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FORESTRY AND ECOLOGY DEVELOPMENT
IN THE SAHEL

OVERVIEW AND PROSPECTS

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**FORESTRY AND ECOLOGY DEVELOPMENT
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EXECUTIVE SUMMARY

The Sahel ecology/forestry programme spans a wide range of considerations. The objective of the programme is to satisfy the human and animal population needs in forestry products, to maintain or improve the ecological balance, and to support agricultural development.

Prior to 1976 this sector was badly neglected. Since that time, increased assistance has been provided, although the level remains relatively low (about 1.5% of all ODA).

Of the estimated 18 million tons of wood consumed in the Sahel annually, about 90% is for fuelwood, the primary source of energy in the region. A regional fuelwood deficit is projected to occur in the next 5 to 10 years and will continue to grow unless the trend is stopped. The fuelwood problem exacerbates the land degradation problem.

Production projects have not been notably successful in recent years. Fast growing exotic species used in industrial plantations have performed only marginally better than the natural bush and such plantations have been costly. Experience in rural forestry (village plantations) has also been disappointing because of failure to involve local population sufficiently and project design mistakes.

Efforts to reduce fuelwood consumption have centered on the development and dissemination of improved cookstoves. While there is hope that this program will eventually contribute to reducing consumption, it has still not produced proven formulas for doing so. Governments should be prudent before launching wide dissemination of unproven technical solutions, because failure would be extremely costly in terms of loss of confidence and

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damage to the idea of fuelwood economy.

Work should proceed in finding substitute sources of renewable energy, but no proven technologies to do so are available. In no case should work on renewable energy serve as an alibi for neglecting the forestry sector.

The past two years, during which the CILSS/Club du Sahel have conducted the bilan-programme, exercise (sectoral reviews) has been a period of reflection and re-evaluation as projects continued to proceed in the forestry sector. Specific directions and priorities have not yet emerged from this exercise but the options are clearer: more emphasis on carrying out large-scale plantations in high rainfall zones, broadening the range of forest products taken into account in plantations, increasing emphasis on natural forest management, more emphasis on agro-forestry and agrosylvopastoral schemes within the context of rural forestry, policy reform, and more encouragement of local initiative and participation. These options will be combined or mixed in varying proportions depending on the priority accorded to them.

A badly neglected area is the question of the economics of wood and in particular the economics of fuelwood. Fuelwood is a product like millet, sorghum or rice, but the economics of fuelwood, its pricing, marketing, transportation and distribution have not received the attention they deserve. These mechanisms should be studied with the objective of identifying policy options that governments could take to reduce or change consumption and production patterns.

While it is important to carry out action on the ground, it is more important to set in motion a process for forestry development that will lead to attainment of objectives of the forestry

forestry program. Such a process must concern institutional constraints, training, policy reform, improved forestry sector planning, the role of foresters, land and tree tenure, government commitment, the social dimensions of forestry development and forestry research.

As these new approaches, in line with the biological and social realities of the Sahel region emerge, forestry development will improve and the forest resources can be directed to help meet the broader development goals of the Sahel development programme.

INTRODUCTION

The ecology/forestry program in the Sahel includes a wide range of considerations (both social and technical) and a combination of activities: protection, reforestation, regeneration of natural forests, rational use of natural resources, and integration of forestry, livestock and agriculture. The objective of the program is to satisfy the needs of the human and animal population in forestry products, to safeguard, or where necessary, improve the ecological balance, and to contribute to agricultural development.

This program has been carried out in CILSS countries on three levels:

- the local level through the traditional adaptive strategies of local populations
- the national level through forestry services
- the regional level of the CILSS/Club du Sahel framework, through coordination, analysis, study and mobilization of funds.

The work carried out since 1976 has produced some significant results:

- there is a much greater appreciation of the place and the role of the forest and of wood in the physical, social and economic environment;¹
- the potentialities of forestry are better known;
- a better understanding of the policies needed and

¹CILSS has prepared and adopted a "Desertification Control Programme for CILSS Member Countries" - November 1979 which integrated previous proposals and enriched it with elements from the UNEP Action Plan. This plan is multi-faceted including satisfaction of needs, restoration of the ecosystem and rational use of natural resources.

of how to carry out activities on the ground has been acquired; and

- a significant increase in the level of financing of projects has been mobilized.

