circulation with the goal of protecting crops in the rainy season and natural regeneration in the dry season. Villagers apparently requested this action. Ownership of hedges and rights to eventual benefits have been determined at the village level. Each farmer has the rights to the hedgerow north and east of his

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[2]Unfortunately, due to an overflowing river, the author was only able to visit the village of Sinthiou Kahel. On farm research at Ndimb Taba is reported to include activities similar to Khayes', plus windbreak establishment and soil erosion control measures. The diagnostic survey identified loose soils and absence of vegetation as key problems in Ndimb Taba, combined with severe water erosion.

field. ISRA/DRPF also provided Eucalyptus camaldulensis seedlings to a farmer interested in establishing a private woodlot.

As in Khayes, ISRA/DPRF is attempting to maintain natural regeneration by placing painted stakes near important species. Their intention here is to stake not only A. albida, but other species such as P. africana, Lannea acida, etc. In practice, however, the author only saw staked A. albida and not too many of those. When sufficient regeneration has been established, ISRA/DPRF hopes to be able to eventually develop "lines" of local species (by thinning) to facilitate plowing.

3.1.2.4 **Comments/Observations:**

While not as sophisticated as the trials at Thienaba (Khayes), ISRA/DRPF research at Sine Saloum is progressing quite well. Some areas for improvement include the following:

On-station trials: There was no repetition in the species/hedgerow trials on the grounds that these were only aptitude tests. Without repetition, variation in soils, microclimate, etc. may give misleading results in terms of species performance. It is suggested that all future species trials follow the protocol of simplicity, randomization, repetition (and control).

It is also suggested that intercropping (alley cropping) trials be initiated both on-farm and on-station. The station (Nioro du Rip) has sufficient land to accommodate new line planting/intercropping trials while ISRA's pilot villages appear to be interested in on-farm tree planting.

Choice of species: Several of the species used in the original trials should be eliminated. For example, A. albida does not make a good hedgerow species, while species such as D. melanoxylon and S. spinosa, while extremely valuable, are too slow growing to be of use in a hedgerow configuration. Some thought needs to go into species choice prior to protocol establishment in order to avoid dispersion of effort and resources.

Village Knowledge, Attitudes, Practices: There appears to be a difference in knowledge, attitudes and practices between the villages of Khayes and Sinthiou Kahel. In this latter village, ISRA/DRPF was able to install more private on-farm triais than in Khayes, where the villagers allocated only a 1 ha area of communal, non-arable land in a "bas fond". A comparative study of these two villages might contribute to a better understanding of agroforestry technology transfer.

Research vs. development: As in the case of Khayes, many of ISRA/DRPF's actions in the village are more development than research oriented. ISRA/DRPF needs to reconcile these two roles and initiate closer collaboration with GOS and NGO development agencies and projects if it is going to maximize its impact. (For example, both the Director of the DRPF and the author were concerned about the establishment of a widely spaced Eucalyptus camaldulensis plantation in what is currently a productive millet field. While the request for this plantation was made by the

proprietor, it seems a shame to take viable cropland out of production with a species that is known for its allelopathic effects as well as its high water requirements. Alternatively, ISRA/DRPF should have assisted the farmer in establishing a narrow-spaced production plantation, particularly on the more marginal sites of his farm.)

3.1.3 Casamance (Lower)

3.1.3.1 Agroecological Zone Description

This area still has a relatively rich natural resource base in terms of forests, estuaries, range and wildlife. Many of the forests, however, are being rapidly depleted and villagers note the increased absence of ronier palms (overcutting) and mangroves (salinization). Traditionally Senegal's prime rice producing area, soil erosion is now rampant in some areas due to inappropriate cultural practices on the watersheds. As a result, many paddies are now experiencing severe siltation problems. Rainfall has been decreasing from an average of 1547mm between 1931 and 1960 to 1007mm in 1986-1987.

Soil structure in the region is generally weak with a low water holding capacity and they are extremely susceptible to erosion. Soil fertility is low where the natural vegetative cover has been removed and where the fallow period has been shortened or absent. Soils are generally acidic and given the region's higher rainfall, acidification progresses rapidly once the soil cover is removed. The cost of restoring these soils once acidified can be extremely high.

3.1.3.2 On-Station Research (Djibélor)

Since 1985, ISRA/DRPF in collaboration with ILCA, has been conducting provenance tests on 13 provenances of Gliricidia seoium. The objectives of the test are to determine the growth rates of the various provenances, the effect of the "green manure" obtained through litterfall on soil fertility, and to determine optimum harvesting dates. The best provenances have been identified and are now established in a seed orchard.

Alley cropping research is also being conducted at Djibélor with Gliricidia sepium and Leucaena leucocephala. The objective of the research is to determine if alley cropping is an alternative to shifting cultivation/reduction of fallow periods. Tests are also being conducted to determine alley cropping's influence on fertilizer uptake and soil evolution. The experimental design is eight treatments and four repetitions as described in Annex 1.

3.1.3.3 On-Farm Research (Boulandor)

Prescriptions for on-farm research/village selection stem from ISRA/DRPF and the Agrarian Systems Team. On-farm trials include:

study of the influence of wooded vegetation strips (E. camaldulensis, G. sepium and L. leucocephala) on crop productivity and soil erosion.

- on-farm alley cropping between line spacing trials with G. sepium.

- initial research on improved fallow systems with the annuals Teohrosia SDD. and Crotalaria SDD. and the woody species A. mangium and A. holosericea.

