Comité interétatique de la lutte contre la sécheresse au Sahel
CILSS

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Recurrent costs of forestry projects in Mali and Upper Volta

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CONTENTS

I. GENERAL

Introduction

1. The secretariats of the CILSS and of the Club du Sahel have undertaken an in-depth study concerning the problem and burden of financing recurrent expenditures of Sahelian development programmes and projects which weigh more and more heavily on the financing and absorptive capacities of these countries.

2. The study is divided into three groups:

- case studies of development operations, at the micro-economic level, in the sectors of agriculture, livestock development, fisheries, forestry, village irrigation, transport, education and health;
- sectoral studies on a regional basis;
- country studies attempting to forecast the budgetary problems of these countries, on the basis of certain hypotheses and expected availability of external assistance.

3. This report is part of the first group of studies. It includes two case studies, both at the micro-economic level, of reforestation operations in Mali and in Upper Volta. The recurrent activities and costs of rain-fed tree plantations are examined, and an attempt is made to identify typical operational problems and constraints of such projects. A number of points discussed in the final section of this report (III. Conclusions) may lend themselves to a comparison between artificial forestry operations in the two countries.

4. The method of analysis consists of (a) identifying the necessary recurrent costs during the first production cycle of rain-fed tree plantations, and (b) comparing them with actual and/or envisaged recurrent expenditures, to the extent to which such information was made available. The gap between (a) and (b) is identified and discussed. In addition, some wider recurrent implications of the projects

under study, e.g., economic and administrative structures necessary for viable forestry operations, are identified and discussed. In accordance with the directives for this CILSS/Club du Sahel study, the recurrent expenditure patterns have not been evaluated; only their problématique and implications are identified, at the technical and managerial levels, and suggestions are made as to how the gaps between "necessary" and "actual" recurrent expenditures could be closed.

5. Plans for this particular study have first been discussed in the framework of the CILSS/Club du Sahel working group on recurrent expenditures in Ouagadougou on 21-23 November 1979. Fieldwork was subsequently undertaken in the Bobo-Dioulasso area (late January 1980) in Ouagadougou (late February 1980) and in Bamako (early March 1980).

Forestry problems in Sahelian countries

6. The problem of forest coverage in the Sahelian countries differs according to the different zones of climate in these countries. The table below shows the distribution of these zones in Mali and in Upper Volta.

Zone	Annual Rainfall	Mali	Upper Volta
- Guinean Savannah	1200mm	6%	5%
- Sudanian Savannah	600-1200mm	27%	85%
- Sahelian Steppe	200-600mm	16%	10%
- Tropical sub-desert	50-200mm	21%	
- Desert	-	30%	-

The Guinean and Sudanian savannah have an adequate potential for forest production, but the spread of subsistence agriculture and of urban agglomerations contributes increasingly to rapid deforestation and even desertification in these zones of relatively favourable climate.

In the Sahelian zones, where the ecological equilibrium is in even greater jeopardy, it is no longer possible to identify a "forestry sector". Pastoralism is predominant, and the progressive degradation of natural vegetation is largely due to overgrazing. The severe drought of the 1970s has greatly enhanced this degradation. To stop the encroachment of the desert has become an extremely urgent task in these areas.

7. In all Sahelian countries it has become evident that the expansion of agricultural production and the drive toward self-sufficiency in food must be especially closely linked with the development of forest resources, both natural and artificial. Ecological equilibria are very fragile, and, in many instances, already severely disturbed, especially in the peripheries of urban agglomerations. Without reforestation, fire wood will not only be lacking, but also soils will be degraded, rain water will not be retained, and agricultural production will diminish. Policies of self-sufficiency in food production have no basis, if there is no fuel to cook the food, and if farm land is not protected against erosion.

8. The pressure on the remaining forest coverage is especially hard, because wood plays a key role in the domestic life of the Sahel. Wood is the only source of energy for over 90% of the Sahelian people. The demand for domestic wood exceeds supply from production by far, and prices have evolved accordingly (poor families may spend up to 30% of their incomes for cooking fuel). The deficit, which is growing, is covered by cutting down natural forests at an increasing pace. The accelerated decline in the natural forest cover is especially evident around the large cities. In Bamako alone fuel consumption, now estimated at 200,000 tons annually, is expected to grow to 500,000 tons annually by 1990; this compares with a potential wood yield of some 250,000 tons in the wider environs of Bamako, of which only half can be exploited due to long distances and difficulties of access. While in Mali the situation around urban agglomerations is becoming particularly acute, the cutting of fuel wood in rural areas has - due

to low population densities - not yet led to a marked decline of natural forest cover. In Upper Volta, on the other hand, decimation of natural forests is a more widespread phenomenon. Population pressure has led to increased encroachments upon forests for additional crop land and pastures, in addition to the pattern of deforestation around urban centres. It is estimated that agricultural encroachment, overgrazing and bushfires alone destroy 50,000 to 100,000 ha. of natural forest every year in Upper Volta, which amounts to an annual loss of wood of up to 220,000 tons ($5m^3$/ha. average). On the other hand, while the present forest coverage (1980) suitable for firewood production is estimated to yield annually some 1.6 million tons (3,5 million m^3) of wood in Upper Volta, total annual exploitation is currently estimated at 2 million tons (4.5 million m^3) and may reach over 3 million tons (7 million m^3) by the year 2000. Other things remaining equal, the annual shrinking of natural forest capital may increase from a present 1 million m^3 to 3,5 million m^3 by the year 2000.

9. Following the drought of the 1970s, consultations among Sahelian countries on the role of forestry in Sahelian rehabilitation programmes were initiated in Dakar in 1976 (cf. report on the CILSS/FAO/UNSO Consultation on the Role of Forestry in a Rehabilitation Programme for the Sahel) and led to an identification of priorities for action:

- production of fuel wood for the Sahelian people was considered to be the most urgent problem, given the ecological consequences of actual fuel wood demand and prevailing patterns of exploitation;
- natural forests and scheduled forest areas had to be protected from anarchic and too rapid patterns of exploitation and from voracious bush fires;
- a system of forest management was to be set up which would be responsive to the needs of the population;
- the progressive deterioration of pastures was to be arrested, bearing in mind that none of the Sahelian countries had an effective system of silvo-pastoral management.

It was recognized that forestry services were insufficiently organized and lacked logistical support. The lack of personnel was not only due to inadequate training facilities but also due to lack of public funds to mount adequate structures for forestry management.

10. After the Dakar consultations of 1976, a first generation programme was prepared by the Club du Sahel/CILSS group for ecology and environment (Mindelo, 1977) and approved at the subsequent meeting of the Club du Sahel (Ottawa, 1977). The programme and the guidelines for the struggle against desertification were then revised during the meeting in 1979, in Niamey, of the Club/CILSS group for ecology and environment. The first generation projects are slowly and modestly coming to some fruition, after many difficulties and some defeat; attempts are presently being made to improve and to expand them through a second generation of projects in association with international development finance institutions, including the World Bank, the French Caisse Centrale de Coopération Economique (CCCE) and many other bilateral agencies.

The situation in Mali

11. Mali has a total area of 1,24 m sq.km., 30% of which is desert, and a population of 6.3 million. Some 90% of the total population derive their livelihood from agriculture. Average annual population growth rate is estimated at 2,7%; growth of population in urban areas is, however, 7%. Only about a third of the land has an annual rainfall of 600mm and above; three quarters of the population live on that land. Annual per capita income is estimated to be US$110 (1977).

12. Forest and wildlife reserves cover about .4 m ha. (3% of the total area), and planted forests amount to as little as 1,500 ha. (1978; IBRD) of gmelina,teak, neem and eucalyptus destined mainly for fuel wood.

13. Already before the Sahelian drought the economy of Mali experienced serious difficulties owing to high dependence on imports, including food imports, concentration on a few agricultural products for export earnings (cotton, groundnuts, livestock), and high costs of cross-country transport. In spite of modest expenditures on public investment there were chronic budgetary deficits due to difficulties in raising government revenue and to growing expenditure on government personnel. The effects of the drought and growing international inflation have aggravated the plight of the Mali economy, but the

economy recovered somewhat after the drought, especially in 1976 and 1977, and food imports were reduced. However, the balance of payments deficit widened further, no savings were generated, and budgetary constraints tightened as the inflow of international assistance declined in real terms from 1975 to 1978. Up to the present, continually rising international prices of manufactured goods, further growth of public employment and inadequate growth of public revenues contribute to a continued expansion of the overall financial deficit. It is estimated that the gap between public expenditures and revenues would persist and the deficit may increase, at least until 1982.

14. Like other public services, the national forestry services (which are responsible for forest protection, forest products, conservation of fauna and flora (under the Ministry of Rural Development) suffer from these severe recurrent budget problems which render it difficult to effectively carry out the necessary forestry tasks. The exception is the OAPF (Opération d'Aménagement et Productions Forestières), a parastatal agency operating under the supervision of the Ministry of Rural Development, which has its own revenue from the sale of forest products. The OAPF controls about 10% of the wood market.

15. Mali is institutionally advanced in the forestry field compared with other Sahelian countries. Trained forestry staff is available and has proved to be efficient in the field. Thanks to the existence of a National Forestry Fund which receives 50% of revenues from forest exploitation, hunting and fishing, at least part of the forest revenues are recycled in the forestry sector.