Despite the increased effort put into the ecology/forestry sector the overall percentage of assistance remains relatively modest (less than 2%). But, the average annual rate of growth of commitments to the sector has been extremely high (71% for the period 1975-82). This has provided opportunities for the expansion of sector programs, but a number of problems have been identified in the sectoral analyses (Bilan-Programmes) and other studies carried out by the CILSS/Club du Sahel.

I. A Situation For Concern

The forestry/ecology sectoral analyses conducted by the CILSS/Club du Sahel point out that prior to the 1969-73 drought, farmers and herdsmen maintained an existence in most of the Sahel which appeared to be sustainable within the limits of the natural resource system.¹ However, the drought and pressures from increased population became too much for the natural system to support. As the capacity of the land was strained, vegetative cover was lost and erosion increased. The natural environment was no longer in balance. Although fuelwood is not by any means the only problem in forestry in the Sahel, it is probably the central problem.

¹See Annex B for a list of CILSS/Club studies prepared in the ecology/forestry sector

Wood consumption in the Sahel is estimated at about 18 million tons per year (See Table 1). Of this total, 16.3 million tons is consumed to meet the region's energy needs (fuelwood) and the rest is used for poles, lumber and industrial uses. Computer modeling studies conducted by CILSS show that within the next five to ten years a regional deficit in fuelwood can be expected to occur and will continue to grow through the year 2030. (See Annex A for an extract of the main calculations of this deficit) However, the CILSS computer modelling studies also show that solutions are available and a regional deficit can be avoided and a significant surplus can be attained by 2030.

None of these solutions will be easy to implement and it will be essential that the kind of close monitoring and diagnosis that has been carried on within the CILSS/Club du Sahel framework continue to operate so that correctives can be brought to bear as the program proceeds.

As the sectoral analyses indicate, the list of areas of potential concern is long, including:

- fuelwood needs which increase with population, while supply is decreasing;
- agricultural intrusion on forested areas;
- animal browsing and the relationship of livestock to forestry;
- bush fire control;
- institutional and legal problems, including land and tree tenure;

TABLE 1 - FUELWOOD CONSUMPTION

COUNTRY (population in millions)	WOOD - ENERGY							Furniture etc. Wood (thousand tons per year)	Industrial wood (in thou- sand tons per year)	Total consumption (in thousand tons per year)
	Kg/per person/daily			Thousand tons/per year						
	Urban Sector	Semi- Urban Sector	Rural Sector	Urban Sector	Semi- Urban Sector	Rural Sector	Total			
CAPE VERDE (0.4)	0,08	0,14	0,36	3	1	25	29	2	10	41
THE GAMBIA (0.6)	2,50		3,64	137		591	728	55	7	790
UPPER VOLTA (6.1)	1,42	1,38	1,69	266	91	3.454	3.811	202	28	4.041
MALI (7.0)	0,66 ⁽¹⁾		1,00 ⁽¹⁾	600 ⁽¹⁾		2.150 ⁽¹⁾	2.750 ⁽¹⁾	280 ⁽¹⁾	29	3.059 ⁽¹⁾
	1,90 ⁽²⁾		2,00 ⁽²⁾	820 ⁽²⁾		4.300 ⁽²⁾	5.120 ⁽²⁾	510 ⁽²⁾	29	5.659 ⁽²⁾
MAURITANIA (1.5)	1,50		1,25	193		498	691	35	10	736
NIGER (5.3)	1,00		1,00	250		1.830	2.080	104	3)	2.184
SENEGAL (5.7)	1,42		1,86	1.000		2.800	3.800	640	208 ⁽⁴⁾	3.746
CHAD (4.5)				(Programme overview still to be written)						
TOTALS FOR CILSS COUNTRIES				2.449 ⁽¹⁾ 2.669 ⁽²⁾	92	11.348 ⁽¹⁾ 13.498 ⁽²⁾	13.889 ⁽¹⁾ 16.259 ⁽²⁾	1.318 ⁽¹⁾ 1.548 ⁽²⁾	292	15.499 ⁽¹⁾ 18.099 ⁽²⁾

(1) Low estimate for Mali

(2) High estimate for Mali

(3) Not available

(4) Of which 144 for paper and boxes

Source: Prepared from information in the Programme/ Overviews of the CILSS/Club du Sahel, presented to the Regional Ecology and Forestry Team - Banjul meeting, 13th-22nd October, 1982, in "Quantification of Wood needs in the Sahel countries: an analysis of the Bilans-Programmes (not available in English).