Research • development type activities include:

training of one village nurseryman and one village fruit tree "grafter".

establishment of a 1 ha mango orchard. The site is initially fenced with wood stakes in order to protect a live fence of A. mellifera for the first 1-2 years[3].

on-farm hedgerow trials - Jatropha curcas, Erythrina senesalensis and Moringa oleifera (by cuttings); A. albida and Z. mauritiana (by direct seeding); and Z. mauritiana and D. melanoxylon (by seedlings).

protection of natural regeneration (by staking) on a number of species including A. albida, P. africana and Tamarindus indica.

amenity[4] plantings in the village.

3.2.3.4 Comments/Observations

On-station alley cropping trials: Considerable data has been collected on these trials to date, but the results/conclusions will not be available until the end of 1988. Since these are the first "true" alley cropping trials to be conducted in the Sahel and outside of IITA (and of considerable importance to the Casamance region), ISRA/DRPF needs to carefully evaluate and statistically analyze them. The design of the trials is not overly complicated, but future trials should probably be separated by species and blocked for soil and slope if necessary.

Spacing: More attention needs to be given to between and within row spacing. As stated earlier, there will of necessity be a compromise between the spacing required for optimum crop and tree production and what the farmer will be able to establish on his fields.

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[3]The physical quantity of wood used in the fence indicates that firewood is not a problem in the area.

[4]Shade trees, lining roads, etc.

On-farm alley cropping spacing trials: While ISRA/DRPF will undoubtedly gain some important information from these trials, the results will not be valid since spacing was not selected at random but systematically. The protocol for measuring crop production was initially to be done systematically as well (1 15 m² plot in the middle) but following discussions during this mission, harvest sites will be selected at random, thereby adding a degree of credibility to the results.

Vegetation bandq: ISRA/DRPF calls these "bandes anti-erosifs", but their ability to stem soil erosion- since they have been established on fallow fields where erosion is practically nil- can be questioned. (In fact, the predominant use of E.camaldulensis may enhance soil erosion, as the species tends to eliminate vegetative cover and channels the water rather than slowing it down and "spreading" it.)

The real erosion problem in the Casamance arises from the traditional practice of tilling fields parallel to the slope. ISRA/DRPF needs to change its focus in this critical area from vegetation strips to contour land preparation and simple "passive" erosion control measures such as debris strips, and/or grass strips with or without trees. An on-farm study of the effect of alley cropping on soil erosion appears warranted since this method of soil protection has proven to be successful in other countries.

Leucaena leucocephala: While this species grows quite well in the lower Casamance, its use on-farm appears extremely problematic due to browsing. Basically, the local animal population appears to prefer leucaena to all other species. DRPF attempts to protect the species in the vegetation strips by using wooden "cages" will more than likely result in using more wood than the strips will eventually produce.

Other potential alley cropping species: Given the potential problems with L. leucoceohalq on-farm, it is suggested that ISRA/DRPF explore alternative tree species. Of particular interest would be Calliandrq calothrysus, Casuarina eauisetifolia,[5] Sesbania grandiflora (or S. sesbans) and perhaps some local fast growing N-fixing trees such as Albizzia SDD.

Improved fallow systems: The continued use of Teohrosia spp. and Crotalaria SDD. is recommended. These species have proven quite beneficial in Rwanda in increasing soil organic matter content. However, rainfall will ultimately determine the success or failure of these species in the Casamance.

The use of the Australian acacias in improved bush fallow systems should be discontinued. A. mansium is known to be allelopathic and farmer experience with A. holosericea in Thienaba (Khayes) indicates similar potential. However, research on improved bush fallow systems appears to be warranted in the Casamance and elsewhere in Senegal. It is therefore

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[5] An agroforestry project in Kenya has had particular success with this species in a similar environment. The problem is that it does not coppice and therefore has to be completely replaced after harvest.

suggested that ISRA/DRPF, in collaboration with the villagers, identify local species (e.g. site indicators, good pioneer species, etc.) which may be planted or sown in order to advance succession and reduce fallow periods. During the course of the visit, the villagers identified several species (unknown to this writer) which appear to have considerable potential. ISRA/DRPF should take advantage of indigenous knowledge systems in this important area.

Ronier palm: Discussions with the villagers indicated that they were dismayed with the rapid disappearance of the ronier palm and the dieback of the mangroves. While little can be done with the latter, perhaps ISRA/DRPF could initiate a small ronier palm plantation effort, at least for future Boulandor generations. Methods of propagation of the species need to be explored, however.

On-farm hedges: ISRA/DRPF has had considerable success with the reintroduction of Morinsa oleifera, a multi-purpose tree used for fodder, fencing, fuelwood, food, and medicinal purposes. The species had apparently all but disappeared in the area and its cultivation in the form of a hedgerow deserves special attention.

Research vs. Develooment: As in the case of the other two areas, many of ISRA/DRPF's actions at Boulandor are development rather than research oriented. However, in the case of Boulandor, the villagers appear to be particularly receptive to new ideas/techniques, etc. However, some of these techniques, such as vegetation bands, will have little if any impact in spite of the many hours of village labor that went into their establishment. ISRA/DRPF's key in conducting on-farm research in Boulandor will be to sustain a high level of village/farmer interest in agroforestry activities without jeopardizing the confidence of the villagers towards DRPF staff as a result of inappropriate technologies.

4.0 SUGGESTIONS FOR STRENGTHENING ISRA/DRPF'S AGROFORESTRY/NATURAL RESOURCE PROGRAM

4.1 Determination of Agroforestry (and Forestry) Research Priorities

The DRPF's agroforestry research priorities are for the most part well-defined [6]. However, given its limited staff and budget and considering the wave of interest in agroforestry, donor and individual researcher interests in the future may complicate priority determination.