16. The priority in the forestry sector of Mali is the improvement of fuel wood and building pole supplies by improving the management of tree plantations and by establishing new ones. This is expected to help to contain the rise in fuel wood (i.e. energy) prices and to arrest the decline of the natural forest cover, especially around urban areas. The forests around Bamako, with an average annual rainfall of 1,100 mm, have proven good wood yields (about 9,5 m^3/ha./year) for species such as gmelina and eucalyptus.

17. The OAPF, which was established in 1972, is to create and to manage, with the assistance of the World Bank, the CCCE and other

programmes, some 18,000 ha. of tree plantations over a period of 30 years. By the end of 1979 it had rehabilitated a number of old plantations, created tree nurseries and training facilities, and established over 500 ha. of new plantations, mostly with the fast growing species of gmelina arborea.

The situation in Upper Volta

18. The total area of Upper Volta is 0,27 m sq.km., roughly a quarter of the size of Mali; the size of its population is similar, and estimated to be 6 million. Like in Mali, some 90% of the people depend on low-productivity subsistence agriculture; unlike Mali, it is more densely populated, but its urban growth rate is thought to be somewhat smaller (5%). The population is unevenly distributed and concentrated in the North-Central (Mossi) plateau which has an annual rainfall of 600-900 mm. Many attempts have been made in the past to improve agricultural productivity in that part of the country, but poor soils, erratic rainfall and erosion due to agricultural and livestock pressures have remained the basic constraints of development. Annual per capita income is estimated to be US$118 (1977).

19. Of the total area, about 55% (or 15 m ha.) are covered by natural bush vegetation, of which about a quarter is scheduled as wildlife and forest reserve. Planted forests amount to 6,700 ha. (end 1977; FAO) of fast growing eucalyptus, gmelina, neem and teak which are located around Ouagadougou and Bobo-Dioulasso.

20. While the situation with regard to public finance had shown a favourable trend before the Sahelian drought, due to budgetary austerity and improved tax collection, budget deficits started to grow from 1975 onwards owing to rising costs of public personnel, steep increases in import prices (especially imported energy) and development expenditure. Although the inflow of external assistance increased slightly in real terms between 1975 and 1978, the external position deteriorated persistently due to rising investment and domestic consumption. Exports amount to only 10-12% of Gross Domestic Product and consist mainly of

agricultural and livestock products. The livestock sector is of vital importance to the economy, but it is in jeopardy due to droughts, overgrazing, declining watering facilities due to deforestation and the growing competition of subsistence agriculture.

21. It is expected that the gap between public revenue available for the recurrent budget and the recurrent expenditure requirements will grow. The gap between the "counterpart" requirements generated by the growing number of foreign assisted development projects and the government funds that could effectively be budgeted for Financial Years 1979 and 1980 appears to be particularly alarming. At the same time, the scope for increasing government revenue, both internally and externally, is not promising. Furthermore, domestic savings continue to be either nil or negative.

22. The responsibility for overseeing forestry-related activities is vested in the Ministry of Environment and Tourism. The Director-General of Environment supervises the Directorate of Forest Management and Reforestation, together with three other departments in the Ministry (National Parks, Hunting and Game Reserves; Fisheries; Programme and Studies). Senior officials dealing with forests are small in numbers. Among the middle-level technicians, only some 216 staff are assigned to the regions and are shared among forestry, parks and fisheries. Due to staffing constraints, particularly at the technical level, the forestry administration is unable to fulfil most of its responsibilities. There is practically no forest inventory and no planning, and field operations are weak. Recurrent budget constraints have worsened the situation and led to scarcity of equipment, vehicles and operating supplies. As a result, surveillance and protection against illegal wood-cutting and bush fires is lacking. With the exception of the collection of a very modest wood-cutting tax, the country's forest resources - including their exploitation - are virtually uncontrolled.

23. A multitude of foreign assisted forestry activities have been initiated during and after the great Sahelian drought which include the development of tree plantations, forestry training, forest nurseries and seed multiplication, etc., operated by many multilateral, bilateral and non-government organizations. Even though some projects are undertaken in close cooperation with the forestry administration, there

exists little coordination, and assistance by the government in project planning and implementation is practically non-existent.

24. Large-scale plantations of fast-growing exotic species (mainly for the production of fuel wood) have been programmed and implemented since 1972; they were assisted in particular by UNDP/FAO, Belgium, Canada, France, FRG, Israel and the USA. Some 4,700 ha. have been planted through these activities (1977). This first generation of tree plantations is being extended by a second generation, through activities of the AVV (Aménagement des Valées des Voltas - a parastatal agency assisted by the CCCE, FAC, UNDP and the Netherlands), by an expanded programme of the FRG, and by the World Bank together with UNDP/FAO. Other bilateral programmes are also expected to participate in the second generation projects, including for instance the projects "bois village" (supported by Switzerland) which are engaged in spreading small-scale village reforestation schemes (5-10 ha. per village). These projects are interesting because the village people take charge of a large part of maintenance costs. It is hoped that planted forests would reach some 20,000 ha. in the 1980s with the help of these efforts.

II. EMPIRICAL ANALYSIS

Rain-fed tree plantations

25. The purpose of artificial tree plantations is to provide sustainable sources of wood supplies and thereby to relieve the deforestation pressures on natural forests and bush vegetation. Such plantations can produce five to ten times more wood than natural forests. The plantation activities are centralized; maintenance and protection works are therefore relatively easy to organize. Land preparation and maintenance can be undertaken economically with heavy machinery (which reduces the manpower constraint), and the number of government agents required is relatively low compared with scattered village plantations which are based on complex motivational, training and follow-up activities. Sustainable and sufficient wood supplies through artificial plantations can thus have a favourable impact on fuel prices in the Sahel; they can also help reduce premature cutting of natural vegetation, protect against erosion, and increase agricultural yields and tree volumes. Some of the drawbacks and risks are that

investment and maintenance costs are comparatively high and capital intensive; the requirements for technical and managerial supervision are relatively advanced; plantations are easy prey of bush fires, illicit cutting and disease if not properly maintained. The long-term risks in terms of soil degradation through over-utilization with fast-growing exotic tree species are not well known in the Sahel. Moreover, there is the tendency to appropriate lands already covered by forests which are multipurpose (forage, fruit, gathering, agriculture, wood) and to convert them into plantations with a single purpose (wood production). Finally, industrial plantations are not operated by the local people themselves, for their own benefit; supervision of work and, in particular, the organization of marketing and sales require government intervention, with numerous risks of failure.

26. On the average, the life cycle of a rain-fed tree plantation is expected to be 24 years after which the trees would be uprooted, and the land cleared for replanting. During the 24-year life cycle, wood harvesting is undertaken several times, generally every six to eight years after which the trees shoot out again and continue to grow until the final cut in the 24th year.

27. The planned and actual life cycle of a particular plantation may be different; it depends on several factors including climate (rainfall), quality of the soil and sub-soil and the choice of plant species in relation to the soil. The recurrent maintenance requirements also depend on such factors. Furthermore, the particular objective of a plantation also determines its life cycle: plantations destined to produce fuel wood require less maintenance and may be ready for a first harvest after five to six years already; the production of building poles and timber may require more maintenance and take longer until the first cutting can be undertaken.

28. The establishment of a plantation, i.e. the investment phase, takes place in year one of the cycle. It essentially consists of the selection of a suitable site (soil quality, access, proximity to markets are key criteria); preparation of the land (clearing, log and wood extraction, harrowing and rippering), of roads and fire breaks; planting (lining out, digging, and the actual plantation); and a first round of weeding, cleaning and the setting up of a protection and

surveillance system. Land preparation takes place before the annual rains, between January and April; for the planting phase, which takes place during the rainy season around June/July , it is important that a maximum number of plants benefit from maximum precipitation (which amounts to a short period of only 6 weeks requiring good timing and organization); weeding, clearing and protection activities are undertaken after the rains, from September onwards. First year maintenance is usually more intensive than subsequent years, and includes two passages through the plantation protecting young plants from competition by weeds and bush grass. As a rule, an established plantation consists of several blocks measuring 100 ha. which are sub-divided into plots of 25 ha. separated by fire-breaks. In addition, the whole plantation is surrounded by a fire-break at its perimeter. A planted surface of, say, 600 ha. would thus require preparation and establishment of 650 ha. of land.

29. The recurrent phase of plantation maintenance begins with the second year. In the early years of the cycle, weeding and cleaning around the growing trees is a key task. Grass and weeds must not be allowed to develop in the plantation. Furthermore, fire-breaks and tracks must be regularly maintained so as to enable easy access and protection. The burden of maintenance is different for different species. Gmelina and cassia may no longer require weeding from the fourth year onwards because, unlike in the case of eucalyptus, the tree tops develop shade and eventually discourage growth of weed. Depending on the circumstances and the objective of the plantation, the growth of trees may have to be trimmed to develop building poles and timber.

30. Beside the direct maintenance tasks, tree plantations call for a number of technical, administrative and economic supporting structures which have important, if indirect, recurrent cost implications. Technical planning, management and close supervision is especially important during the first year, but it is no less important (although less intensive) during subsequent years, especially to fight bushfires early and effectively, to provide for a minimum of surveillance against poaching, animals and disease.