- recurrent cost problems and maintenance of projects; and
- research, particularly on the national level.

II. Experience To Date

Forestry development in the Sahel in the years following the most recent drought has been based primarily on two concerns: a concern about 'desertification' or environmental degradation that underlay the entire program on the one hand and a concern about meeting the energy needs of Sahelian populations on the other. Fuelwood is the energy source used by the overwhelming majority of that population so the economies of fuelwood and trees have been at the center of both of these concerns. The forestry program that was developed to address these concerns had four principal emphases: increasing fuelwood production, reducing consumption, improving utilization, and developing alternative energy sources with an emphasis on renewable sources. As the program has moved from the planning phase into implementation in recent years, it has become increasingly clear that initial expectations were unrealistic and that the constraints that needed to be overcome were both more numerous and more complex than originally expected. Experience to date may be summarized briefly as follows:

A. Increasing Production

Following the drought, Sahelian governments and donors alike placed great hope, considerable emphasis and substantial sums of money into the establishment of large scale plantations of 'fast-growing' exotic species designed to help meet the rapidly growing demand for fuelwood

and other wood products. Many of the assumptions on which these efforts were based have been called into question:

- the exotic species planted in such projects have not performed nearly as well as expected (in some cases only marginally better than the natural 'bush'),

- the costs of this type of intervention have soared, due in part to rising oil prices.¹

- the benefits foregone by clearing natural vegetation to plant exotics has turned out to be substantially higher than originally calculated,

- governments have found it difficult to meet recurrent costs (leaving plantations unmanaged once the funding for the projects that established them has run out), and

- the absorptive capacity of Sahelian Forest Services measured in terms of the number of hectares they have been able to plant and maintain per year has proven to be below the minimum projected to be required if future demands for fuelwood and other forest products are to be met.

As a result, other possibilities designed to meet these needs began to get increased attention. Among

¹It is impossible to advance an "average" cost for large scale plantations. In one very careful study of this question done by CILSS/Club du Sahel, costs ran from about \$750. to \$900. per hectare in Upper Volta, Niger and Mali. See Morel-Pajor Politiques Forestieres au Sahel, Sahel D(82)185 - November 1982. However, costs have been registered as high as \$5,000. per hectare in more difficult areas such as Mauritania and in dune fixation in Niger costs ran over \$3,600. per hectare.

them: rural forestry and, more recently, natural forest management. Experience to date with rural forestry has also been disappointing on the whole. Here too a number of basic assumptions have been called into question: local populations have been less enthusiastic than expected. This has been due in part to a history of relations with Sahelian Forest Services characterized by considerable antagonism coupled with a failure to adequately review and reform forest policy and legislation prior to launching rural forestry programs and a tendency for programs to be designed and implemented from the top down, rather than from the bottom up. In addition, in many instances suitable land has proved hard to find, the dispersed nature of this type of intervention has made supervision and follow-up difficult and costly, communal planting efforts have been plagued by lack of adequate attention to details of the eventual distribution of the products, and the range of species used has often been limited (with neem serving as the workhorse in most schemes and exotic species tending to predominate over indigenous ones). At the same time, the block-planting methods used in many of these projects have been alien to local patterns of land use as have the elaborate, expensive systems used for tree protection. Many efforts have been focused solely on wood production, failing to adequately take into consideration local needs for a host of non-wood forest products ranging from tree crops used as essential components of human diets through tree forage for animals, to medicinal and a range of other traditional uses for forest products.

B. Reducing Consumption

Efforts to reduce fuelwood consumption have centered primarily on the development and dissemination of "improved" wood and charcoal stoves. While there has been a flurry of activity in this area over the last few years -- with the development and dissemination of many different prototypes, each promising substantially reduced consumption coupled with social acceptability -- the process as a whole has raised more questions than it has answered: questions about the reliability and thoroughness of testing methodologies prior to dissemination, questions about the wisdom of rushing into a dissemination phase with so many different models, questions about cost, maintenance and long-term social acceptability of the various models being developed, and questions about the process being put in place to disseminate the stoves and its sustainability in the absence of external funding. Great emphasis has been placed, and continues to be placed, on the importance of the unanswered questions, however, there is a growing concern that the move from prototype development and testing to dissemination has been somewhat premature. As the Secretariat Note, prepared by CILSS for the Meeting of the Equip Regionale Ecologie/Forets in Banjul (October, 1982) notes: "Despite the priority that should be given to this activity, Governments should adopt a prudent and patient attitude, and wait until one or several technical solutions proves themselves before authorizing their wide dissemination; any error in this domaine stemming from undue haste could be harmful to the future of forestry in the Sahel countries."