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[6] With the somewhat arbitrary exception of nematocide and anti-desiccant research. Additionally, as Gold (1987) points out, a large proportion of DRPF research consists of species introduction trials leftover from a variety of projects. Limited resources require ISRA/DRPF to evaluate these trials and eliminate those that are no longer of interest to current priorities.

In order to assist ISRA/DRPF, Annex II provides a list of "Suggested Criteria to Prioritize Research Needs" adapted from Wadsworth (1983). The key to using these criteria is the notion that the best applied research stems from local participation in problem identification and research design and implementation, and not from a top-down predetermination of research needs.

4.2 Linking Research with Policy, Prices and Institutions

For the time being, most of ISRA/DRPF's research focusses on biological aspects and neglects the socio-economic and institutional context and the macro-economic setting. The development of successful agroforestry and related technologies requires that biological and socio-economic on- station and on-farm research be linked to broader economic and policy issues. Several examples of the importance of this linkage in Senegal can be cited.

4.2.1 Markets

Studies by the USAID-funded Senegal Reforestation Project indicate that there is virtually no demand/market for Eucalyptus SDD. (or other) poles greater than about 10 cm in diameter. This is supported by the experience in the Bayotte "forêt classée" where DRPF staff were unable to market the poles (20cm diameter) from a coppicing trial. Nonetheless, most DRPF research on Eucalyptus SDD focusses on the rotation periods required to maximize wood production rather than rotations for diameter/market considerations.

A similar problem exists with gum arabic (Acacia senesal). Despite considerable donor and GOS inputs into gum arabic plantations, the program is unsuccessful due to depressed world prices, tribal differences over harvesting and marketing rights and the fact that traditionally, Senegalese have never grown gum arabic as a crop as is common in other countries[7]. Tree tenure also appears to be a problem particularly in the Northern Peanut Basin.

4.2.2 Land and Tree Tenure

Under Senegal's current forest code all trees belong to the State and farmers must have permission from a local forestry agent[8] to harvest them. Currently, a new forest code, which has been awaiting approval from the National Assembly for over two years, provides for some transfer of responsibility for tree planting and harvesting from the national to the local, or at least community level. However, it is unclear how the code will address private/individual tree planting activities which are necessary for agroforestry program success. As the revised code has been

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[7] According to Mark Freudenberger, UC/Berkeley.

[8] In most cases, considered to be "policemen" by the farmers rather than extension agents.

before the National Assembly for over two years, chances that it will appear in its original form appear slim according to most Senegalese officials.

Additionally, a hypothesis currently being formulated by some Senegalese and expatriate foresters is that given that a new forest code will eventually be instituted, wealthy or better educated farmers are planting more trees (or protecting natural regeneration) than poor farmers in order to position themselves for the day when tree establishment may be equated with security of land tenure. This may partially explain why A. albida is declining in some areas of the Peanut Basin while increasing in number in other areas.

4.3 Suggestions for Expansion of ISRA/DRPF'S Current Program

The following areas require significant additional attention by the DRPF over the next several years.

4.3.1 Erosion Control (water)

Research on dryland water management techniques presents opportunities for the development of technologies which may have both short and longer term impacts on crop production. Considerable practical knowledge and research data are currently available from the Sahel and other countries which ISRA/DRPF might use to build a more cohesive watershed management program. Of particular interest and relevance to Senegal are:

Water harvesting techniques: - i.e., micro-catchments, diguettes, etc., which are capable of capturing rainfall and runoff and channeling it to a specific area for storage and plant use. On-farm research in Yatenga, Burkina Faso indicates that water-harvesting techniques have the possibility of "extending" the rainy season by up to three months. While labor intensive, these techniques have been widely accepted by farmers in the Yatenga area. While primarily intended for agricultural crops (sorghum and millet), trees have been successfully introduced into these systems in Burkina.

- Soil Structure Imorovement: ISRA/DRPF is currently working on a number of techniques to increase soil organic matter content, including alley cropping and line plantings. However, one area that deserves particular attention is improved bush fallow systems and the use of green manure. Some work has begun on this topic, but much more needs to be done.

Soil Preparation and Passive Erosion Control Techniques: Techniques that show considerable promise include contour plowing, tied ridges[9] and post-harvest plowing. Research and development are quite advanced on these techniques in the Sahel

[9] ICRISAT has an excellent tied ridge program in Burkina Faso.

but may need to be adapted/tested to the conditions of the Senegalese farmers. This implies a very strong role for ISRA/Agrarian Systems Teams. ISRA/DRPF's role in this type of research will obviously be limited. However, the DRPF could make substantial contributions to the development of other on-farm erosion control methods such as debris strips, and more active methods such as grass strips (with or without trees) and alley cropping. The point is that research in these areas must be inter-disciplinary.

4.3.2 Erosion Control (wind)

On-farm windbreak research in the Maggia Valley in Niger indicates that the use of single line Azadirachta indica (neem) windbreaks can increase millet yields by up to 30% while providing a substantial source of income through the sale of poles and firewood. Research has shown that windbreaks significantly reduce plant stress during the critical time of sowing/germination and that survival of young plants is improved due to reduced damage from moving sand.

Research in Sudan and Egypt has also shown that windbreaks and shelterbelts can substantially reduce evaporation from irrigated perimeters as well. This may have particular significance in the Fleuve area in the near future.

ISRA/DRPF has some windbreak trials near Podor and Ndimb Taba, but they were not visited during this mission. However, before expanding its windbreak program, ISRA/DRPF should address several questions:

Determination of soil types most prone to wind erosion and selection of the best multi-purpose species for the soil type.

