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Forestry Development Options in the Fifth Region of Mali: The Economic Tradeoffs

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EXECUTIVE SUMMARY

I. The Economic and Institutional Setting

The Fifth Region of Mali is a low rainfall zone with low forest stand volumes and growth rates. Over the last several decades, increasing animal and population pressure, recurrent drought and poor environmental management have brought about a serious imbalance between the supply and demand for wood. The results have been a rapid decline in forest cover, wood products scarcity and a degradation of agricultural land. Table 1 summarizes the estimated demand and supply for wood in the Fifth Region (by Cercle).

The economic analysis of the FSDP project suggests that it will be extremely difficult to plant enough trees to restore the overall environment and to supply sufficient wood to keep pace with a growing population. The most promising approach appears to be to focus on two objectives: to create "micro-environments" around agricultural lands to both protect the soil and provide limited forest products; to pursue only those demand management and supply enhancement strategies which have reasonable prospect of success, with first priority to those approaches which can have the greatest global impact for the resources spent.

II. Microeconomic Evaluation of Projects

Six project approaches were evaluated: In-Field Tree Planting, Windbreaks and Hedgerows, Commercial Urban Cookstoves, Natural Forest Management (commercial and village-run) and Village Woodlots. The results of the economic and financial analyses are summarized in Table 2.

The findings for In-Field Tree Planting and Windbreaks and Hedgerows suggest that agroforestry projects are highly attractive from a financial and an economic standpoint. Eight alternative cases under a variety of assumptions confirm this result. The major benefit is the potential increase in agricultural yields and both the increased food security and cash income that it implies. Wood output, however, is limited, and holds little prospect for meeting total wood energy needs.

There is very strong financial incentive for urban residents of the Fifth Region to use improved cookstoves. Some traditionally made models are already penetrating the market. At the current high price of firewood, payback periods for available stoves range between one week and twelve weeks. The costs of a stove program are likely to be relatively low, with the private sector playing the lead role. Over 60,000 m^3 of wood could be saved annually if all urban residents adopted improved stoves. This is equal to the

TABLE 2
Summary of Microeconomic Analysis of Projects
(Internal Rates of Return)

		Financial	Economic
In-Field Tree Planting			
Base Case		28.0%	28.6%
Case 1		9.0%	1.4%
Case 2		41.7%	44.1%
Case 3		52.2%	56.1%
Case 4		33.1%	33.1%
Case 5		25.4%	24.7%
Case 6		31.5%	32.1%
Case 7		30.3%	NA
Case 8		50.2%	62.8%
Windbreaks and Hedgerows			
Base Case		36.5%	32.4%
Case 1		18.4%	7.4%
Case 2		49.4%	47.6%
Case 3		59.8%	59.6%
Case 4		33.4%	28.5%
Case 5		39.4%	35.8%
Case 6		68.1%	66.4%
Natural Forest Management	Cash IRR		
Base 1 (Formal Management)		8.6%	14.8%
Case 2		13.4%	19.0%
Case 3		15.5%	20.7%
Case 4		12.9%	NA
Case 5		11.0%	18.2%
Base 2 (Minimum Management)	0.0%	10.5%	26.4%
Case 7	5.2%	13.7%	29.3%
Case 8	5.1%	16.6%	31.8%
Case 9	4.1%	17.3%	28.1%
Village Woodlots			
Base Case		-2.8%	-5.7%
Case 2		-1.9%	-7.7%
Case 3		4.8%	2.3%
Case 4		10.3%	7.3%
Case 5		15.7%	13.9%
Case 6		-8.3%	13.9%
Case 7		2.9%	NA

Improved Urban Cookstoves

Payback Periods at Current Wood Price of 20 CFA/Kilogram
(in Weeks)

Traditional To Bozo	Traditional To Metal	Bozo To Metal
0.58	4.62	10.6

TABLE 1
Estimated Wood Supply and Demand by Cercle

	Demand	Accessible Supply	Ratio SS/DD
MOPTI	310,790	155,395	0.50
BANDIAGARA	226,044	94,185	0.42
BANKASS	169,186	70,494	0.42
DJENNE	135,564	67,782	0.50
DOUENTZA	169,727	70,720	0.42
KORO	219,035	91,265	0.42
TENENKOU	108,189	54,095	0.50
YOUVARU	91,572	45,786	0.50

annual output from 50,000 hectares of village woodlots.

If properly planned, commercial management of the natural forests can be at least marginally viable from a financial standpoint, and quite attractive economically. There are several useful lessons to be learned from long-established natural forest management projects in Burkina Faso and Niger.