The availability of personnel must be ascertained through an adequate training system; a permanent applied research structure is required to test the behaviour of species under varied circumstances, to test soils and to work on phytosanitary problems. At the national level, the forest administration must establish an administrative and legal framework that makes it possible to operate a plantation system economically and usefully. This includes general administration and finance, inventory and planning work, a field support structure (including management of equipment and supplies) and, also, appropriate land legislation and an effective forestry tax in support of the sector. Other supporting activities which weigh heavily on the national forestry budget include reforestation extension programmes in the villages, programmes aimed at fuel economy to reduce wood consumption, production of plants and prospecting for land suitable for reforestation.

31. In addition to the normal annual maintenance tasks and their national and field support structures, the plantation system requires that the harvesting and commercialization phase be well organized. This, also, has recurrent cost implications in terms of both direct and overhead expenditure. Harvesting of the first generation takes place on the average between the sixth and eighth year of the cycle. Trees to be cut have to be identified, labour must be available for cutting, clearing and stacking; the system of selling, either on the roadside or in the towns (which includes transport), the payment of the cutting tax, collection, handling and banking of receipts, etc., must be organized.

32. In conclusion, the success of artificial tree plantations in the Sahelian countries depends especially on the careful choice of the plantation site, land and soil preparation, the good quality and proper maintenance. The protection against fire, animals and poaching is equally important, as are organization of work in the

field, participation of local people and commercialization to generate revenues and to cover costs. The plantation site may have to be located in some proximity of human settlements, so that occasional labour can commute to work and, possibly, the village people could be linked with an alarm system to intervene early in the case of bush fires. Furthermore, experience in Mali shows better survival of plants and faster growth rates when land preparation is carried out by specialized machinery rather than by manual labour. While preparation costs per ha. amount to about the same, deep sub-soiling and ploughing with mechanical means result in better water retention and better weed control; yields can be substantially higher than with preparation through manual labour. Moreover, manual labour may not be available in sufficient numbers at the required time, because the planting season coincides with peak labour requirements of agriculture.

33. Mention should be made of "taungya" (or the "shamba system", as it is known in East Africa). It can reduce maintenance cost and diminish rivalry between agriculture and forestry. The plantation is more widely spaced and the land in and around the plantation is made available for cropping. The advantages are that the interests of peasants can coincide with the interests of forestry; supply of manual labour would be assured; weeding would be done automatically; cultivation within the plantation improves infiltration and retention of water; fire protection may be better controlled than in more isolated plantations. But it can work only under special conditions of land availability, e.g., where agricultural land is scarce and peasants are interested in the opportunities provided under the system. Moreover, cultivation on the fire-breaks and around the growing trees is only possible during the early years of the cycle; the land can no longer be cultivated when the trees have developed shade, and alternatives (e.g., rotation) would have to be made available to the peasants.

Mali: Bamako rain-fed tree plantations

34. Standard aggregate cost estimates worked out at 1978 prices by the OAPF and the World Bank indicate that the necessary establishment cost for rain-fed tree plantations in the Bamako area are about FM 300,000.- per ha. after amortization of equipment (FM 215,000.- before amortization) or US$682 (US$489, respectively) per hectare, which includes construction of roads, tracks and firebreaks and maintenance for the first year. The largest amount in this figure is the cost of land preparation. Necessary annual maintenance costs for the second and the third years are given at FM 14,000 (US$32) per ha./year on the average. The costs of harvesting and commercialization, before profit, based on OAPF experience in 1978 amount to FM 2,700 per stere, i.e. FM 243,000 (US$552) per ha./year (based on an average yield of 90 steres/31.5 tons per ha. after six years). Table I shows the normal plantation activities implicit in these overall estimates and their timing up to the harvest of the first generation of fuelwood. This model is used to compare necessary expenditure with actual expenditure for a sample of individual plantation activities in the Bamako area.

35. A number of abbreviations are used in the tables in this section:

/ha	per hectare
MD	man-days (one labour man-day: FM 700)
h/mec	machine hours
FM	Malian francs ('000 FM = thousands of Malian francs)
	(US$1 = 440 FM)
	(100 FM = 1 French franc)

1 stere of plantation fuelwood (gmelina) = 0.60 m^3 = 350 KG.

TRAC	Light tractor with appropriate attachment
CHEN + R	Crawler 140 HP with land clearing rake
CHEN + D	Crawler 140 HP with ripper and bulldozer
CHEN + P	Crawler 140 HP with shovel/blade
NIV	Motorgrader
Km.C	Kilometers of 7 ton lorry with trailer

Figures calculated for machine hours include the cost of drivers, maintenance, running and amortization.

TABLE I: FUEL WOOD PRODUCTION, BAMAKO AREA (MODEL) : TYPICAL ACTIVITIES

	Years								
1. INVESTMENT ACTIVITIES	1	2	3	4	5	6	7	8	9 ..
- Site selection	x								
- Roads, tracks, fire-breaks	x								
- Felling, clearing	x								
- Extraction (logs, wood)	x								
- Windrowing	x								
- Land preparation	x								
- Cleaning up	x								
- Plantation	x								
. lining out	|								
. digging	|								
. plant supply	|								
. planting	|								
2. RECURRENT ACTIVITIES									
a) Maintenance:									
- Weeding, cleaning up	x	x	(x)*				x	x	(x)*
- Roads, tracks, fire-breaks	x	x	x	x	x	x	x	x	x
- Surveillance	(p.m.)								
b) Commercialization:									
- Extraction (cutting)						x			
- Stacking						x			
- Cutting tax						x			
- Transport						x			
- Sales						x			
	FIRST GENERATION →								
						SECOND GENERATION			

* May be necessary at a reduced scale only.

36. The sample of plantations analysed in Tables II-V are located in the La Faya and Monts Mandingues forests outside Bamako. The OAPF plantation programme is located at the edges of these two natural forest reserves. Tables II and III show the establishment (i.e. investment) costs of two blocks (Koblé and Sébé 791), excluding first year maintenance activities. Table IV shows the first-year maintenance of the Koblé, Morel, Sikoroko, ExTeck, Mofa blocks in the La Faya forest and the Sébé block in the Mt. Mandingues forest; table V shows the second-year maintenance of the Kasséla, Sikoroko, Kasséla Goudron, Mofa blocks and the 771 plot (part of Mofa) in the La Faya forest.

37. The tables include a series of technical remarks which provide a short-hand explanation of the differences between the plantation "model" and the actual "OAPF expenditures". It can be noted that these differences, at the level of direct expenditures in the field, are not fundamental in nature. But they are characterized by a number of structural problems of the OAPF which the comments in the following paragraphs attempt to identify.

38. On the investment side (tables II and III), it can be noted that expenditures on extraction of wood are considerably higher than prescribed by the model. Felling and clearing at both Koblé and Sébé was undertaken too late, when the ground was dry, requiring more expensive machinery and more machine time. In Sébé, wood and log extraction was undertaken with inexperienced labourers who did not finish their work in time; this resulted in costs of windrowing much higher than expected. The same problem caused the high costs of cleaning-up. Slippage in time schedules and difficulties with organization/supervision of labourers have made an important contribution to unexpected increases in investment expenditure. These excesses were, however, compensated by the land preparation item in which the model is said to have over-estimated the required work. Land preparation includes two sub-items, harrowing and rippering, and provides cost estimates for both. The OAPF experience is now that only one of the two sub-activities is usually required. During the 1979 plantation period the hourly cost of equipment was also lower than foreseen, because much of the OAPF machinery is new and the incidence of breakdown and repair is, at the moment, relatively low.

TABLE II: PLANTATION KOBLÉ (LA FAYA), 70.45 ha. Planted 1979

INVESTMENT PHASE - PLANNED AND ACTUAL EXPENDITURES

	MODEL /ha		70.45 ha			OAPF EXPENDITURES 70.45 ha				
	MD	h/mec	MD	h/mec	'000 FM	MD	h/mec	TYPE	'000 FM	Remarks
1. Site selection	1,0	-	70	-	49.0	5	-	-	3,5	
2. Roads, tracks, fire breaks	(0,2)	(0,8)	(14)	(11,2)	(937.2)	(p.m.			)	
3. Felling, clearing	-	1,1	-	77,5	1465.4	-	210	CHEN +P	2310.0	Due to lateness and dry ground, more expensive equipment had to be used
4. Extraction (logs, wood)	42,0	0,8	2818	56,4 +265km.c	5929.7	1861	210	CHEN +P	3612.0	All work done.
5. Windrowing	-	1,1		77,5	1310.4	-	118	CHEN +R	1298.0	
6. Land preparation	2,0	3,2	141	225,5	4002.1	-	92	CHEN +D	1288.0	Rippering was not undertaken; not necessary.
7. Cleaning up	5,0	-	352	-	246.4	767	-	-	536.9	Labourers were not broken in.
8. Lining out	9,0	-	634	-	443.8	594	-	-	415.8	
9. Digging	2,0	-	141	-	98.7	77	-	-	53.9	Part digging done during plantation.
10. Transport	-	1,5	-	105,7	447.2	-	150 +500km.c	TRAC	785.0	Excluding price of plants.
11. Plantation	5,0	-	352	-	246.4	637	-	-	445.9	Includes rest of digging
				TOTAL MODEL	14239.1			TOTAL OAPF	10749.0	
				/ha	202.1			/ha	152.6	Excluding (2) roads, tracks, fire breaks
										Excluding cost of plants @ 40 FM x 1111/ha