Determination of the optimum planting configuration and species mix with particular reference to protection of the windbreaks from browsing during initial establishment.

Determination of the optimum harvesting schedule and technique for the particular tree species.

4.3.3 Natural Forest Management

The emergence of natural forest management as a technique for fuelwood production is only beginning to gain some recognition in the Sahel. However, almost all of the fuelwood in the Sahel as well as many secondary and tertiary products corne from the natural forests and woodlands. While these forests have been used for multiple and sustained purposes by rural people over the centuries, little has been accomplished in terms of research on biomass productivity, cutting yields, rotations as well as socio-economic considerations involving use of forest resources. However, research in Niger (USAID's Forestry Land Use Planning Project- FLUP) indicates that when rationally exploited, natural forests and woodlands can

be more productive than traditional Eucalyptus spp. block plantations while yielding a, wide variety of other economic benefits from secondary and tertiary forest products not found in intensive plantation culture.

Additionally, research on the FLUP project indicates that the key to "rational" management of natural forests and woodlands is the involvement of local people in the decision making process, and transferring management responsibilities from the capital city to the local population.

However, these type of actions are in direct conflict with Senegal's current natural forest management strategy of "mise en defense" and enrichment planting strategy. 1t has generally been proven (Burundi and Kenya) that it is impossible to keep the rural population from using protected natural forests (forets classees). Moreover, evidence is accumulating that increased yields obtained through enrichment plantings do not cover establishment costs (South America, Burundi).

Considering that Senegal has over 50 "forêts classées," most of which are severely degraded, a small pilot natural forest management research project, similar to the FLUP project in Niger, could be initiated in a foret classee near one of ISRA/DRPF's stations or villages.

4.3.4 Supporting and Component Research

ISRA/DRPF's collaboration with other research institutions such as ORSTOM appears instrumental in providing the basic research for improved agroforestry systems. ORSTOM/DRPF has already made substantial contributions in isolating effective rhizobial strains for Prosopis spp., Albizzia spp., and Leucaena leucoceohala which have been incorporated into many of the DRPF's on-station and on-farm trials.

Time did not permit a review of ORSTOM's research nor a review of ISRA's crop production/soils/agronomy research, and its relevance to the agroforestry program. However, of particular interest to DRPF's current program would be research on tree-plant water relationships, the allelopathic potential (positive or negative) of agroforestry tree species, research on Frankia spp. for Casuarina spp., the potential for use of vesicular-arbuscular mychorrizae (VAM) on agroforestry species as a means of enhancing water and phosphorus uptake, as well as additional work on the impact of trees on soil characteristics such as moisture content, organic matter content, temperature, structure, infiltration rates, etc.

ORSTOM will also be adding a micro-propagation (tissue culture) lab to its facility and it is foreseen that this will also play an important role in the development of more viable agroforestry systems through the propagation of genetically superior material.

4.4 Suggested Areas for Additional Long-Term Training

In addition to the two candidates currently scheduled for long term training in genetics and agroforestry, long-term training in the following areas would contribute substantially to a more problem-responsive DRPF.

Forest/Natural Resource Economist: The DRPF is in desperate need of an economist capable of addressing both micro (farm issues) as well as the aforementioned macro-economic policy issues. One of the complaints most often heard about ISRA/DRPF is that research priorities and technologies developed in ISRA/DRPF have been done with little regard to their financial and economic viability. In particular, it is feared by many "development" foresters that some of the more intensive agroforestry technologies may not be viable, based on farm labor and capital constraints. ISRA/DRPF' first priority in terms of long-term training should be to fill this post[10]. Michigan State University has excellent agriculture and natural resource economics programs.

Social Forester/Rural Sociologist: On-farm socio-economic conditions, constraints and opportunities on the research and development of improved agroforestry systems was to have been the responsibility of ISRA/DSAEA in the original FAC-funded agroforestry project. However, for a number of reasons, as will be discussed later in this report, the Systems Teams have had relatively little input in terms of agroforestry research and development. For this reason, the author suggests that ISRA/DRPF make every effort to "acquire" and train its own "social forester". Again, MSU could provide this type of training.

Watershed Management/Soil Erosion Soecialist: ISRA/DRPF's program would benefit considerably by a person specialized in arid land watershed management/soil erosion control. Washington State University and the University of Arizona both have good programs for this specialization.

Windbreaks/Shelterbelts Soecialist: Again, the DRPF's program would be considerably strengthened by the addition of a MSc-level researcher specializing in windbreaks and shelterbelts. The Universities of Kansas and Nebraska (and most "plains states" universities in the U.S.) all have excellent windbreak/shelterbelt programs.

Natural Forest Management Specialist: Long-term training in natural forest management should be oriented away from the traditional U.S. focus on plantation and monocultures and instead concentrate on sustained yield and multiple use of natural forests. Yale and Oxford (UK) have natural forest management programs that might be worth exploring.

4.5 Short-Terra Training

The following short-term training activities would contribute directly to DRPF's immediate needs:

- Natural Forest Manasement: A visit to the FLUP project in Niger by Ibrahima Thomas.

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[10] Note that ISRA/DRPF at one time did have a forest economist on their staff but economists are in such high demand in Senegal that he resigned for more lucrative employment.

Forest Administration Short-course: This course is sponsored by USDA/USAID's Forestry Support Program (FSP). It is intended for top level forest administrators and researchers and would present an excellent opportunity for the Director of the DRPF to strengthen his research administration skills. Brochures on the course should be available at the AID Mission or through the Forestry Support Program.