Village run natural forest management systems are likely to be both financially and economically attractive. As many of the benefits can be "in-kind" rather than in cash, the major obstacle will be to assure that cash inflow at least covers cash outflow. Experiments now being conducted in the Guesselbodi project (Niger) are testing management systems which could address this problem, and should be tracked closely over the coming years.

Village woodlots appear to be neither financially nor economically viable, except when producing large amounts of commercial non-wood by products (such as fruit). From an economic standpoint, the expenditure of resources substantially exceeds the economic value of the wood produced. Unless there are extremely large external benefits from isolated woodlots which serve no soil protection function, and unless these benefits are greater than those which can be gotten from spending equivalent resources on other projects, further expenditure of public resources on village woodlots seems questionable in the Fifth Region.

3. Global Impacts from FSDP Project

The greatest potential benefits per dollar expended will come from agroforestry (in-field tree planting and windbreaks /hedgerows) and demand management (urban commercial stoves). Limited efforts at natural forest management may also be viable, but could require much greater resources than are likely to be availabe (from all sources) in the Region if large-scale impacts are to be attained. Table 3 ranks the various measures considered by potential for overall impact.

Within the limited resources of the FSDP, the most efficient use of funds will come from pursuing a soil conservation/demand management strategy. Given the financial returns analyzed, an acceptable real rate of return on project resources expended will be realized if annual agroforestry planting levels reach 800 hectares, and if stove production rises to 1300 stoves per year.

4. Policy Reform and Recurrent Cost Issues

"Stumpage Value" refers to the real economic value of wood at site. In the Fifth Region, stumpage value is estimated at 15 CFA/kilogram. The stumpage cost refers to what users pay at site to gain access to wood. At current permit fee levels (100 CFA/Stere), stumpage cost is two

percent of stumpage value. Since only a limited proportion of the wood exploited for commercial sale is in fact taxed, the "effective" stumpage price (actual times percent taxed) is roughly one half of one percent of stumpage value.

There is no realistic hope of bringing stumpage costs up to stumpage values. Substantial permit fee increases and improved tax coverage can help bring about more rational forest exploitation and increase forestry fund revenues, however. The impact on urban wood prices of increased permit fees will be minimal (because they represent such a small percentage of retail price), but the impact on producer prices will be approximately two-and-a-half times as high. This can have an important effect on peasant incentives to grow wood to supply commercial markets.

The policy and project initiatives of the FSDP are likely to have two major effects on forestry revenues in the Region: first, any attempt to curtail abusive fining by forestry agents (which is thought to be a major disincentive to rational environmental management by peasants) may affect the amount of transactions (fine) revenues; second, projects begun by FSDP will entail recurrent costs to be borne by the regional forestry service after project life.

Careful analysis does not confirm the hypothesis that reduced abusive fining will necessarily reduce transactions revenues. To the extent that abusive fines are also unreported fines, a systematic attempt to curtail them could reduce the overall percentage of unreported fines, thereby increasing reported citations and overall revenues. A clear answer on this question must await actual attempts at implementation.

Recurrent costs after project life are estimated at 36 million CFA per year. A number of reasonable combinations of increased permit fees and/or increased tax levels can raise the incremental financing needed. Moreover, negative effects on urban prices would be minimal (and could be more than offset by improved stove efficiencies) and the positve impact on rural incentives to produce wood could be substantial.

Comparison of Alternative Approaches

Initiative	Total Cost	Total Benefits	Cost/ Benefits
URBAN STOVES	$2,000,000	$13,800,000	0.14
WOODLOTS	$67,000,000	$55,125,000	1.22
NATURAL FORMGMT	$50,500,000	$55,125,000	0.92
AGROFORESTRY	$31,800,000	$241,587,533	0.13

Note: Economic values are used for both wood and agricultural outputs (1 Kg wood = 15 CFA; 1 Kg Sorghum = 120 CFA) Total benefits refer to hypothetical cumulative impacts for the period 1985-1996. These are not estimates of what FSDP will or might achieve.

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I. THE ECONOMIC AND INSTITUTIONAL SETTING

1. THE PROBLEM

Most of the Fifth Region of Mali recieves between 350-500 mm of rainfall. Human and animal population pressure has increased rapidly over the last four decades, and now exceeds the carrying capacity of the land. The region has suffered two major droughts in the last twelve years, including the current drought which has not yet run its course. There has been rapid and widespread depletion of forest resources in the Fifth Region, suggesting that the demand for wood products significantly exceeds sustainable supply. This imbalance has created increasing scarcity of wood products, as has been widely documented. Even more importantly, however, it has accelerated soil erosion, water and nutrient loss, with adverse long term effects on the viability of agricultural and livestock production systems.