TABLE III: PLANTATION SEBE 791 (Monts Mandingues), 52.0 ha., planted 1979

INVESTMENT PHASE - PLANNED AND ACTUAL EXPENDITURES

	MODEL /ha.		MODEL 52.0 ha.			OAPF EXPENDITURES 52.0 ha.				
	MD	h/mec	MD	h/mec	'000 FM	MD	h/mec	Type	'000 FM	Remarks
1. Site selection	(1,0)	-	(52)	-	(36.4)	(p.m)			(p.m)	Executed in 1978; figure not available.
2. Roads, tracks, fire-breaks	(0,2)	(0,8)	(10)	(42)	(691.5)	(p.m ————			) (p.m)	Calculated globally for all road works.
3. Felling, clearing	-	1,1	-	57	1081.7	-	254	CHEN +P	2794.0	Due to lateness and dry ground, more expensive equipment was used.
4. Extraction (logs, wood)	42,0	0,8 +165Km.C	2184	41 +8580Km.C	4377.0	1631	(p.m)	(p.m)	(1141.7)	Manual labour not properly done; had to be stopped due to lateness.
5. Windrowing	-	1,1	-	57	967.3	-	133	CHEN +R	1463.0	High cost due to (4).
6. Land preparation	2,0	3,2	104	166	2953.8	-	40	CHEN +D	560.0	Actual work amounted to much less than foreseen by model.
7. Cleaning up	5,0	-	260	-	182.0	331	55	TRAC	479.2	Labour inexperienced
8. Lining out	9,0	-	468	-	327.6	659	-	-	461.3	Technique was not yet optimal
9. Digging	2,0	-	104	-	72.8	88	-	-	61.6	As in Table II; increased costs due to manpower problems.
10. Transport	-	1,5	-	78	330.1	-	307	TRAC	1381.5	
11. Plantation	5,0	-	260	-	182.0	745	75 +500Km.C	TRAC	969.0	
			TOTAL MODEL*		11202.2	TOTAL OAPF*			(7848.3)	See note*
			/ha.*		215.4	/ha.*			(150.9)	

*NOTE: The totals are not strictly comparable; some actual expenditure items are missing.

TABLE IV: OAPF PLANTATIONS (1979) : FIRST YEAR MAINTENANCE (1979)

Costs in '000 FM	MODEL /ha. MD or h/mec.	MODEL /ha. Cost /ha.	MODEL TOTAL COST	OAPF EXPENDITURE Total MD or h/mec.	OAPF EXPENDITURE Unit cost	OAPF EXPENDITURE TOTAL COST	OAPF EXPENDITURE COST /ha.	REMARKS
LA FAYA FOREST								
(a) Koblé (70,45 ha.)								Maintenance cost reduced because land was well prepared; only one instead of two mechanized passages were necessary; the block is also along a major road which reduces maintenance of tracks and fire-breaks.
Cleaning up - manual	10,04	7,03	494.9	683	0.70	478.1		
- mechanical	3,00	13.4	942.3	117	4.23	494.9		
Firebreaks, tracks	...	3.0	211.4	10(NIV)	4.22	42.2		
Total		23.43	1648.6			1015.2	14.4	
(b) Morel (18,0 ha.)								
Cleaning up - manual	10,04	7.03	126.7	103	0.70	72.1		Cleaning up activities were simpler than foreseen (fewer weeds than normal); fire-breaks required no maintenance
- mechanical	3,00	13.4	241.2	27	4.23	114.2		
Firebreaks, tracks	...	3.0	54.0	-	-	-		
Total		23.43	421.9			186.3	10.4	
(c) Sikoroko (30.0 ha.)								
Cleaning up - manual	10,04	7.03	210.7	205	0.7	143.5		All necessary maintenance was done. h/mec: 28h. TRAC + D (at 5230/h.) 49h. TRAC + P (at 4230/h.)
- mechanical	3,00	13.4	402.0	77	-	353.7		
Firebreaks, tracks	...	3.0	9.0	10(NIV)	4.22	42.2		
Total		23.43	702.7			539.4	18.0	

Table IV (cont.)

	MODEL			OAPF EXPENDITURE				
	/ha.							
	MD or h/mec.	Cost /ha.	TOTAL COST	Total MD or h/mec.	Unit Cost	TOTAL COST	COST /ha.	REMARKS
(d) Ex Teck (17.0 ha.)								
Cleaning up - manual	10,04	7.03	119.7	187	0.7	130.9		All maintenance completed; MD higher due to development of thorny bushes.
- mechanical	3,0	13.4	227.8	28	4.23	118.4		
Firebreaks, tracks	...	3.0	51.0	-	-	-		
Total		23.43	398.5			249.4	14.7	
(e) Mofa (38 ha.)								
Cleaning up - manual	10,04	7.03	267.4	367	-	256.9		
- mechanical	3,0	13.4	509.1	96	-	432.0		H/mec.: 26h. TRAC + D (at 5230 FM/h, 70h. TRAC + P at 4230 FM/h), done in January 1980
Firebreaks, tracks	...	3.0	114.0	-	-	-		
Total		23.43	890.5			688.9	18.1	
MONTS MANDINGUES FOREST								
(f) Sébé (52 ha.)								
Cleaning up - manual	10,04	7.03	365.4	266	0.7	186.2		
- mechanical	3,0	13.4	696.7	198	4.23	837.5		Block was planted late; second maintenance passage not undertaken
Firebreaks, tracks	...	3.0	156.0	3(NIV)	4.22	12.7		
Total		23,43	1218.1			1036.4	19,9	Average actual expenditure 16,481 FM/ha for a total of 225,45 ha; (average size of block; 37.6 ha.).

TABLE V: OAPF PLANTATIONS (1978) : SECOND YEAR MAINTENANCE (1979)

Costs in '000 FM	MODEL /ha. MD or h/mec.	MODEL /ha. Cost /ha.	MODEL TOTAL COST	OAPF EXPENDITURE Total MD or h/mec.	OAPF EXPENDITURE Unit cost	OAPF EXPENDITURE TOTAL COST	COST /ha.	REMARKS
LA FAYA FOREST								
(a) Kasséla (93 ha.)								
Cleaning up - manual	2,04	1.43	113.0	-	-	-		No manual labour required; weeds were high and well visible; all necessary maintenance done
- mechanical	2,0	8.93	830.7	94	5.23	491.6		
Firebreaks, tracks	...	3.0	279.0	23(NIV)	4.22	97.1		
Total		13.36	1242.7			588.7	6.3	
(b) Sikoroko (14 ha.)								
Cleaning up - manual	2,04	1.43	20.3	-	-	-		Mechanical maintenance was considered sufficient
- mechanical	2,0	8.93	125.0	19	4.23	80.4		
Firebreaks, tracks	...	3.0	42.0	7(NIV)	4.22	29.5		
Total		13.36	187.3			109.9	7.9	
(c) Kassēla Goudron (11 ha.)								
Cleaning up - manual	2,04	1.43	16.1	-	-	-		Same as for (b)
- mechanical	2,0	8.93	98.3	18	5.23	94.1		
Firebreaks, tracks	...	3.0	33.0	18(NIV)	4.22	76.0		Average actual expenditure 7362 FM/ha. for a total of 118 ha. (three blocks).
Total		13.36	147.4			170.1	15.5	

Table V (cont.)

	MODEL			OAPF EXPENDITURE				
	/ha.							
	MD or h/mec	Cost /ha.	TOTAL COST	Total MD or h/mec.	Unit cost	TOTAL COST	COST /ha.	REMARKS
(d) Mofa (80 ha.)								
Cleaning up - manual	2,04	1.43	114.1	151	0.7	105.7		This block was only partially maintained
- mechanical	2,0	8.93	714.6	50	5.23	261.5		due to shortage of time
Fire breaks, tracks	...	3.0	240.0	-	-	-		
Total		13.36	1068.7			367.2	4.6	(partial maintenance)
(e) Plot 771 (10 ha.)								
Cleaning up - manual	2,04	1.43	14.3	-	-	-		
- mechanical	2,0	8.93	89.3	2	4.23	8.5		Only 3 ha. maintained
Firebreaks, tracks	...	3.0	30.0	4(NIV)	4.22	16.9		All 10 ha.
Total		13.36	133.6			25.4	2.5	(partial maintenance)

39. Table IV shows the first-year maintenance costs of six plantation blocks; table V shows the second-year maintenance costs of five blocks. It can be noted that in nearly all cases actual maintenance activities and costs were much lower than considered necessary in the model. (Only in two cases, mechanized work turned out to be more expensive than expected). The explanations for this phenomenon vary: maintenance cost was reduced, because the land was mechanically well prepared during the investment phase; some cleaning up activities were simpler requiring fewer machine hours than expected; some fire- breaks apparently required no maintenance; or, one block was planted late and only one maintenance passage was undertaken, and another block was only partially maintained due to shortage of time. All plantations reviewed were maintained, not exactly according to the model, but from the OAPF point of view sufficiently. In two cases, time for full maintenance ran out. It is, however, important to note that the management of the maintenance system works and delivers the services.