Manipulation and Analysis of Systems Teams Data: Should the difficulties involved in the intra-departmental use of this data be resolved, it is suggested that the DRPF request USAID assistance to organize a workshop for already computer-cognizant DRPF staff in the manipulation and analysis of Agrarian Systems Team data.

4.6 Collaboration with the IARCS.

ISRA/DRPF's experience with ILCA in the provenance testing of Gliricidia sepium has been very favorable with benefits occurring on both sides. ISRA/DRPF gains experience in provenance testing, experimental design and seed orchard development while ILCA benefits from an extended national presence. It is suggested that the DRPF explore with ILCA the possibility of provenance testing of other forage species, including A. albida.

ISRA/DRPF should also explore collaborative research arrangements with IITA, ICRISAT/SAFGRAD and ICRAF. For example, IITA is currently attempting to strengthen its own alley cropping research program by developing stronger linkages with national research institutions.

USAID is currently financing a major portion of ICRAF's Agroforestry Research Network for Africa (AFRENA) project. While the first phase of this project was to concentrate on Africa's bimodal highlands, the second phase will focus on the arid and semi-arid areas. Furthermore, the author understands that ICRAF and ICRISAT have entered into a collaborative agreement for supporting national agroforestry research in the Sahel. ISRA/DPRF should explore this possibility as well.

4.7 Information/Documentation

There is currently a very low level of information exchange between Senegal and other Sahelian countries. This is particularly distressing because of the many similarities in sector problems that exist among these countries. While there is no substitute for site-specific research, there is a great deal that can be learned both in terms of approaches to problem solving and in basic technologies which transcend national boundaries. As a result, the DRPF library is several years out of date in both Sahelian and other relevant literature.

The author has developed an annotated bibliography on agroforestry in the Sahel which was supposed to have been forwarded to ISRA/DRPF but was not available during the course of the mission. Another copy will be forwarded

to both USAID/Senegal and DRPF in order that photocopies of the more relevant materials can be provided to DRPF. DRPF should also request support from USAID for subscriptions to relevant scientific journals such as Agroforestry Systems Journal and International Tree Crops Journal. (MSU's Forestry Department could ensure that photocopies of other relevant literature is made available to the DRPF over the remaining life of the project.)

Finally, while the francophone-anglophone issue remains a critical issue in information dissemination, it is understood that the USAID Africa Bureau NRMS project will provide funding for the translation (English-French, French-English) of documents, articles and reports which have wide application. ISRA/DRPF and USAID/Senegal should be able to benefit from this relatively new "innovation" in information exchange.

4.8 Short-term Technical Assistance

During the course of the author's visit to ISRA/DRPF's field stations and on-farm research sites, the most pressing need for short-term advice is in the area of experimental design and statistical analysis of results. In almost every trial, at least one of the four laws of simplicity, randomization, replication and control was broken.

'DRPF should request USAID to provide the services of a consultant to conduct a 2-3 day workshop on agroforestry (and other) experimental designs and on their statistical analysis. This consultant should spend an additional 3-4 days working with individual researchers on developing appropriate designs for the next season's trials.

5.0 THEMES FOR DISCUSSION BY ISRA'S SCIENTIFIC AND TECHNICAL COMMITTEE

In the context of strengthening ISRA/DRPF's research program and in addition to the issues and recommendations discussed above, two additional themes require the attention of ISRA's Scientific and Technical Committee: intra and inter-agency collaboration.

5.1 Intra-Agency Collaboration

5.1.1 Problems

Gold (1987) provided two suggestions for improved ISRA intra-agency collaboration; improved project design protocols and research design for rural development. ISRA/DRPF has made considerable progress in implementing these suggestions. Planned experiments address national priorities and focus on key problems, as well as permit a certain continuity or follow-through, albeit dependant on external funding.

Feedback on research is now enhanced through a series of monthly meetings in which DRPF scientists present the results of their work. However, interna1 review of design protocols, at least in agroforestry,

still appears problematic and perhaps contributes to the generally poor experimental designs and analyses.

ISRA/DRPF has also made considerable progress in moving research from the station to the farm, thus enhancing its potential contributions to rural development. However, station-farm linkages are weak in certain regions, financial analyses are almost never conducted on technologies, and many of DRPF's on-farm actions are better classified as development rather than research activities.

While DRPF is working to alleviate some of these problems, one of the major stumbling blocks in conducting more appropriate on-station and on-farm research has been a lack of collaboration between ISRA/DRPF and the ISRA/DSAEA Systems Teams in diagnosis, research design, implementation and evaluation. While the Systems Teams did provide some assistance to the DRPF in Boulandor and in Sinthiou Kahel, it was done more on a persona1 and informa1 (ad hoc) level than by any forma1 obligation.

Issues in achieving closer collaboration include:

Different Geographic Priorities: DRPF's and DSAEA's geographical (regional and village) priorities do not coincide. For this reason, DSAEA was unwilling to collaborate with DRPF in the "diagnosis" of the Khayes village. However, the village and area in general are representative of production and natural resource problems in the Peanut Basin as well as being the prime Acacia albida - millet zone.

Difficult access to DSAEA Data: Currently, at least in the Casamance, DRPF must pay DSAEA for the analysis of the Systems Team's diagnostic data. DSAEA will not provide DRPF with the data disks for interna1 use/analyses although DRPF researchers are competent in a wide variety of computer applications. DSAEA's apparent fear is that DRPF (and other ISRA departments) will use this data to "publish" reports and papers prior to the Systems Teams. Research rivalry and the push to publish are academic problems that a nascent research institute can ill afford.