This process has been on-going for several decades. To date, no measures have succeeded in perceptibly slowing the global degradation. It is no longer possible to think in terms of restoring the overall environment through supply side interventions, at least not in time to forestall devastating economic impacts on agricultural and herding populations. Therefore, this project focusses on initiatives which create micro-environments around productive lands to maximize the soil and water conservation benefits of tree planting and environmental management.

Such an approach leaves open the question of how to bring total demand for wood products into equilibrium with the regenerative capacity of the forests. As detailed in later sections of this paper, the basic finding is that it will be extremely difficult to meet wood energy needs, in particular, through increased tree production, given the long lead times for production, the low expected yields, the high costs of tree growing and the already high and growing woodfuels demands. In the medium term, potentially economic approaches include demand management and increased price, financial and legislative/administrative incentives to more rational forest exploitation.

2. THE SUPPLY AND DEMAND FOR WOOD

Table I.1 shows the rural, urban and total populations and growth rates for the Fifth Region. There are no reliable

TABLE I.1

Estimated Urban and Rural Populations - 1976 and 1985
(Based on Resident Population Present)

Cercle	Urban 1976	Urban 1985	Rural 1976	Rural 1985	Total 1976	Total 1985
MOPTI	51,488	102,925	128,874	156,067	180,362	258,992
BANDIAGARA	8,809	13,666	144,264	174,704	153,073	188,370
BANKASS	3,186	4,943	135,626	164,244	138,812	169,186
DJENNE	14,224	22,066	93,722	113,498	107,946	135,564
DOUENTZA	6,931	10,752	131,275	158,974	138,206	169,727
KORO	11,298	17,527	166,398	201,509	177,696	219,035
TENENKOU	15,691	24,342	69,238	83,847	84,929	108,189
YOUVAROU	2,055	3,188	72,984	88,384	75,039	91,572
Totals	113,682	199,408	942,381	1,141,227	1,056,063	1,340,635

data on demand for forest products in the Region. However, drawing from surveys elsewhere in Mali and in other parts of the Sahel, we can construct an approximate wood demand, as shown below:

Estimates of Capita Demand	
Cooking (Domestic)	0.7 m^3/hab/yr
Institutional Cooking	0.1
Construction	0.25
Other	0.15
TOTAL	1.2 m^3/hab/yr

Table I.2 attempts an order of magnitude breakdown of urban vs. rural demand, based on relative population. These numbers are consistent with approximations based on permis de coupe data shown in Section II.3.

The urban/rural breakdown is important because it reflects very differently structured wood products supply and demand markets. These markets, in turn, lend themselves to different policy approaches to influence wood flows. Virtually all the wood products consumed in the urban areas (see definition in Section II.3) are commercialised. Under existing legislative codes and practice, the wood exploited for commercial sale is subject to wood cutting permits. The prospects for influencing urban demand and the rational exploitation of forests around urban areas are enhanced by the ability to influence price, permit fees and wood movement along major supply axes. Because similar options are generally not available in rural areas, public action must rely more heavily on direct intervention/extension. This is both more costly, and, essentially because wood is available as a free good, runs counter to short term incentives.