40. The OAPF takes pride in the efficiency of its actions against encroaching weeds and herbs early in the plantation cycle. By criss-crossing the plots with the appropriate machinery, undesirable vegetation is uprooted and cleared away; weeding is said to be no longer necessary after the second year. Efficiency and the fact that the model may be too generous in a number of its provisions may contribute to the consistent under-achievement of actual expenditures compared with the model. In the view of the OAPF, a bias in favour of machinery rather than manual labour, enhances efficiency. However, it remains to be seen in the maintenance requirements of subsequent years whether the presently reduced amount of man and machine time and the omission, in many cases, of fire break maintenance was fully justified, or whether certain necessary maintenance tasks were not merely "postponed" to the future generating increased maintenance costs in later years.

41. Surveillance against poaching and animals is not included in the recurrent costs of individual plantations. It is considered as part of OAPF overheads. The problem is not considered to be serious in the Bamako area. Due to the location of most plantations, surveillance

takes care of itself to a certain extent. The environs of the La Faya and Monts Mandingues forests are not very much populated. People living nearby are said to dislike the plantations, because the species are unfamiliar to them. They also are said to respect them because, unlike the "free" natural forests, they "belong to somebody". The plantations are located at the edges of the natural forest thus providing a boundary which protects the natural forest from poaching to a certain extent. The entire forest reserves in the Bamako area are patrolled by five technicians ("préposés") on bicycle.

42. Other personnel for direct supervisory duties on plantation sites (up to 1000 ha.) include two engineers, two technicians, two foremen and some permanent labourers. They have a light pick-up truck ("bâchée") and motorcycles ("mobylettes") for their transportation. But proper supervision is also said to be possible with less personnel.

43. While the OAPF now appears to be in adequate control of the technical side of the field work reviewed above, it had to struggle against a number of important constraints in the implementation of its overall plantation programme. Table VI summarizes the "planned" and actually "implemented" plantation programme.

Table VI: OAPF PLANTATION PROGRAMME

Year	Planned	Implemented
1975		21 ha.
1976		16 ha.
1977		110 ha.
1978	400 ha.	205 ha.
1979	400 ha.	222 ha.
1980	555 ha.	?
1981	600 ha.	
1982	800 ha.	
1983	1000 ha.	

In the early years (1975, 1976) lack of experience and, also, the emphasis on training, establishment of nurseries and other structural

development account for the rather modest plantation programme. In addition, selection of new sites was difficult and slow, due to the lack of proper cartographic documentation - a constraint which is now removed. More recently, it was the heavy equipment (and the lack thereof during peak times), financial and other management problems, and problems related to manual labour supplies which caused the main constraints. On the other hand, the availability of technical and supervisory personnel, at least in numbers, is not a constraint; on the contrary, the numbers of such personnel are actually too large for the present volume of activities, and even double occupancy exists, due to in-service training, for a number of posts. This situation may be beneficial for the important expansion of activities in the years ahead (while only 574 ha. have been planted in the past five years, nearly 3,000 ha. are planned for the next four years), but it presently weighs heavily on the recurrent budget.

44. A major problem is the tight situation with regard to cash flow. For instance, the Koblé plantation (Table II) was planned for 144 ha. in 1979, but only 70.45 ha. were actually planted, because the crawler on site (as did other equipment on other sites) broke down, and the cash for repairs could not be raised. Moreover, a 7 ton lorry transporting plants from Sikasso to the site in the Bamako area broke down in mid-journey, and additional transport to rescue the shipment was not available. The plants perished in the sun. It was noted that the amortization and maintenance schedules for heavy equipment are not adapted to the abrasive conditions of the African bush; amortization is loo long and maintenance problems, even though attended to in accordance with the factory manuals, were underestimated. Tight cash flow (together with a general shortage of petrol in the country) has also led, on one occasion, to a total depletion of OAPF petrol stocks leading to a standstill of plantation machinery. The lack of suitable statistical information and of informative accounts did not help in overcoming these constraints. A new system of analytical accounting, which is presently being introduced, is much superior and provides OAPF management with information necessary to anticipate recurrent expenditure problems.

45. The dispersion of plantation sites (and of natural forest management zones) leads to a shortage of key equipment at peak times for

the plantation programme. OAPF operated only two crawlers in 1979; they could not be despatched for land preparation to more than six different sites before the beginning of May, and the planned plantation programme of 400 ha. had to be reduced to 222 ha.

46. The problem of shortage and inadequacy of equipment is known for some time and is expected to be alleviated under the new World Bank and CCCE credits which are expected to become effective later this year. The credits incorporate an important innovation for OAPF financial management: they provide an advance of FM 110 million to eliminate the tight liquidity situation. Under earlier arrangements, for instance with the FAC (French cooperation), OAPF had to advance funds for purchasing equipment and was reimbursed much later, after the purchase and after completion of all paper work. Such advance funds could only be raised by forcing the sale of wood and by creating severe liquidity problems throughout the OAPF system.

47. Can rain-fed tree plantations be economically viable? For the OAPF, which is organized along commercial lines and which is intended to operate on the basis of the sale of its produce, the question is vital. Fuel wood is currently transported to Bamako and sold to wholesalers or individual customers at a price of 2800 FM (just over US$6) per stere of 350 kg. (a different source quoted the price of 2300 FM per stere). The price is controlled by the government which observes its regulating function in the market, but which thereby also constrains the OAPF's flexibility in covering its net production cost. The net cost of a stere of fuel wood has recently been recalculated (November 1979) in a bid by the OAPF to persuade the Government that prices should cover costs. At least, uneconomically low prices should not be maintained at the expense of subsidies to be provided by concessional external finance through agencies such as the World Bank and the CCCE.

48. Table VII is based on a detailed survey undertaken in 1978 and summarizes the net cost of one stere of fuel wood in the Bamako area:

TABLE VII: NET COST OF FUEL-WOOD PRODUCTION (per stere)

		FM
a)	Value of standing wood	200
b)	Preparation for cutting	70
c)	Extraction and stacking	235
d)	Transportation on site	350
	Sub-total (1)	855
e)	Overhead costs (A)	340
	Sub-total (2)	1,195
f)	Transportation to Bamako (1978 prices): 100 km roundtrip/stere	1,081
g)	Handling (overhead B)	340
h)	Petrol price increase (1979, 42%): added cost 100 km/stere	94
	Total net cost (November 1979), before tax	2,710

NOTE: The price of petrol increased by about a further 20% in March 1980.

The value of standing wood (a) is a symbolic figure which does not reflect the real value of the product; it merely reflects a portion of government expenditures in natural forest management. Preparation for cutting (b) involves the opening of tracks and roads by mechanical means to facilitate cutting. Extraction (cutting) and stacking (c) are paid contractually to labourers on a stere-by-stere basis. Wood which is not immediately transported to Bamako must be shifted to the nearest all-weather road so that it can be picked up by normal vehicles during the rains (d). Overhead costs (e, g) are divided between the cost of production and of commercialization. Finally, the costs of transport to Bamako (f, h) have been updated to reflect the increase in petrol prices in 1979. The Bamako wholesale price of FM 2800/stere barely covered the OAPF net cost of November 1979, before any profits. Today the price no longer covers the costs. On the other hand, the government may resist an increase in fuelwood prices, on the grounds that the expanded plantation programme was expected to contribute to the stopping of such increases.

49. The above total net cost does not include the cutting tax, which

should actually be added. In earlier calculations (1975, 1976) payment of a cutting tax of FM 150/stere was included, and the OAPF in turn benefitted from State subsidies (salaries of higher personnel, replacement of equipment and other operational support) which were partly financed by the national forestry fund. While higher OAPF staff is still paid by the recurrent budget of the "Direction des Eaux et Forêts" (Ministère de développement rural), equipment subsidies are no longer forthcoming since 1976 and, since 1979, operational State subsidies have no longer been received. This may be connected with the general shortage of government funds. The cutting tax is actually under review by the Government, and an increase is projected for the years ahead.

Upper Volta: Lessons from experience at Dagouma, Dinderesso and Gonsé

50. The situation with regard to rain-fed plantations in Upper Volta is different compared with Mali. There is a wide variety of opinions as to what is "necessary" in terms of a recurrent supporting structure, and the actual maintenance performance is equally varied, ranging from neglect (resulting in destruction) due to lack of funds and personnel to intensive care by well financed projects such as the FRG plantations at Gonsé, south of Ouagadougou. Moreover, the costs of rain-fed tree plantations are considerably higher in Upper Volta than in Mali, especially around Ouagadougou. Table VIII presents a comparison between Mali and Upper Volta of projected overall establishment and recurrent costs for the second generation of reforestation projects. Investment cost in Upper Volta is estimated to be nearly 50% higher than in Mali, and second year maintenance costs are more than threefold. Several factors account for this phenomenon: the savannah in the Ouagadougou area is more difficult to work, involving more labour and more machine time, than the more fertile areas around Bamako; the cost of labour (per day) is double in Upper Volta, and the use of machinery (including amortization) is costed at higher rates; and plants ex-nursery cost also about twice in Upper Volta.