Additionally, while the Systems Teams' diagnostic approach was to have been a compromise between the "rapid appraisal" method favored by U.S. farming system experts and the lengthy survey method prescribed by the French, most diagnostic surveys now exceed two years and in some cases are approaching five years as in the case of the Fleuve region (Montagut 1988). Delays of this length can hardly be justified in the context of Senegal's rapidly declining natural resource base.

A contributing problem is DSAEA's reluctance to initiate on-farm activities prior to complete data analysis and publication. As a result, diagnostic information may not be valid in a particular village by the time the data have been analyzed and published.

No Systems Team Follow-up: Farming (and agroforestry) systems research needs to be inter-disciplinary in both the diagnostic and the research design and implementation phases. However, it appears that in the

case of the Systems Teams, the diagnostic phase is inter-disciplinary but that the research design and implementation (and evaluation) phases are not. Diagnostic results are simply given to single discipline researchers for implementation. According to DRPF officials, there is no "systems" input into the research and development process once the diagnosis has been completed causing some to refer to the process as "diagnose and disappear".

Cropping System vs. Farming System Focus: As is the case of most farming system activities in sub-Saharan Africa, ISRA's farming systems research can be more aptly described as cropping systems research. The crop components are given considerably more attention than the farming system as a whole. When foresters or livestock people are omitted from the teams, the role of trees and livestock in the farming system (even if considered to be a major component of the system) are generally ignored or relegated to "second phase" studies.

5.1.2 Suggestions for Improved Intra-agency Collaboration

The resolution of the above issues can be a problematic, lengthy and costly process. Considering the extent of Senegal's natural resource and agricultural productivity problems, the question to ask is whether ISRA/DRPF can afford to spend the time and resources necessary to promote improved long-term intra-agency collaboration on agroforestry research and development or develop its own diagnostic capabilities. Thus, two strategies are available for the Committee's consideration.

In the first approach, ISRA/DRPF could move gradually toward the recruitment and training of its own agroforestry systems team composed of a forestry/agriculture economist, an agronomist, a forester/agroforester and a rural sociologist/social forester. Ideally, this team would be able to draw on other ISRA researchers (animal production, etc.) when particular situations warrant. This team would be responsible for all agroforestry diagnosis and design activities and would backstop all subsequent on-station and on-farm research, including monitoring and evaluation activities. The team would be located in Dakar but would travel to all regions for backstopping purposes. Additionally, the team could be made available to the numerous DCSR projects on a time available, contractual basis.

An alternative approach which may at least alleviate some problems in the short-term and lay the groundwork for improved longer-term collaboration would focus on stronger joint programming. In this approach, it is suggested that:

> ISRA's Scientific and Technical Committee address the issue of priority regions for the DSAEA and the DRPF. If DSAEA and DRPF were at least operating in the same regions, some degree of collaboration could probably be obtained at least at the informa1 level.
>
> DRPF should be involved in all diagnostic activities conducted by the DSAEA. While this may detract from DRPF's current activities, DRPF participation is seen by this author as an

investment in the development of agroforestry technologies more appropriate to farmer needs. In short, the investment should pay considerable benefits over the long term.

DSAEA make all diagnostic data and analyses available to the DRPF within a timeframe that reflects the need to act while farmer interest is high. Alternatively, DSAEA data disks should be made available to DRPF researchers. As previously stated, a short course in systems data analysis may be appropriate for DRPF researchers.

Questions regarding the length of the diagnostic process as well as the lack of inter-disciplinary follow-up in the farming systems research process are beyond the scope of this report, but are nevertheless topics with the Committee should address. The issue to keep in mind is that the financial and economic costs and benefits of both of these approaches need to be carefully weighed beforc any decision is reached.

5.2 Inter-Agency Collaboration

While not specifically called for in the mission's terms of reference, another major problem that ISRA's Scientific and Technical Committee needs to address is the lack of collaboration between the DRPF and the DCSR[11]

5.2.1 Problems

Annex III provides only a partial list of DCSR projects. Out of these 21 activities, DRPF is only involved in three[12]. Considering the proximity between the DRPF and the DCSR in Hann, visits between DRPF and DCSR project and administrative personnel are rare. Some of the stated reasons (real or imagined) for this lack of collaboration include:

"ISRA/DRPF does too much on-station research and their results are not applicable in the real world";

"the results of ISRA/DRPF's research are never communicated and when they are, they are never in a form which can be used by DCSR agents";

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[11] Note that there is little collaboration among DCSR projects, but a planning/coordination project currently being designed by FAO will no doubt alleviate this situation. While FAO envisions a role for ISRA/DRPF in this project, details are not yet available.

[12] Plantations Irriguees dans la Vallee du Fleuve, Projet d'Amenagement et de Reboisement des Forets du Centre-Est, and Projet de Reboisement Villageois in Louga.

"given its location in the Ministry of Rural Development, ISRA/DRPF is isolated from the DCSR and any real world problems. DRPF needs to be brought back under the MPN[13];

- "ISRA/DRPF researchers are not interested in the administrative/"negotiative" aspects of collaboration, preferring research to all other activities";

"there is no financial or economic analysis of any of ISRA/DRPF's research activities. How do we know what the financial incentives to the farmer are?"

Evidence of this lack of coordination is apparent in the activities of both organizations. As previously stated, many of the DRPF's on-farm activities are more development that research-oriented. Similarly, many of the DCSR projects contain a research component, although as the Directorate of the DCSR stated, these research activities are often a result of donor-imposed bilateral requirements. However, DRPF is usually never consulted on these project-related research activities. As a result, there is much duplication of effort between the DCSR and the DRPF, a tendency to "reinvent the wheel" and a tendency for the DCSR to focus on technologies and species which the DRPF has already determined to be inappropriate.