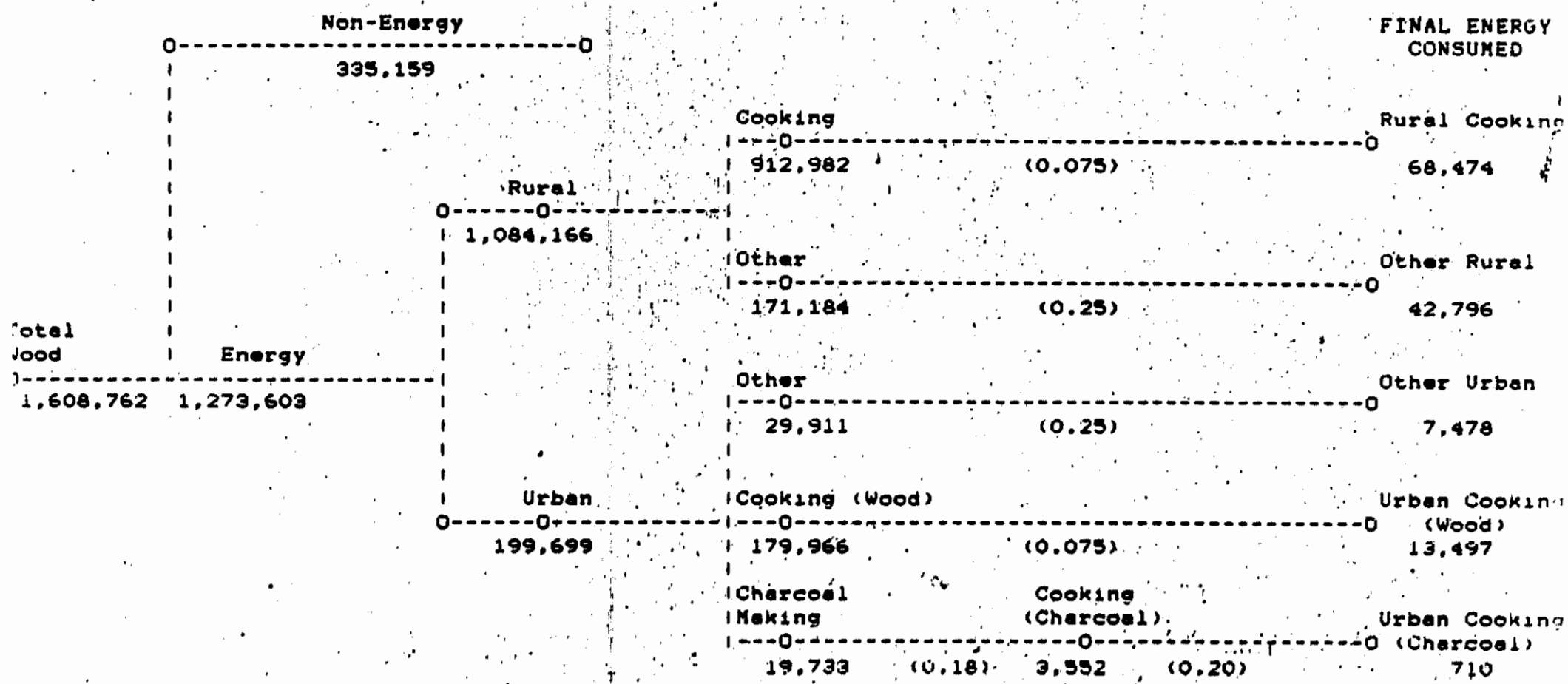
Wood for cooking probably constitutes over 60% of wood products demand. Virtually all rural households and the majority of urban ones use the traditional three stone stove, with efficiencies between 6%-10%. A growing percent of urban households use the ceramic Bozo stove, which sells for between 150 CFA and 500 CFA. While it has never been formally tested, it probably achieves between a 30% and 50% efficiency improvement.

The recent Transenerg Study and the 1982 CILSS Forestry Sector Report class the eight cercles of the Fifth Region in the following zones:

Zone 2: Sahelian or soudano-sahelian

- o Douentza
- o Bankass

TABLE I.2
ESTIMATED WOOD ENERGY FLOWS IN THE FIFTH REGION
Volumes in Cubic Meters. Figures in Parentheses are Conversion Efficiencies



o Bandiagara o Koro

Average natural forest yields are estimated between 0.1 and 0.5 m^3/ha/yr. Due to low population densities, the theoretical wood availability is 0.76 m^3/yr per inhabitant. However, accessible supply is put at 0.5 m^3 per inhabitant.

Zone 3: Sahelian or soudano-sahelian, but with special potential

o Mopti o Djenne
o Youvaru o Tenenkou

In good conditions, yields could potentially be as high 2-5 m^3 per hectare, but actual yields are put at 1 m^3/ha. Accessible supply per inhabitant is estimated at 0.6 m^3.

Table I.3 summarizes the estimated supply and demand by cercle. The ratio of accessible supply to demand is less than 50%. Even this ratio is probably an overstatement, since the forests are severely degraded (lowering supply) and population is increasing.

3. FORESTS IN THE VILLAGE ECONOMY

Any economic evaluation is likely to undervalue the benefits that villagers derive from the forests because: (a) they are generally not quantitified (b) most have never even been estimated quantitatively and (c) many are not adequately percieved by the villagers themselves. Table I.4 lists some of these products and services.

In a non-cash village economy, forests provide free access to benefits without which the structure of village economic life would be strained. As forest resources have become increasingly scarce, traditional forest/land management systems have in fact come under increasing strain, and have begun to break down in a number of areas (see Social Soundness Analysis).