C. Improving Utilization

In addition to the work underway on "improved" stoves outlined above, improved utilization has focused on improving the efficiency with which wood is converted to charcoal. Results in this area have been encouraging. After some testing of imported metal kilns it was found that modest improvements in the traditional system of production used in the Casamance could provide comparable levels of efficiency. This method is now being taught to charcoal makers across the Sahel and represents an important success in beginning to address this facet of the overall energy equation.

D. Developing Alternative Energy Sources

Although there has been a considerable work on a whole range of alternative renewable sources and technologies (solar, wind, biogas, etc.) in recent years significant breakthroughs have not yet been made. Efforts continue to be somewhat diffuse. There is a need for increased coordination of efforts in this and a role that will likely be filled by the newly-formed CEAO/CILSS regional solar energy center (CRES) in Bamako.

III. The Road Ahead

Clearly, there are a whole series of important questions that emerge from experience to date: questions as to how much has actually been accomplished on the ground, questions on the economic and social viability of these programs (including the important issues of recurrent costs and the need for active local participation), questions on the degree to which a process is being set in motion that can be self-sustaining once external funding is no longer available, questions on what lessons can be drawn from experience to date that will help to put both on-going and future efforts on a sounder footing.

The Bilan-Programme exercise, set in motion by CILSS/ Club du Sahel in early 1981, was designed as a systematic country by country sector review that examined the whole range of experience to date. In addition, special studies were commissioned on a number of issues of central importance to forestry development across the region including recurrent costs, the economics of forestry projects, forestry research, local participation and natural forest management.

At the same time, project evaluations were beginning to address some of the same questions in a more detailed project-specific context.

A. Re-evaluation Of The Forestry Programme

What has emerged is an increasingly clear sense in both the Sahelian and donor communities that there is a need to re-evaluate the direction of forestry programs in the Sahel, the speed with which they can reasonably be expected to be carried out, the sequence of interventions

needed to attain the desired results, and the overall strategy for sector development across the region.

The process of review, reflection and re-evaluation is still underway. It would be premature to expect a consensus on where future priorities should lie. Taking forestry production as a case in point, some -- with an eye on energy needs, counsel moving large-scale plantations further south into high rainfall zones (and, in special cases, undertaking pilot irrigation schemes tied to irrigated agricultural projects). Others, taking a broader range of forest products into account, propose substantially increased attention to protection and management of the existing vegetation, with emphasis on natural forest management in classified forests. Still others view rural forestry (including its current variant agroforestry and agrosylvopastoral schemes) as the key long-term solution. Many propose mixes of two or more of the above, coupled in most instances with continued strong emphasis on efforts to reduce consumption and improve transformation and utilization. Using material generated from CILSS studies currently underway on forestry projects coupled with the month-long CILSS training seminar on forestry economics and planning held in Bamako in May 1983, it should be possible for Sahelian planners to begin to narrow the options for future programs and to assign priorities to various types of interventions needed in the short, medium and long-term.

Two broad areas of priority concern will continue to be the contribution of forests to meeting energy needs and the contribution of forests and forestry to agricultural production and development. In addition, it is

expected that the linkages between forests and environmental protection will continue to be stressed.

B. Support For Forestry Programmes

An important lesson learned from the experience with forestry projects to date is that there is a need for relatively less concentration on projects per se and substantially increased attention to broader concerns that impact on project success: concerns ranging from policy reformulation through economic issues of pricing and marketing of forest products, to questions of public administration involving the training and incentive structures for Forest Service personnel.

Clearly, much more emphasis needs to be put on the economics of wood and fuelwood, its marketing and distribution. Fuelwood must be viewed as a product like millet, sorghum or rice. The pricing and marketing mechanisms of fuelwood need to be studied in a similar manner as food crops are studied so that appropriate policy options can be identified.