The case of collaboration in agroforestry research and development has its own unique set of problems. Agroforestry to many DCSR officials means everything from composting to village woodlots to the planting of any combination of crops and trees. For example, in some areas, the DCSR is advocating the intercropping of E. camaldulensis with manioc. The use of these two species in combination will render the site completely useless for any future agriculture or forestry activities.

As difficult as it might be, scarce financial and intellectual resources in Senegal require close collaboration between the DCSR and DRPF. DRPF should be able to draw on DCSR projects to help define and refine its research priorities. DRPF should be able top provide the projects with concrete applied results. Increased collaboration would also avoid duplication of effort by allowing the DRPF to fulfill its research mandate while allowing the DCSR and projects to use their resources on other priority areas.

5.2.2 Suggestions for Improved Inter-Agency Collaboration

A Research-Extension Workshop: An attempt was previously made by the DCSR to address research-extension linkages in a one day workshop in Sokone in April 1988. However, research-extension linkages was only one of five agenda items and as a result, there has been very little follow-up to

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[13]Note that bringing DRPF under the MPN would even further distance it from ISRA's other departments, particularly agriculture/DSAEA. The costs and benefits of such an action need to be carefully weighed.

workshop recommendations[14]. Given this situation, the author suggests that ISRA/DRPF and DCSR consider conducting a more in depth research-extension workshop which would serve to:

> bring together representatives of all forestry-oriented organizations in Senegal having a research interest;
>
> encourage a high level of collaboration and cooperation among these organization both in Dakar and in the regions;
>
> work out additional means for increasing research efficiency both within and among members of the forestry community.

A similar workshop was conducted in Kenya in 1983 where research - extension linkage problems were very similar to Senegal's. Rather than discuss this workshop in detail, a copy of the proceedings will be forwarded to the DRPF for review and consideratiun.

DRPF Actions: DRPF needs ta take the initiative in establishing contacts with DCSR projects. An initial small investment of DRPF time and resources will more than likely have considerable medium and longer term benefits[15]. Furthermore, this type of collaboration needs to be done from the bottom-up and not through any sort of higher level decree. In a similar vein, ISRA/DRPF needs to assess the potential and constraints of its current collaborative efforts with DCSR in view of documenting successes and alleviating future problems.

Research Coordination: DCSR needs to at least "pass" all project implemented research activities to DRPF for comment. Even if DRPF cannot participate in these activities due to time and resource constraints, the DRPF needs to be aware of what's going on and have the opportunity to provide comments and suggestions.

DCSR Agent Rotation: Another potential means of enhancing collaboration between the DCSR and the DRPF would be to have the DCSR agents spend up to two years of their professional careers in the DRPF as research assistants as part of DCSR's normal rotation system. This would have the advantage of familiarizing DCSR agents with DRPF research which would hopefully carry over into the agents professional careers with DCSR.

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[14]The workshop stressed the need to create research committees involving project directors, the "chefs d'inspection" and regional DRPF researchers in order to better formulate regional research priorities. However, to the author's knowledge, regional reports and recommendations have not as yet been forthcoming.

[15]Note that ISRA/DRPF was to have participated in USAID's Cereals II project but negotiations broke down when a request for vehicles by DRPF was denied. Collaboration, if only on a small scale, should corne before material needs in most cases.

Increased DRPF Communications: The complaint that DRPF does not present its research findings in a form which can be utilized by technicians appears to have some validity. it is therefore suggested that DRPF publish some "how to" manuals in French and Wolof based on the results of past and current research programs. A simple manual on appropriate agroforestry techniques/species seems particularly important.

Additionally, the DRPF should expand/continue its on-station on-farm research field days. An agroforestry field day was held in Thienaba, where project, ISRA, DCSR and other staff were invited to see ISRA/DRPF actions on the ground. This program should be expanded to the other regions and conducted on a yearly basis.

ANNEX I

SUMMARY OF ISRA/DRPF ON-STATION SPECIES-RELATED RESEARCH

ON-STATION RESEARCH (THIENABA)

1985 to Present

Living hedges - seedlings

Indigenous	Australian
Bauhinia rufescens	Acacia holesericea
Ziziohus mauritiana	Acacia tumida
Combretum aculeatum	Acacia sclorsperma
Balanites aesvptiaca	Acacia trachvcaroa
Prosoois cineraria	

Living hedges - direct seeding

Bauhinia rufescens (1 line)
Ziziphus mauritiana (2 lines-parallel)
C. aculeatum t Z. mauritiana (2 lines-parallel)
Z. mauritiana t C. aculeatum t Z. mauritiana (parallel)
Acacia mellifera t Z mauritiana (2 lines-parallel)
B. rufescens t Z. mauritiana (2 lines-parallel)

Fruit tree/field trials

Sclerocarva birrea
Parkia bislobosa
Anacardium occidentale
Tamarindus indica
Adansonia disitata
Balanites aesvotiaca
Ziziohus mauritiana

Forage species trials

Acacia trachvcarpa
Combretum aculeatum
Prosoois cineraria

1988 - Trials - species performance:

8 species and four treatments -

Balanites aegyptiaca	Parkinsoni a aculeata
Acacia tortilis	Bauhinia rufescens
Acacia seneoal	Ziziphus mauritiana
Acacia nilotica	Prosopis juliflora

Treatments include 2 methods of seed treatment (pre-germination and sulfuric acid) and with and without mulching.