The benefits listed in Table I.4 can be grouped in four categories:

- o wood products (woodfuels, construction materials)
- o non-wood products (fruits, medicines, forrage)
- o services (shade, recreation, religious/social uses)
- o "custodial" functions (soil and water conservation, nutrient cycling, game habitat)

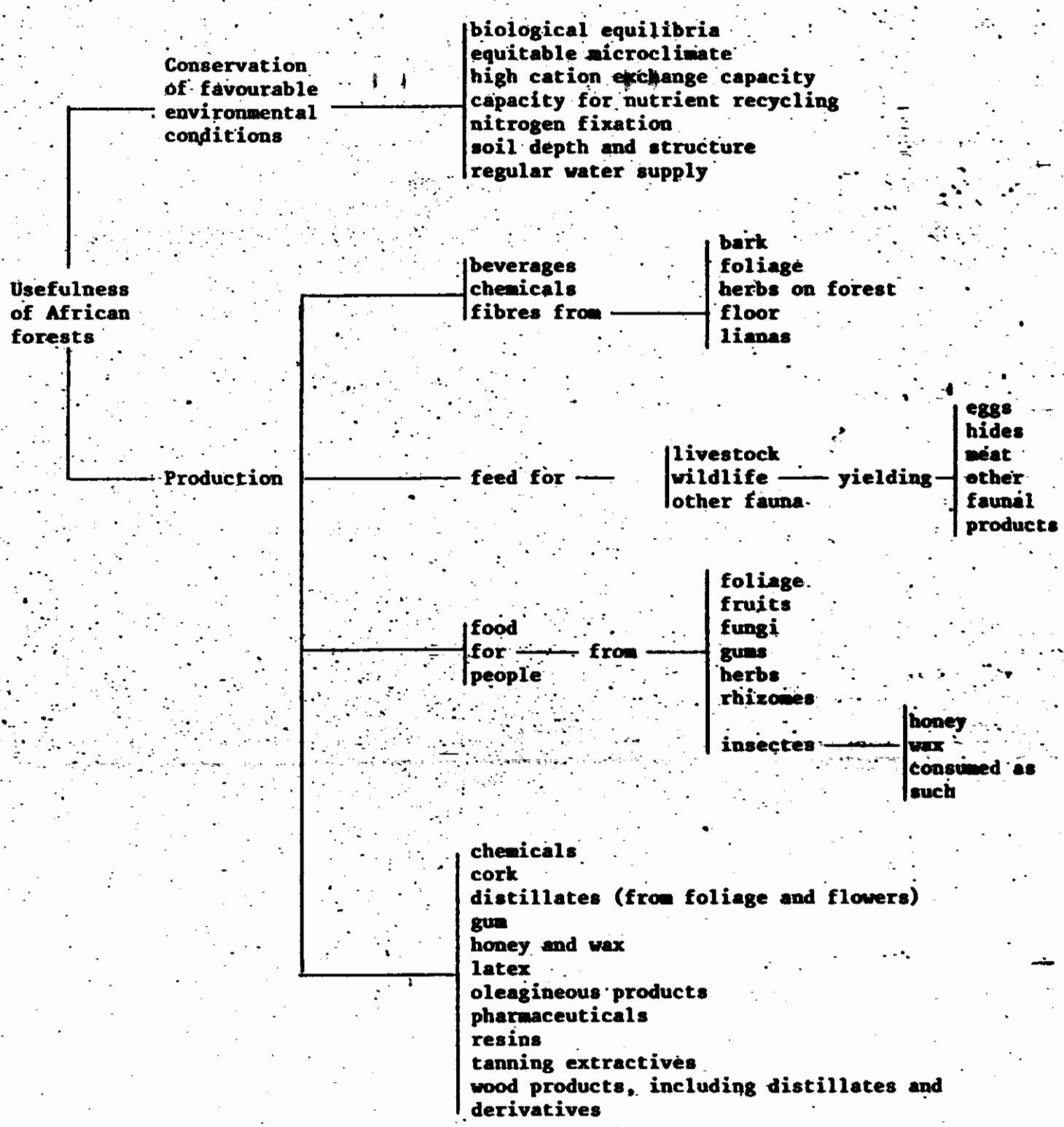
Of these, it is only the first category which both removes something from the forest and for which demand can be satisfied (in the short term) in excess of the sustainable yield of the forest. This, of course, is accomplished by

TABLE I.3
Estimated Wood Supply and Demand by Cercle

	Demand	Accessible Supply	Ratio SS/DD
MOPTI	310,790	155,395	0.50
BANDIAGARA	226,044	94,185	0.42
BANKASS	169,186	70,494	0.42
DJENNE	135,564	67,782	0.50
DOUENTZA	169,727	70,720	0.42
KORO	219,035	91,265	0.42
TENENKOU	108,189	54,095	0.50
YOUVAROU	91,572	45,786	0.50

TABLE 1.4

Contributions of the Forests to the Village Economy



From: Gunnar Poulsen, Minor Forest Products

depleting stand volume and reducing future forest yields.