TABLE VIII: MALI AND UPPER VOLTA: AVERAGE DIRECT ESTABLISHMENT AND MAINTENANCE COSTS OF RAIN-FED TREE PLANTATIONS (PER HECTARE)

FM 440 = US$1 = FCFA 220; Prices after amortization of equipment

	PRICES PER HECTARE			
	Mali		Upper Volta	
INVESTMENT	FM	US$	US$	FCFA
- Roads, tracks, fire breaks	18,355	42	93	20,350
- Land preparation	111,220	253	377	82,870
- Wood extraction	40,450	92	95	20,800
- Wood transport	55,455	126	90	19,710
- Plant supply	31,880	72	117	25,770
- Maintenance (1st year)	44,620	101	221	48,510
TOTAL	301,970	686	993	218,010
RECURRENT				
- Maintenance (2nd year)	14,030	32	108	23,700
- Maintenance (3rd year onwards)	-	-	36	8,000
- Commercialization : net cost (FM 2,700 per stere)	243,000	552	n/a	n/a

51. More important for the purpose of this study, the desirable organization of maintenance is more elaborate and extends over more than the merely two first years of the cycle as practised in Mali (Table IX). The main differences are that weeding and cleaning up, i.e., the struggle against encroaching herbage, is envisaged to be undertaken in each year of the cycle; the surveillance problem (against animals, disease and poaching) is taken more seriously, and an allowance is made for trimming the trees from the fourth year of the cycle onwards. In addition, some operators feel that plantations should be regarnished in the second year if too many plants have not survived. Others prefer (like the OAPF in Mali) not to regarnish but to rework and replant the whole plantation if the mortality of plants is greater than 20%. It may be noted, on the other hand, that nothing much appears to be planned for the commercialization phase.

TABLE IX: FUEL WOOD PRODUCTION, UPPER VOLTA (MODEL): TYPICAL ACTIVITIES

	Years									
	1	2	3	4	5	6	7	8	9	...
1. INVESTMENT ACTIVITIES										
(same as for Mali, Table I, p.14)	x									
2. RECURRENT ACTIVITIES										
a) Maintenance:										
- Regarnishment		(x)								
- Weeding, cleaning up	x	x	x	x	x	x		x	x	...
- Roads, tracks, fire-breaks	x	x	x	x	x	x	x	x	x	...
- Surveillance	x	x	x	x	x	x	x	x	x	
- Trimming				x	x	x				
b) Commercialization:										
(activities not organized)							?			
	FIRST GENERATION →									
							SECOND GENERATION →...			

52. The costs of the investment phase are illustrated by three examples shown on Table X. These examples demonstrate that, within the generally high cost expectations for field work in Upper Volta, actual experience can vary considerably. The basic constraint is the availability of funds and the flexibility with which such funds can be employed. A poorly funded project can do with comparatively very little but, as the subsequent maintenance experience shows, this can be very risky. Casual manpower being expensive in Upper Volta, the UNDP/FAO project in Dinderesso (near Bobo-Dioulasso) economized and used only 17 man-days per hectare, while the well-funded and well-run German (FRG) project in the Gonsé forest employed an average of 125 man-days per hectare, and considers this as a basic and necessary requirement. The disparities in first-year maintenance are even more striking: one project considers twice the amount of maintenance necessary compared with another project. On the other hand, the planned World Bank project has budgeted more than thrice the amount for first-year maintenance than the well-financed FRG project.

These diverse views on maintenance have been discussed with project leaders, in the context of this study, and have led to an attempt to define a maintenance model which could help the government of Upper Volta to envisage (and to plan for) the infrastructure necessary for the successful operation of its artificial tree plantations.

TABLE X: UPPER VOLTA - COMPARATIVE INVESTMENT COSTS (per hectare)

('000 FCFA) Plantation/Activities				Total (1979 prices)
A) UNDP/FAO				
Dinderesso Plantation (1977)				
- Site delimitation	0.4			
- Extraction of wood	20.0	(1^h 45^m CHEN)		
- Windrowing	18.7	(1^h 40^m CHEN)		
- Cleaning up (wood)	2.3	(6 MD)		
- Land preparation	14.5	(1^h 20^m CHEN)		
- Lining out	2.3	(6MD)		
- Plant supply	26.0	(625/ha)		
- Plantation	2.0	(5 MD)		
- Maintenance (1st year)	5.9	(15 MD)		UNDP/FAO
TOTAL (1977 prices)	92.1	121.8 (1979 prices)		121.8
B) FRG				
Gonsé Plantation (1976-1979)				
- Mechanical preparation work		78.0	(6^h 30^m CHEN)	
- Manual preparation work		90.0	(125 MD)	
- Plant supply		22.5		
- Maintenance (1st year)		15.0		FRG
TOTAL		205.5		205.5
C) WORLD BANK (planned 1981)				
Maro Forest				
- Roads, tracts, fire-breaks, land preparation, wood extraction, transport, plant supply			169.5	
- Maintenance (1st year)			48.5	IBRD
TOTAL			218.0	218.0

54. It must be borne in mind that Upper Volta, especially the region around Ouagadougou, is a very difficult place for growing trees. Poor soils, high population densities and an acute shortage of fuel wood call for a constant maintenance effort and for intensive surveillance of artificial plantations. The eucalyptus, which is more expensive to maintain than the gmelina, is the preferred plantation tree, because of its remarkable resistance and its vitality under adverse circumstances. Poor soils require that plants must be more widely spaced (625 plants/ha. compared with 1111 plants/ha. in Mali) which encourages more growth of weeds, calling for more intensive maintenance and guarding from theft and fire. Maintenance is more labour intensive than in Mali, in spite of the high cost of manpower. Plantation experience under these circumstances, gathered during the first generation of post-drought Sahel projects, has led project leaders to formulate, for the purpose of this study, the basic maintenance model illustrated in Tables XI and XII. This model is used to compare some actual maintenance performance in Dinderesso and in Dagouma and to comment on the gap between necessary and actual activities (Tables XIII and XIV).

TABLE XI: PERMANENT MAINTENANCE TEAM (for each 600 ha.)

('000 FCFA, 1979 prices)	No.	Unit annual cost	Total annual cost	Remarks
Technician ("préposé")	1	p.m	p.m	720.0 p.a
Foreman	1	300.0	300.0	
Labourers	10	180.0	1800.0	
Motorcycle (running)	1		p.m	300.0 p.a
Motorcycle (running)	1		208.0	Mobylette
Small equipment/tools			300.0	
Total (per year)			2608.0	Direct costs
Total/ha./yr.			4.3	

Note: The costs of the technician and his transport are considered to be part of the overheads.

55. Permanent maintenance teams should be set up for each 600 ha. of tree plantations, consisting of a forestry technician ("préposé"), a foreman and ten permanent forest workers (labourers). They would be equipped with a tractor (including the necessary attachments), a trailer, motorcycles for the technician and the foreman, and with the necessary forestry tools. The team would perform the basic surveillance duties, supervise manual and mechanical maintenance activities, guarding, fire drill, and check on the plantations throughout the year. Maintenance of fire breaks and tracks would be part of the permanent duty of these teams. The cost of the team is included in Table XI.

56. The annual maintenance model is shown on Table XII, on a per-hectare basis. In addition to the input of the maintenance team, the model requires an average of 11,7 man-days per ha. per year of casual labourers (plus 0.5 tractor hours) for weeding and cleaning up. Maintenance takes place in every year of the cycle (not only in the second and third years, like in Mali). The provision of man-days includes an amount necessary for trimming the trees from the fourth year onwards. Guarding is based on a requirement of six permanent watchmen (day and night) for 600 ha. requiring a budget of 1800 FCFA per ha./year.

TABLE XII: MAINTENANCE MODEL (per hectare)

('000 FCFA, 1979)

	MD	H/mec.	Unit cost	Total cost
Permanent team	(pro rata per hectare)			4.3
Cleaning up - manual	11,7		0.72	8.4
- mechanical		0,5	5.0 (TRAC)	2.5
Guarding	(pro rata per hectare)			1.8
	Total/ha./yr.			17.0

57. The figure of 17,000 FCFA per year represents the annual minimum for maintenance and supervision. This compares with the norms for second-year maintenance in Bamako (2,04 MD + 2 h.TRAC/ha. + fire-break maintenance) of 13,360 FM which amounts to 6,680 FCFA. If calculated at the higher rates for labour and machinery prevailing in Upper Volta, the comparable total would amount to 12,968 FCFA (excluding the cost of guarding).

58. Tables XIII and XIV compare the necessary maintenance implications, based on the model described above, with the maintenance work actually undertaken in 1978 in Dinderesso and Dagouma. No maintenance records were found for the preceeding years. Due to lack of funds and lack of government support, these plantations were only partially maintained in 1978 (20% of the necessary maintenance). These plantations are under acute risk of fire, weed encroachment and theft. Maintenance of fire-breaks, which is considered to be a much more serious requirement than in Mali, appears to have been postponed to the following year. In Dagouma it was shown that particularly the cassia and neem trees suffered from lack of care from the second year onwards: competition with weeds and savannah grass has led to a drying up of the tree tops and to increased attacks by termites. The disappointments are, however, not only a result of poor maintenance, but also of poor soils, especially in Dagouma. One part of the plantation is located on an abandoned groundnut field. The devastating impact of that crop on the quality of the soil has led to a poor performance even of the hardy eucalyptus plants. All trees suffer from poor maintenance, as a result of which mortality of plants may increase to 50% or more, compared with the normal expectation of 5-10%.

59. The greatest potential dangers for the tree plantations in Upper Volta comes from uncontrolled bushfires. It is recommended that fire-breaks of 50m. (in some cases even of 100m.) width should be established, compared with the average size of fire-break of 10m. in Mali. These fire-breaks must be free of combustible remnants and of grass at all times, which implies frequent and expensive maintenance work. Bad experience with fire has led the Dinderesso plantation to improve its network of fire-breaks. Long procedures for release of funds, including government funds, have led to delays. A fire attacked the plantation just before completion of the work destroying 52 ha. of trees. Plans for fire-break improvements at Dagouma had to be abandoned, because funds were not available to bring the heavy equipment from Dinderesso where it was previously utilized.