Experience to date has clearly indicated the need to sort out the process through which forestry development is to be undertaken without worrying unduly about the number of trees or hectares planted. The successful implementation of a particular project or set of projects should not be confused with 'successfully solving the problem' or even necessarily setting in motion a process that will eventually 'solve the problem'. While the concern that talk about forestry needs to be translated into concrete action on the ground continues to be a valid one, an excessive preoccupation with project outputs can serve to confuse short-term objectives with long-term goals. In other words, what must

be examined is not simply how much is achieved (or not achieved) in quantitative terms, but how it is achieved and whether or not a process has been set in motion that will likely be continued in the absence of external funding. As such, careful attention needs to be devoted to the strategy of project expansion as well as to the strategy of incorporating innovation and improvement into ongoing efforts through the linking of training and research efforts with a process of evaluation and analysis that feeds back into the planning of project activities.

C. Institutional Constraints

Another concern is a need to address institutional constraints to forestry development including work on improving planning, managerial, operational and training capabilities of forestry institutions. At the same time, specific areas of priority concern range from policy reform and government commitment to forestry development on the one hand to the need for increased attention to the social dimensions of forestry development and forestry research on the other.

D. Policy Reform

Forest policy and legislation across the Sahel are for the most part out of date and do not constructively address the changing circumstances surrounding both the relationship between foresters and Sahelian populations and the role of foresters in relation to Sahelian forests. In the former case, a consensus has been building across the region in recent years on the need for a basic transformation of the role of the Forest Service and the need for foresters to stop being rural policemen charged with the impossible task

of enforcing the current codes and start working much more closely with rural communities as technical extension agents. At the same time there is a need to remove disincentives to tree planting and other forest management activities contained in the current legislation and substitute incentives in their place. While it is clear that changes of this magnitude do not occur overnight and that there will need to be a gradual institutionalization of new approaches, it is equally clear that forestry projects have failed to date in no small measure because these issues were not faced earlier on, prior to the initiation of projects.

E. Change In The Role of Foresters

There is also a need for change in the role of foresters in relation to Sahelian forests. Current policy and the role that has emerged from it is essentially one of protection and conservation. Cutting and transport permits are sold for various forest products but there is little active management of the forest resource. The change that is called for in this case is a shift from protection and conservation to a policy of development and management. This, in turn, will require review of many facets of forest policy including, among others, pricing policies (stumpage prices, permit fees, government subsidies and fuelwood and charcoal pricing in addition to pricing policies for seedlings and other technical services), marketing (including analytical work on market structure and operations as well as an examination of possibilities for private sector involvement, forest product cooperatives and the

development of forest product-based cottage industries), possibilities for forest-based revenue generation (thought to be substantial but overlooked for the most part to date), as well as strategies for meeting the recurrent costs of operations undertaken as part of this new emphasis on forest utilization and management.

F. Government Commitment

While most Sahelian governments have emphasized the important role of forestry in their overall strategies aimed at countering the effects of the drought and promoting food self-sufficiency, the level of funds provided to the forestry sector have often been meager. Prior to the infusion of large amounts of additional external funding into the sector, this contradiction merits careful scrutiny. At question is not simply government commitment (although that is an important and perhaps telling indicator of the priority assigned to the sector), but the issue of recurrent costs and the ability of Sahelian governments to continue the programs that have been set in motion. Unless the issues of absorptive capacity and recurrent costs are faced squarely, there is a danger that project funds will serve to build government infrastructure which will in turn generate a dependency on the part of Forest Services on outside funds to meet operational expenses. It should be noted that the issue of government commitment is not simply a Sahelian issue but one that applies to the donor community as well. Given the long time horizons with which foresters and forestry projects must work, donors committing themselves to work in the sector should consider making commitments on a ten year basis at the least.

G. Social Dimensions Of Forestry Development

Results from a wide range of forestry projects undertaken across the Sahel over the last few years point to the need for more systematic attention to the social dimensions of forestry development, attention that moves substantially beyond the listing of social concerns as something to be taken into consideration in project design to a careful and sustained effort to assess 'felt needs' at the local level, priority of forestry in relation to other possible interventions, species/planting preferences to identify constraints to forestry development, land & labor availability, land and tree tenure, distribution of benefits, etc., and to outline means of addressing those constraints.

H. Forestry Research

Along with training, research is critical to a balanced forestry program. With the notable exception of Senegal, the forestry research infrastructure in place and currently operational across the Sahel is so small as to be virtually non-existent. Given the rapidly expanding portfolio of forestry projects on the one hand and the relative scarcity of tested technical packages on the other, this is a situation that cannot be allowed to continue. Forestry research is an essential prerequisite to more effective project interventions and it must be given the increased attention it deserves. Among the topics for priority consideration: the silvics and silviculture of indigenous species, the economics of natural forest management, and the identification of social constraints to the expansion of rural forestry programs.