In this context, the economic rationale for rural forestry efforts is not simply to determine if it is cost-effective to produce enough wood to meet wood products demand, but instead to determine under what economic circumstances villagers can continue to gain maximum sustained benefits from the forest. This requires that long term supply and demand be roughly in equilibrium. Achieving this will involve a combination of supply enhancement and demand reduction (conservation, substitution) as well as better management of the resources available.

The objective of this economic analysis is to shed light on the financial and economic attractiveness of the major available options.

II. MICROECONOMIC EVALUATION OF PROJECTS

Six types of project approaches are evaluated in this section: in-field tree planting, windbreaks/hedgerows, commercial urban cookstoves, natural forest management, improved villager land-use management and village woodlots.

Each analysis is carried out first from a financial and then from an economic perspective. Section III considers some of the major tradeoffs in selecting between the viable project options. It also assesses the potential for widespread impacts through each measure, with explicit treatment of financial resource constraints that might be encountered.

A number of uncertainties underlie all of the project analyses:

<u>data uncertainty</u>. there are little or no data on expected yields, investment costs, time requirements and time savings for tree planting/wood collection, tree/agricultural yield interactions, conversion efficiencies and efficiency improvements, etc. All data used are best guess technical estimates provided by project design technical staff.

<u>risk</u>. any investment involves the risk that the investment will not bear fruit. Perception of this risk colors both the financial incentive to invest and the economic benefit of doing so. Forestry production projects in extremely low rainfall zones are especially subject to risk, as past efforts in the Fifth Region have amply shown.

<u>valuation</u>. economic analysis requires quantification of costs and benefits. When these are largely non-monetized and unquantified in real life, a number of very imperfect valuations is required. For example, what value should be assigned to non-peak season village labor required to

maintain a seedling? To child labor? To peak season adult labor? How highly do villagers value cash income vs. benefits in kind? What is the appropriate discount rate for financial analysis? etc.

perception of benefits, many of the costs and benefits are not perfectly percieved by villagers. In project implementation, it is the role of extension agents to heighten the perception of potential benefits from such things as environmental management, soil conservation and so on. In financial analysis, on the other hand, actual villager perceptions are an important indicator of their incentive to participate in the proposed activities.

In order to address more effectively the uncertainties inherent in small-scale forestry project evaluation, an Appendix to this Economic Analysis report uses advanced economic and computer techniques to determine, by probabilistic means, the liklihood that rates of return will fall within an acceptable range. The technique involves assigning to each uncertain variable a range of possible values rather than an arbitrary single point estimate. Within that range, using the best judgement of project technical staff, each uncertain variable is assigned a probability distribution and, where appropriate, at expected mean. Three hundred computer runs are performed on each case analyzed. On each run, every uncertain variable takes on a random value from within its assigned range specified probability distribution. The result is then tabulated to created a frequency distribution (both relative and cumulative) of the rates of return. Put simply, what this tells you is, for example, not just that the base base gets a 6% return, the high case gets 10% and the low case gets 3%, but rather that, for example, there is a 65% probability that the rate of return will fall between 5% and 8%, that there is only a 10% chance that it will be above 9% and a 4% chance that it will fall below 3.5%.

The full methodology and results of this analysis are presented in Appendix A.

1. IN-FIELD TREE PLANTING

Financial Analysis

Table II.1 shows the principal input, output and valuation assumptions used in the finahcial analysis of in-field tree planting. It is assumed that sixty trees per hectare are planted on five hectares of privately held agricultural land. Adult off-peak labor is valued at 125 CFA/day, and peak season labor is valued at 1400 CFA/day. Child labor is valued at 60% of adult labor rates.

Two outputs are assumed in the base case: a wood yield of 0.3 m^3/Ha, and a 5% increase in agricultural yields. Wood

TABLE II.1
Base Case Financial Assumptions for In-Field Tree Planting

INPUTS		OUTPUTS	
Investment Inputs		Wood	
Labor		Kg/Ha/Yr	150
Off-Peak	30		
Peak	5	Labor Saved	
		Off-Peak	19.5
Reccurrent Inputs		Peak	4.5
Adult Labor			
Off-Peak	17.5	PROJECT LIFE	
Peak	1	Years	20
Child Labor		Terminal Value	50%
Off-Peak	4.5	Years to Full	
Peak	1	Production	6
		VALUATIONS	
		Adult Labor	
AGRICULTURAL YIELDS/PRICES		Off-Peak	125
Kg/Ha/Yr	541	Peak	1400
Price/Kg	70	Child Labor	
Increased		Off-Peak	75
Yield	5%	Peak	840