TABLE XIII: DINDERESSO PLANTATION, UNDP/FAO (1976, 1977): THIRD YEAR MAINTENANCE (1978)

('000 FCFA, 1979 prices)

Plantation: 545 ha.: Eucalyptus (201 ha.); Cassia (132 ha.); Neem (71 ha.); Gmelina (133 ha.); Anacardium (25 ha.)

	MODEL /ha.			545 ha.	ACTUAL EXPENDITURE		
	MD	H/mec	Cost /ha.	Total Cost	Average EXP./Ha.	Total EXP.	Remarks
Permanent team			4.3	2343.5	0.35	191.0	From some documents it appears that only 143 ha. (man.) and 15 ha.(mec.) have actually been maintained.
Cleaning up: - manual	11,7		8.4	4591.1	2.1	1147.4	
- mechanised		0,5	2.5	1362.5	0.9	504.1	
Guarding			1.8	981.0	-	-	Fire-breaks were maintained in 1979
Miscellaneous			-	-		67.0	
TOTAL				9278.1		1909.5	

TABLE X IV: DAGOUMA PLANTAT ION, UNDP/FAO (1975, 1976): FOURTH YEAR MAINTENANCE (1978)

('000 FCFA, 1979 prices)

Plantation: 428 ha.: Eucalyptus (219 ha.); Cassia (125 ha.); Neem (84 ha.)

	MODEL /ha.			428ha.	ACTUAL EXPEND ITURE		
	MD	H/mec	Cost /ha.	Total Cost	Average EXP./ha.	Total EXP.	
Permanent team			4.3	2343.5	n/a	n/a	
Cleaning up: - manual	11,7		8.4	4591.1	4.0	1705.0	Actual maintenance is reported for 97 ha.(man.) and 31 ha.(mec.); total input 2368 MD + 80 MD foremen, 22 hours TRAC + discs (calculated at 5000 FCFA/ha.)
- mechanized		0,5	2.5	1362.5	0.2	110.0	
Guarding			1.8	981.0	-	-	
Miscellaneous					-	n/a	
TOTAL				9278.1		(1815.0)	

60. In the past, all plantation projects (including the well-finances ones) have underestimated the problems and costs of fire-break establishment and maintenance. The provisions of the above maintenance model (which includes continued fire-break maintenance by the permanent team) are now considered as an absolute minimum if the technical and environmental risks of plantation work should be minimized.

61. While poor maintenance is bedevelling the UNDP/FAO plantations for some time now, their conception includes a number of advanced elements which distinguish them from the other projects. For instance, while the standard procedure for most projects (including the planned World Bank project in the Maro forest) consists of appropriating a slice of natural forest (due to the alleged shortage of non-forest land), chopping it down and replanting it with fast-growing exotic species, the UNDP/FAO projects were planted on agricultural land in the savannah involving difficult negotiations with multitudes of individual landowners. These projects, unlike others, contribute however to a genuine net addition of forest coverage. Furthermore, the Dinderesso plantation is experimenting with the "taungya" (shamba system) in order to rationalize maintenance expenditures and to bring the local peasants closer to the concerns of forestry. An assessment of this experiment (started in 1978) would have to be undertaken with caution, due to its novelty, but early reports are positive and encouraging.

62. Projects with trouble on the recurrent expenditure side are likely to be those which are conceived on the basis of the traditional "counterpart" system and its inflexibility. "Counterparts", whether or not some sort of government commitment was made, often simply do not exist - be they funds in the recurrent budget or staff, supervision and general support. The adherence to the counterpart fiction went as far as to consider WFP food rations (i.e., aid inputs of another international organization) as "counterpart" and to use them in part-payment of manual labourers. Project operations, especially those in the orbit of the UNDP, would benefit from a more rational, more up-to-date definition of burden sharing between government and external development agencies.

63. The most serious constraint to the viability of the whole plantation programme is the virtual absence of a forestry administration and the absence of a vision of rational and economic management of the forestry sector. Apart from the general problems and limitations noted in the introduction (para. 18ff.), there is no proper framework of field management in the sector. Complementary to the maintenance teams at the plantation level (at each 600 ha. of plantation), there should be technical and supervisory teams, for each 3000 ha. of plantations, which would organize inspection and exploitation of forest resources - both artificial and natural. A concrete effort should at least be made to plan for a forest management system, to identify the requirements of personnel and other inputs, and to find means by which an appropriate structure of forest administration could be financed. In the absence of much hope from the central government and its recurrent expenditure situation, means must be identified by which the forestry sector could become - at least in part - self-financed. An associated concern is training: the trend of training and employing an increasing number of government officials, and no middle-level forest technicians, should be reversed.

64. There is hope that steps are being taken in the right direction. For instance, the possibility of a National Forestry Fund (similar to the one existing in Mali) has been considered over the past few years, and its creation may occur in 1980 or 1981. It is envisaged that part of the proceeds from the sale of forestry products be reinvested in the sector. This can work if the present forest tax is revised upward and if the wood market is organized for the benefit of forestry and of the people who buy wood. At the moment, its workings are anarchic and mysterious.

65. This problem is linked with the complete absence of organized harvesting and commercialization in the plantation programme. The question did not arise as yet, because the plantation programme is young and cutting of the first generation has not yet taken place. But it will begin in 1980 and 1981, and the survival of the programme may well depend on a fair and effective organization of harvesting and sales. Prices must cover costs. As far as costs of commercialization are concerned, little information is available. As the

net cost of production of 1 stere of fuel wood on the road-side was FM 1200 (FCFA 600) and FM 2700 (FCFA 1350) whosesale in Bamako before tax, the corresponding figures for Upper Volta would certainly be higher - perhaps the double. Concerning prices, a marketing test was recently conducted by one of the plantation projects producing a seemingly paradoxical result: while 1 stere of fuel wood costs FCFA 5000 (US$23) retail in Ouagadougou (where fuel wood is often unavailable), the wood at the above plantation was sold with difficulty some 20 miles outside Ouagadougou - at a price of FCFA 350 (US$1.60). Conclusions from such tests must be drawn with caution, and other tests may help to explain the forces at work. As a working hypothesis one may, however, suggest that the wood market is locked up on an oligopolistic structure which challenges the viability of the plantation system.

66. Calculation of net cost of fuel wood production would call for a careful examination of the nature and dynamics of overhead costs. Project records often omit to take them into account, or assume a flat rate of 10-20 percent. The UNDP/FAO plantations have shown that overhead costs may reach up to 40% (and in certain cases even more).

67. It should also be noted that the present forest tax is minimal and merely symbolical in character. It consists of two elements: (a) in rural areas a "concession familiale" is issued for the price of FCFA 200 (about US$1) permitting rural people to collect as much wood as they can and to transport it on the day of the permit; (b) a commercial transportation permit of FCFA 40/stere (about US$0.20). Neither will the Treasury ever get rich, nor could much support for the forestry sector be expected from such a tax. Its revision, which is implicit in the planned World Bank project (to contribute to the viability of tree plantations) and which is being considered by the Government, should attempt to focus on the regulatory function that it might have in support of forestry; it may also focus on bringing the apparent margin of actual wood commerce to reasonable proportions in support of a sustainable forest economy.

III. CONCLUSIONS

68. In both countries, the situation with regard to government finance and, therefore, recurrent expenditure, is grim - with little prospect of improvement in the nearer future. Like for other sectors of government activity, the possibility of an expansion of the recurrent budgets of forestry departments appears to be excluded. In Mali, the financial situation is less constrained, because forestry operations are entrusted upon a parastatal agency which is organized along commercial lines. Although it is not fully viable in economic and financial terms, if all its costs are taken into account, it enjoys considerable independence (thanks to its own revenues from the sale of wood); but it is quite likely that its subsidies may decrease in importance as the size of its operations grows. In Upper Volta, where the Government (with its financial and managerial constraints) is the only forestry authority, the situation is less flexible; an absorption into the government budget of the on-going and future tree plantation projects is impossible. The uncertain future of these projects, at least in financial terms, is a matter of great concern, especially because there is no economic and managerial structure in sight that would make it work, except continued external assistance inputs. High level government officials have begun to ask themselves whether the way out would be to make these projects pay for themselves. In addition, the recurrent cost implications of the necessary national support structures, and the budgetary constraints, would require that a more effective forestry tax be established and that at least part of the receipts be used directly for forestry development and management.

69. In Mali, the problems facing the plantation programmes of the forestry sector are not fundamental in nature. They can be overcome without great uncertainties and disruptions. The framework of field work, supervision and the necessary qualified staff is adequate and, even, sufficient to absorb the planned expansion of plantation work in the next few years. Commercialization and wood markets are well organized. Mali benefits from a cost advantage compared with Upper Volta. Labour costs are half, and the operation of machinery is

also cheaper, even if amortization is included. The reasons for the latter are not clear. Plantation maintenance requirements can be reduced to three years (rather than six or seven years) without jeopardizing the future of individual blocks and plots. Security is not much of a problem.