ON-STAION RESEARCH (NIORO DU RIP)

Living fence trials were initiated in 1987 on the following species (all single row):

Balanites aesvotiaca
Acacia mellifera
Acacia seyal
Z, mauritiana t C, aculeatum (alternating)
Z.mauritiana t B. rufescens (alternating)
A. albida - direct seeded

Spacing within lines is 50 cm and between lines 4 m - no repetition.

In 1988, several additional species (single line, living hedges) were planted with no repetition:

Direct Seeded:

A. seneoal
A. laeta
Dalbersia melanoxvlon
Mavtenus senesalensis
Strvchnos spinosa
Prosoois cineraria

From cuttings:

Commiohora africana
Erithrvna senesalensis

In association (2 lines 50 cm diagonal spacing, no repetitions):

Combretum aculeatum + A. ataxacantha
B. rufescens t A. ataxacantha
Commiphora africana t Z. mauritiana
D. melanoxvlon t Z. mauritiana
Xvmenia americana t Z. mauritiana

ON-STATION RESEARCH (DJIBELOR)

Alley cropping trials

1. control: crops without fertilizer
2. crops with fertilizer
3. Leucaena alley cropping without fertilizer
4. Leucaena alley cropping with 1/2 recommended fertilizer
5. Leucaena alley cropping with full fertilizer
6. Gliricidia - no fertilizer
7. Gliricidia - 1/2 fertilizer
8. Gliricidia - full fertilizer

ANNEX II

SUGGESTED CRITERIA TO PRIORITIZE RESEARCH NEEDS IN AGROFORESTRY[16]

1. Urgency

   a. Leads to solution of one or more immediate, critical problems
   b. Early results to be expected
   c. High demonstration and educational value

2. Lack of Alternatives

   a. Not already solved by experience locally or elsewhere
   b. Not already being studied adequately somewhere
   c. Not likely to be undertaken soon otherwise

3. Compatibility

   a. Not incompatible with local traditions and customs
   b. Compatible with prospective land use needs
   c. Utilized familiar techniques and existing talent and skills
   d. Enthusiastically supported by affected communities
   e. Has cooperative multi-donor support

4. Returns

   a. Benefits quantifiable
   b. Contiguous intra-regionally exportable technology of utility to a large area'or population
   c. High output per unit of land area
   d. High output per unit of input
   e. Meets diverse forest product requirements, not just one
   f. Large prospective gain in foreign exchange
   g. Large auxiliary multiple benefits: food, fodder, soil and water conservation, timber, other products
   h. High leverage, large gain for small donor input

5. Residual Benefits
   a. Degree to which improved national policies a likely result
   b. Degree to which local capability to continue research is enhanced
   c. Technical training value
   d. Degree to which door opened to further research
   e. Degree to which self-propelled research is apt to continue
   f. Degree to which self-sustaining private efforts stimulated

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[16] It would be an intersting and extremely useful exercise to use these criteria to weigh ISRA/DRPF's current program. This could perhaps be achieved under ISRA's "memoir de confirmation" process.

ANNEX III

PARTIAL LIST OF CURRENT MPN/DCSR PROJECTS

NAME	REGION	DONOR
Boisements Communautaires	Diourbel	AFRICARE
Fixation des Dunes du Gandiolais	Gandiolais	CANADA/CIDA
Fixation des Dunes et Protection des Cuvettes Maraicheres	Kebemer	USAID
Gommier Gonakier Vallee du Fleuve	Fleuve	Netherlands
Gommier Podor	Podor	W. Germany
Gommiers et Reboisement Pastoraux	Mbiddi	CRDI
Plantations Irriguees dans la Vallee du Fleuve [17]	Fleuve	
Projet d'Amelioration des Methodes de Carbonisation Energies Renouvelables	Dakar	USAID
Projet d'Amenagement et de Reboisement des Forets du Centre-Est [18]	Kaffrine	
Projet d'Amenagement et de Reboisement Senegalo-Allemand	Fleuve	W. Germany
Projet Anacardier Senegalo-Allemand	Sokone	W. Germany
Projet de Boisement Villageois [19]	Louga	UN/FAO
Projet de Reboisement Villageois de Bakel	Bakel	UN/FAO
Projet de Co-operation pour la Promotion de la Verdure du Senegal	Thies	Japan

[17] ISRA/DRPF is currently negotiating a joint research-development project with DCSR for this activity.

[18] ISRA/DRPF provides assistance to this project in terms of provenance testing of Acacia nilotica and A. raddiana.

[19] ISRA/DRPF assist this project with species/provenance trials.

Projet Poles Verts	Richard-Toll	
Projet de Protection Forestiere de Casamance	Casamance	Canada/CIDA
Projet Reboisement Villageois dans le Nord-Ouest du Bassin Arachidier-Tivaouane	Thies	UN/FAO
Projet Tobor	Ziguinchor	
Reboisement Communautaire dans le Bassin Arachidier	Fatick	FAO/Finland
Reboisement, Fixation des Dunes, et Protection des Cuvettes Maraicheres du Kayar	Diander	USAID
Projet de Reboisement du Senegal	National	USAID

ANNEX IV

PERSONS CONTACTED

ANAM ____ FAO Forestry Project (and coordination)
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ANNEX V

FIELD TRIPS

September 12	DRPF Station at Thienaba and on-farm agroforestry trials at Khaye
September 14	DRPF Station at Sine-Saloum (Kaolack) and on-farm agroforestry trials at Sinthiou Kahel
September 15-17	Casamance: DRPF Station at Djibelor, on-farm agroforestry trials at Boulandor, and natural foret management at the Foret Classe de Bayottes
September 20	Gossas: collaborative field trip with ISRA/DRPF, DCSB and Projet Reboisement du Senegal

ANNEX VI

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