Labor inputs and savings in days. Labor values in CFA/day.
Average Land Holding Assumed to be 5 Ha

yields are valued in terms of labor saved. Increased agricultural yields do not begin until year 3, and the full 5% increase is only realized when trees reach maturity (year 6). Using average 1976-1983 millet/sorghum yields for the Fifth Region, the base yield per hectare is projected at 541 kilograms. The official 1985 producer price for millet/sorghum of 70 CFA/kg is used to obtain production values to the farmer.

Table II.2 shows the twenty year base case financial projections. The Base Case IRR is 28%, indicating that even assuming 20% peasant discount rates, the project remains potentially attractive to villagers, <u>if they percieve the agricultural yield benefits.</u>

Eight alternative cases have been analysed to test the effect on project returns, as summarized in Table II.3.

Case 1 assumes that there will be no improvement in agricultural yields as a result of in-field tree planting. It therefore corresponds to the assumption that the promise of agroforestry is not realized. The IRR remains close to 9%. This case represents both a reasonable approximation of the downside risk and a gauge of how a farmer may percieve the project if he is not convinced that improved yields will follow.

Cases 2 and 3 are highly attractive, and show the potential benefits if optimistic, but still reasonable agricultural yields were achieved. Case 4 adds the assumption that 50% of the trees will bear fruit or other commercial by-products (starting in year six, 3 kgs per tree valued at a producer price of 10 CFA/kg). This case not only shows the positive impact of commercial by-products on rates of return; it demonstrates the potential for cash income generation. Evidence throughout Africa suggests that farmers may place an extremely high value on cash income and that perception of cash benefits is stronger than that of environmental or labor saving benefits.

Cases 6 and 7 are also more attractive than the base case, for reasons that appear self-explanatory. Case 7 does, however, underscore the interaction between agricultural policy and forestry efforts, in that higher real producer prices increase farmer incentives to invest in improved production methods (including agroforestry). This case assumes that <u>real</u> producer prices increase by 5 CFA every five years, with the first increase taking place in year 1 of the project (approximately 1987).

The corollary to the Case 6 increase in NPV is the decline noted in Case 5. While this case assumes base agricultural yields 20% below the 1976-1983 average for the Fifth Region, it remains considerably in excess of average yields observed in 1984. In that year, ORM, OMM and DRA reported a total of 199,280 Ha planted, with a total output

TABLE II.3
In-Field Tree Planting
Rates of Return for Financial and Economic Analysis

FINANCIAL	IRR
Base Case	28.0%
Case 1 (No Increase in Agric Yields)	9.0%
Case 2 (10% Increase in Agric Yields)	41.7%
Case 3 (15% Increase in Agric Yields)	52.2%
Case 4 (Commercial By-Product: Fruit)	33.1%
Case 5 (Base Agric Yields of 430 Kgs/Ha)	25.4%
Case 6 (Base Agric Yields of 650 Kgs/Ha)	31.5%
Case 7 (Higher Real Agric Producer Prices)	30.3%
Case 8 (Declining Yields w/o Agroforestry)	50.2%

ECONOMIC	IRR
Base Case	28.6%
Case 1 (No Increase in Agric Yields)	1.4%
Case 2 (10% Increase in Agric Yields)	44.1%
Case 3 (15% Increase in Agric Yields)	56.1%
Case 4 (Commercial By-Product: Fruit)	33.1%
Case 5 (Base Agric Yields of 430 Kgs/Ha)	24.7%
Case 6 (Base Agric Yields of 650 Kgs/Ha)	32.1%
Case 7 (Higher Real Agric Producer Prices)	NA
Case 8 (Declining Yields w/o Agroforestry)	62.8%

of 41,765 MT, or an average of 210 kg/Ha -- less than 40% of the yield used in the base case analysis. This catastrophic result was attributable to the drought and to the fact that a large proportion of the hectares planted yielded nothing at all (ORM, for example, reported an output of 0 MT for 1600 Ha planted). However, there is a very real prospect that future yields will remain below historical averages.

Case 8 examines the problem of declining agricultural yields from a different perspective. The hypothesis underlying agroforestry interventions is that drought is not the only cause of declining agricultural yield. Another important set of factors is soil and water erosion resulting from environmental degradation. In-field tree planting can not only help stem such erosion, it may improve soil quality and water retention.