70. Recent problems, which have led to occasional technical set-backs, are financial (cash flow) and managerial (equipment) in nature. These are being removed. The new analytical accounting system is very useful, shortage of equipment during peak times is being corrected, and the tightness of cash flow is eased thanks to a World Bank/CCCE innovation in international assistance - a credit advance to improve liquidity.

71. The financial distress of the Government may cause some problems in the future. One indication is that the OAPF did not receive its annual operational subsidy from the National Forestry Fund. A next step could be that the OAPF may be asked to absorb salaries of higher staff which are actually paid from the recurrent budget of the Ministry of Rural Development.

72. One source of disappointment may be that the OAPF plantation programme has not (yet) led to a stabilization, or even a decrease, of Bamako wood selling prices. On the contrary, due to the pressure of increasing net costs, the OAPF is pushing a case for increasing its controlled wholesale price. It would appear that hopes for a favourable price impact of OAPF activities are premature, because the quantities of production involved are still relatively small.

73. In Upper Volta, top priority should be the strengthening of the technical and management capacity of central forestry institutions, including field support structures. In addition, an urgent task (due to the timing of the plantation programme) is the organization of harvesting and commercialization - in support of a sustainable national forest economy. The establishment and operation of tree plantations, under conditions of poor soil, is very burdensome - for understandable reasons, technical, ecological and social. Pricing, taxation and the

organization of the wood markets must therefore be brought under better control if the plantation programme should survive - if the forest sector should not fall back to accelerated decimation of the natural endowment, to desertification. The way out would seem to be to find a system by which forestry operations could become, at least partially and gradually, self-financed. Revenue collection from the forestry sector should become more efficient and more lucrative, and the proceeds should be recycled into the forestry sector. In view of the high costs of production, of the high pressure on the natural environment and of the bleak prospects of government finance, a fundamental change of national objectives toward a sustainable forestry economy is necessary and urgent.

74. Under what conditions of direct costs and prices can rain-fed tree plantations be economically viable? The basic data necessary to provide an answer to this question are assembled in this report and are summarized in Tables XV (Mali) and XVI (Upper Volta).

(a) Mali: Direct production costs in the Bamako region are estimated to amount to 1,396,400 FM per hectare (1,620,500 FM, based on the alternative calculation) during the life of a plantation (24 years, 4 cycles of 6 years). Actual Bamako wood selling prices of 2,800 FM/stere must be increased by at least 39 per cent (by 61 per cent on the basis of the alternative calculation) to 3,900 FM/stere (4,500 FM/stere respectively), in order to meet direct production costs (see Table XV). On the other hand, it appears that a change in the harvesting costs of the OAPF could improve viability from the cost side. Harvesting costs are estimated to amount to 50-60 per cent of total production costs.

(b) Upper Volta: With the actual wood selling price of about 3,500 FCFA/stere in the Ouagadougou region, rain-fed tree plantations risk to make an economic loss of 16 to 26 per cent. Production costs are estimated to amount to 999,700 FCFA per hectare (1,138,000 FCFA per hectare, based on the

alternative calculation) during the life of a plantation (24 years, 3 cycles of 8 years). Wood selling prices have to be increased by at least 20 per cent (37 per cent on the basis of the alternative calculation) to 4,200 FCFA per stere (4,800 FCFA/stere respectively) in order to meet total production costs (see Table XVI).

It appears that under the conditions prevailing in the Ouagadougou region (scare rainfall, poor soils, cost of machinery, plants and labour) wood must be sold at more than twice (average estimate 4,500 FCFA/stere) the price estimated for the wood of the OAPF (average estimate 4,200 FM = 2,100 FCFA/stere) in order to make rain-fed tree plantations viable.

* * *

TABLE XV : MALI - Estimated Profitability of Rainfed Tree Plantations

Costs/prices per hectare, in '000 FM

(A) AVERAGE COSTS

	'000 FM		Source
1. First cycle:			
- Investment (incl.1st yr maintenance)	300.0		para.34,Table VIII
- Maintenance 2nd/3rd year	14,0		para.34,Table VIII
- Harvesting (2700 FM/stere,90 steres/ha)	243.0		para.34,Table VIII
Total cost, first cycle		557,0/ha	
2. Second cycle:			
- Maintenance,first year	23,4		Table IV
- Maintenance,second/third year	13,4		Table V
- Harvesting	243,0		
Total cost, second cycle		279,8/ha	
3. Third cycle: total cost		279,8/ha	
4. Fourth cycle:total cost		279,8/ha	
5. Total (1-4)		1396,4/ha	

Total cost(average)during the life of a plantation (24 years, complete four cycles of six years) amounts to 1 396 400 FM per hectare.

(B) COST BASED ON ACTUAL FIGURES

1. First cycle:			
- Cost of planting	152,0		Tables II,III
- Fire breaks	13,5		Table II
- Amortization of machinery	85.0		para.38,estimate
- Cost of plants	44.4		Table II
- Maintenance,first year	16.5		Table IV
- Maintenance,second year	7.4		Table V
- Harvesting (3000 FM/stere,90 steres/ha)	270.0		Table VII,cf.note
Total cost,first cycle		588.8/ha	
2. Second cycle:			
- Maintenance,first year	16.5		Table IV
- Maintenance,second year	7.4		Table V
- Fire breaks; amortization	50.0		Estimate
- Harvesting	270.0		Table VII,cf.note
Total cost,second cycle		343.9/ha	
3. Third cycle: total cost		343.9/ha	
4. Fourth cycle:total cost		343.9/ha	
5. Total (1-4)		1620.5/ha	

Total cost(based on some actual figures) during the life of a plantation(24 years, complete four cycles of six years) amounts to 1 620 500 FM per hectare.

TABLE XV (continued)

(C) PLANTATION REVENUE

- Actual wood selling price (Bamako)	:	2 800 FM/stere
- Yield: 15 steres/ha/yr, cycle of six years (90 steres/ha.)	:	252 000 FM/ha/cycle
- Complete four cycles (24 years), total revenue/ha	:	1 008 000 FM/ha/24 yrs.

(D) PROFITABILITY / LOSS

- Total costs (four complete cycles)			
(A) Average figures	1 396 400		
(B) Actual figures		1 620 500	
- Total revenue	1 oo8 000	1 008 000	
- Deficit	388 400	612 500	FM/ha
(loss)	(28%)	(38%)	
- Break-even wood selling price (rounded)	3 900	4 500	per stere
(increase compared with actual price	(39%)	(61%)	

NOTE

Plantations of gmelina arborea, Bamako region. Rainfall: 1 100 mm/yr.

The cost of supervisory and management personnel and the OAPF overhead costs are not included in the above calculations.

TABLE XVI : UPPER VOLTA - Estimated Profitability of Rainfed Tree Plantations

Costs/prices per hectare, in '000 FCFA

(A) AVERAGE COSTS

	'000 FCFA		Source
1. First cycle:			
- Investment(incl.1st yr.maintenance)	218.0		Table VIII
- Maintenance,second year	23.7		Table VIII
- Maintenance for 5 years (8.o/yr)	40.o		Table VIII
- Harvesting	160.0		Estimate
Total cost,first cycle		441.7 /ha	
2. Second cycle:			
- Maintenance, 7 years at 17.0/yr	119.0		Tab.XII,para.54f.
- Harvesting	160.0		
Total cost,second cycle		279.0 /ha	
3. Third cycle: total cost		279.0 /ha	
4. Total (1-3)		999.7 /ha	

Total cost (average) during the life time of a plantation (24 years, complete three cycles of eight years each) amounts to 999 700 FCFA per hectare.

(B) AVERAGE COSTS (alternative)

	'000 FCFA		Source
1. First cycle:			
- Investment(incl.1st yr.maintenance)	218.0		
- Maintenance for 5 years at 17.0/yr.	102.0		Tabl.XII,para.54f.
- Harvesting	160.0		Estimate
Total cost,first cycle		480.0 /ha	
2. Second cycle:			
- Maintenance,guarding	119.0		
- Fire breaks	50.0		
- Harvesting	160.0		
Total cost,second cycle		329.0 /ha	
3. Third cycle: total cost		329.0 /ha	
4. Total (1-3)		1138.0 /ha	

Total cost (average,alternative) during the life of the plantation (24 years, complete three cycles of 8 years each) amounts to 1 138 000 FCFA per hectare.

TABLE XVI (continued)

(C) PLANTATION REVENUE

- Actual wood selling price (Ouagadougou)	:	3 500 FCFA/stere
- Yield: 10 steres/ha/yr, cycle of eight years (80 steres/ha)	:	280 000 FCFA/ha/cycle
- Complete three cycles (24 years), total revenue/ha	:	840 000 FCFA/ha/24yrs.

(D) PROFITABILITY / LOSS

- Total costs (three complete cycles)		
Alternative (A)	999 700FCFA/ha	
Alternative (B)		1 138 ooo FCFA/ha
- Total revenue	840 000	840 000 FCFA/ha
- Deficit	159 700	298 000 FCFA/ha
(loss)	(16%)	(26%)
- Break-even wood selling price (rounded)	4 200	4 800
(increase compared with actual price)	(20%)	(37%)

NOTE

Mixed plantations (predominantly eucalyptus), Ouagadougou region. Rainfall: 600-800 mm/yr. Poor soils.

The cost of supervisory personnel and the costs of government support structures are not included in the above calculations.

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(Mali)

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