CONCLUSION

The forestry sector has played an active and dynamic role in the overall Sahel Development Program to date. Although many projects have not lived up to expectations, lessons have been learned. A period of review, evaluation and reflection on both the lessons learned from experience to date and the nature and direction of future programs was initiated in the past two years by CILSS/Club du Sahel even as projects were being developed and increased financing sought for such projects. In fact, the CILSS/Club du Sahel have insisted that this process of reflection not serve as an alibi for refusing to finance programs in a sector that has been traditionally underfinanced.

New approaches, in line with the biological and social realities of the Sahel region, are beginning to emerge from the CILSS/Club Bilan-Programme process. They will serve to chart future directions, to put forestry development on a sounder footing and to help ensure that the forest resources of the region are used, to the greatest extent possible, to help meet the broader development goals of the Sahel Development Program.

ANNEX A

Fuelwood Estimates for the Sahel and Solutions

The following calculations are the results of a series of hypotheses on future fuelwood consumption in the Sahel and possible solutions to the fuelwood problem. They were prepared by CILSS on its computer using a Visicalc program. The data covers five countries : Upper Volta, Mali, Niger, Senegal and the Gambia. The calculations represent a level of generalization over and above national level calculations used in fuelwood projections and should only be considered as very rough orders of magnitude. For the sake of simplicity and because of lack of data parameters such as the % of charcoal use, fuelwood used in the commercial/industrial sector and non-energy uses of wood are not included. With these limitations in mind, this gross analysis does show that if nothing is done to rectify the situation, a regional deficit in fuelwood in the Sahel can be expected to occur within the next five to ten years and will continue to grow through the year 2030. It also shows that solutions are available and that if the five admittedly optimistic hypotheses can be realized, a regional deficit can be avoided and a significant surplus attained by 2030.

The following table is a summary of results in thousands of cubic meters of wood. A negative (-) value indicates a deficit.

Year	1982	2000	2030
Current trend (supply less consumption)	2,578	-7,656	-37,390
Hypothesis 1	2,618	-7,256	-36,390
Hypothesis 2	3,001	-1,570	- 8,618
Hypothesis 3	3,036	-3,330	-28,350
Hypothesis 4	3,420	2,356	- 576
Hypothesis 5	3,607	4,630	6,366

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An explanation of the hypotheses is as follows :

Hypothesis 1 -

This shows the result of increasing supply by establishing new plantations at the rate of 10,000 hectares per year (100 km²) times an annual yield of 2 m³/ha/yr (200 m³/km²/yr). It is assumed that exhausted plantations are replaced during the 50 year period. The program assumes that plantations at the beginning of the program (presumably from previous years) have begun to produce. As one can see, plantations do not make much of a dent in the deficit i.e. in the year 2000 instead of a deficit of 7,656 thousand m³ it could be 7,256 thousand m³, an insignificant reduction of the deficit.

Hypothesis 2 -

This hypothesis calls for a decline in per capita consumption calculated at the rate of 1 % per year through the year 2030. This estimated 1 % reduction could result inter alia from the introduction of improved wood stoves, increasing fuelwood prices, and longer distances travelled to gather wood. Clearly, this parameter does more to reduce the deficit than any other.

Hypothesis 3 -

This hypothesis calculated the results of improving the yield of natural woodland (30 m³/km²/yr) by 1 % per year by applying improved management techniques and protection through the year 2030. This may be optimistic, but it reflects some thinking being done at the Bandia Research Station (Senegal). It is significant to note that improving yields of natural woodlands by 1 % per year has a much more significant impact on reducing the deficit than does the planting of 10,000 ha per year under Hypothesis number 1.

Hypothesis 4 -

The fourth hypothesis shows the results of adding hypothesis 2 and 3.

Hypothesis 5 -

This hypothesis assumes the introduction of substitute sources of energy to replace wood at the rate of 0.5 % per year through the year 2030, representing 25 % use of substitute fuels introduced gradually over the 50 year period. Results are added to hypothesis 4.

An explanation of each line in the following table is as follows :

1. Rural population

The rural population starts at 20 million in the year 1981 and increases at a rate of 2 % per year through the year 2030 where it reaches 53 million.

2. Urban population

The urban population starts at 5 million in 1981 but because of in-migration from rural areas, it grows at a rate of 3 %/yr reaching 21 million by 2030.

3. Rural consumption

Rural consumption is assumed to be 0.75 m³/person/yr. Total rural consumption is calculated by multiplying the consumption rate per person by the total rural population. This gives 15 million m³ in 1981 and 40 million m³ by 2030, probably an over-estimation because as deficits increase and prices rise, per capita consumption can be expected to decline.

4. Urban consumption

Urban consumption is assumed to be 0.75 m³/person/yr. Total consumption is calculated by multiplying the consumption per capita by the urban population. This gives 3.75 million m³ in 1981 and 16 million m³ by 2030.

5. Total consumption

Total consumption represents the sum of urban and rural consumption. It is 18.8 million m³ in 1981 and 55.5 million m³ by 2030.

6. Forest 700,000

This is the initial number of square kilometers of forested land in the five country area (Upper Volta, Niger, Mali, Senegal and the Gambia).

7. Intrusion

Here the annual extent of agricultural intrusion is calculated. It has been estimated by SAFGRAD and others at roughly 0.5 ha or 0.005 square kilometers for each per capita increase in rural population.

8. Forest - I

This is the original forest area minus agricultural intrusion.

9. Increase

This is the annual growth increment of 30 m³/km² or 0.3 m³/ha times the forest area adjusted for agricultural intrusion.

10. Clearcut yields

This represents the clearcut yields from agricultural intrusion. It is assumed that 40 % of the standing volume of 1000 m³/km² or 10 m³/ha is used for energy and that the rest is wasted. The FAO forest inventory in Upper Volta estimated the national average standing volume to be 16 m³/ha.

11. Supply

The supply is the sum of the growth increment for the forested area and the clearcut yields from agricultural intrusion.

12. Situation

This is the total supply minus the total consumption or demand assuming that none of the parameters change. This is listed as "Current Trend" in the following Table.

13. Plantations

This calculates the increase in supply due to establishing new plantations at the rate of 10,000 ha/yr (100 km²) times the annual yield of 2 m³/ha/yr (200 m³/km²/yr). It assumes that exhausted plantations are replaced throughout the 50 year period.

14. Hypothesis 1

This shows the result of the first hypothesis, i.e. planting 10,000 ha/yr and is the total supply plus plantation yields minus total consumption.

15. Result

Here a decline in per capita consumption is calculated at a rate of 1 % per year through the year 2030. The estimated 1 %/yr reduction results from a number of factors including the introduction of improved wood stoves, increasing fuelwood prices and longer distances travelled to gather wood.

16. Hypothesis 2

This is the second hypothesis which includes both the increase in plantation yields and reduced consumption.

17. Hypothesis 3

The third hypothesis calculates the results of improving the yield of natural woodland (30 m³/km²/yr) by 1 % per year by applying improved management techniques and protection through the year 2030. This is very optimistic but reflects the current thinking of the National Center for Forestry Research in Senegal.

18. Hypothesis 4 Hypothesis 2 + hypothesis 3

The fourth hypothesis shows the results of adding Hypothesis 2 and 3.

19. Hypothesis 5

This assumes the introduction of substitute sources of energy to replace wood at a rate of 0.5 %/yr through the year 2030, representing a 25 % use of substitute fuels introduced gradually over the 50 year period. The results are added to hypothesis 4.

Hypothetical Projection of Supply and Demand for Wood
in 5 Sahel Countries through the Year 2030

Year/Année	1982	2000	2025	2030
1. Rural population/ Population rurale	20400000	29136223	47801063	52776236
2. Urban population/ Population urbaine	5150000	8767530.	18357261	21281097
3. Rural consumption/ Consommation rurale	15300000	21852168	35850797	39582177
4. Urban consumption/ Consommation urbaine	3862500	6575648.	13767946	15960823
5. Total consumption/ Consommation totale	19162500	28427815	49618743	55543000
6. Forest/Forêt	700000	700000	700000	700000
7. Intrusion	2000	45681.12	139005.3	163881.2
8. Forest I/Forêt I	698000	654318.9	560994.7	536118.8
9. Increase/Accroissement	20940000	19629566	16829841	16083565
10. Clearcut yields/ Défrichement	20940000	19629566	16829841	16083565
11. Supply/L'Offre	21740000	20772163	18704392	18153221
12. Situation	2577500	-7655652	-3.091E7	-3.739E7
13. Plantations	40000	40000	900000	1000000
14. Hypo 1 : A	26175001	-7255652	-3.001E7	-3.639E7
15. Result/Efficacité	18779250	22742252	27290309	27771500
16. Hypo 2 : A	3000750	-1570089	-7685917	-8618279
17. Hypo 3 : A	3036300	-3329739	-2.244E7	-2.835E7
18. Hypo 4 : C	3419550	2355825.	-112488	-576497.
19. Hypo 5 : S	3607343.	4630050.	6027831.	6366378.

Explanatory Notes

1. Lines 1 and 2 are population figures.
2. Lines 3, 4, and 5 are in m³ of wood.
3. Lines 6, 7 and 8 are in square kilometers
4. Lines 9 through 19 are in m³ of wood.
5. The five countries include Upper Volta, Mali, Niger, Senegal and the Gambia.

ANNEX B

LISTE DES PRINCIPAUX DOCUMENTS CILSS/CLUB DU SAHEL DU
SECTEUR ECOLOGIE/FORETS

LIST OF PRINCIPAL CILSS/CLUB DU SAHEL DOCUMENTS IN THE
ECOLOGY/FORESTRY SECTOR

- FORETS ET SYLVICULTURE DANS LE SAHEL : LA GAMBIE
FORESTS AND FORESTRY IN THE SAHEL : THE GAMBIA
D(81)126, Février/February 1981
- ANALYSE DU SECTEUR FORESTIER ET PROPOSITIONS :
LE NIGER (3 volumes)
D(81)132, Avril 1981
- ANALYSE DU SECTEUR FORESTIER ET PROPOSITIONS : LE MALI
D(82)165, Mai 1982
- ANALYSE DU SECTEUR FORESTIER ET PROPOSITIONS : LE CAP
VERT
D(82)179, Octobre 1982
- ANALYSE DU SECTEUR FORESTIER ET PROPOSITIONS : LA HAUTE
VOLTA
D(82)159
- ANALYSE DU SECTEUR FORESTIER ET PROPOSITIONS : LA
MAURITANIE
D(82)181
- SITUATION DE LA RECHERCHE FORESTIERE DANS LES PAYS
DU SAHEL MEMBRES DU CILSS
D(82)182, Novembre 1982
- POLITIQUES FORESTIERES AU SAHEL : CONTRAINTES, COUTS,
ORGANISATION
D(82)185, Novembre 1982
- LA PARTICIPATION, L'ORGANISATION LOCALE, LA POLITIQUE
D'UTILISATION DES TERRES ET DU SECTEUR FORESTIER : ORIEN-
TATIONS FUTURES DE LA FORESTERIE SAHELIEENNE
PARTICIPATION, LOCAL ORGANISATION, LAND AND TREE TENURE
FUTURE DIRECTIONS FOR SAHELIAN FORESTRY
D(83)190, Janvier/January 1983

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- QUANTIFICATION DES BESOINS EN BOIS DES PAYS SAHELIENS :
UNE ANALYSE DES BILANS-PROGRAMMES, Document de travail
préparé par l'Equipe Ecologie-Forêts pour la réunion de
Banjul (Gambie), octobre 1982
D(83)198
- L'ENERGIE DANS LA STRATEGIE DE DEVELOPPEMENT DU SAHEL
ENERGY IN THE DEVELOPMENT STRATEGY OF THE SAHEL
Octobre/October 1978
- MISE EN VALEUR D'UNE STRATEGIE DE L'ENERGIE DANS LES
PAYS DU SAHEL
Septembre 1979
- LES FOURNEAUX AMELIORES DANS LE SAHEL
IMPROVED COOKSTOVES IN THE SAHEL
D(80)127, Octobre/October 1980
- PLAN DE LUTTE CONTRE LA DESERTIFICATION DANS LES PAYS
MEMBRES DU CILSS
DESERTIFICATION CONTROL PROGRAMME FOR CILSS MEMBER
COUNTRIES
Document N°50483, Nov. 1979
- DOCUMENT DE SYNTHESE - SECTEUR ECOLOGIE-FORETS DES PAYS
DU SAHEL: SYNTHESE DES ANALYSES NATIONALES
D(83)194