If we assume that in the absence of specific micro-environments to protect agricultural land, crop yields will continue to deteriorate at 3% per year, then the benefits of in-field tree planting must be measured against the most likely outcome without such planting. Figure II.1 plots the current yield (A-B), the yield with tree planting (A-C) and the likely yield without tree planting (A-D). The benefits from the project are no longer the area between A-C and A-B, as assumed in the base case, but the area between A-C and A-D.

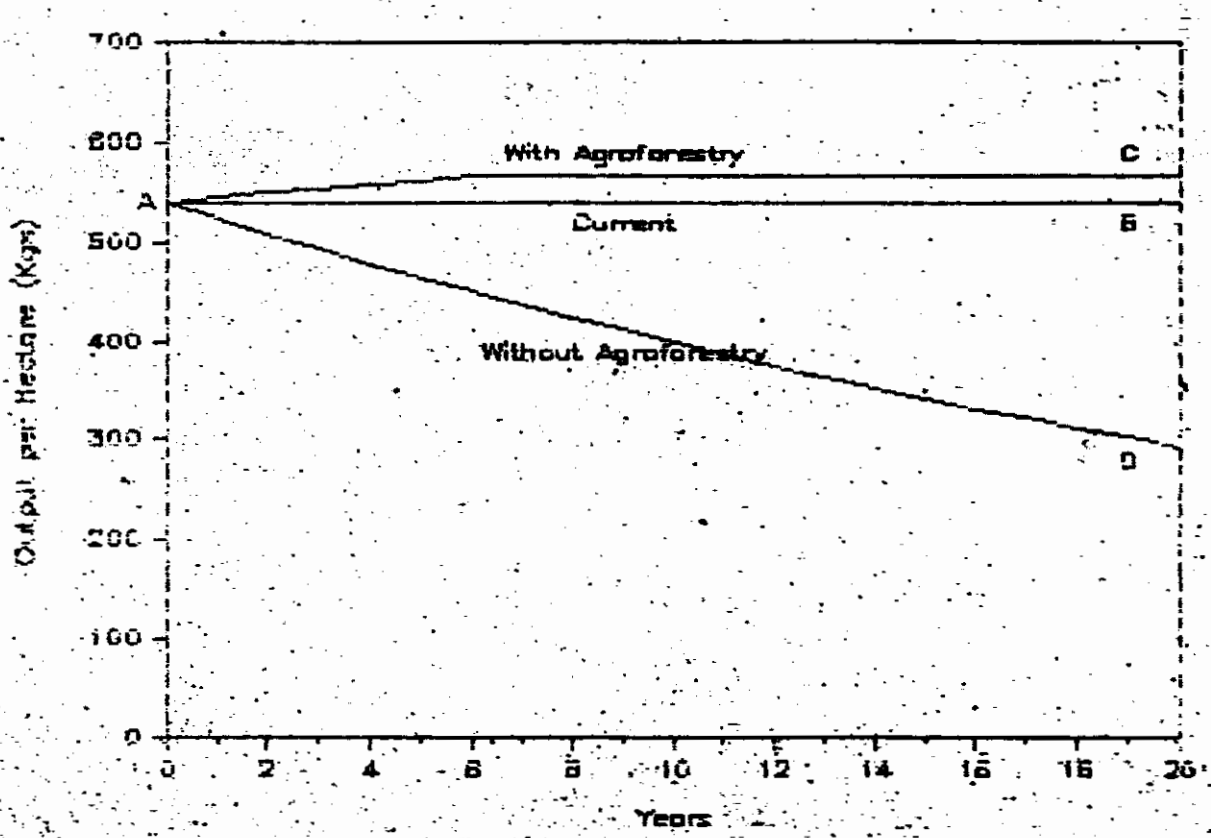
Case 8 depicts the fundamental argument for agroforestry interventions in a deteriorating environment. The IRR is seen to rise from 28% in the base case to 50%. Even this substantial improvement, however, masks the real economic/financial value of this case, for two reasons:

o declining agricultural production in the Fifth Region implies the serious risk of undernourishment and famine. As food becomes more scarce, the marginal value of an extra kilogram of output increases, perhaps dramatically. Yet the analysis gives a uniform value to all food output. Surely a villager values the extra tonne of food which keeps his family from starving more highly than an extra tonne which can be sold for discretionary cash income.

o there are few dangers which farmers in the region percieve more acutely than the risk of failing agricultural production. If forestry and agricultural extension agents succeed in making farmers aware (through sensitization, demonstration and other means) of the protective functions of tree-planting, farmer incentives to participation could be extremely high.

In conclusion, the financial incentives to in-field tree planting appear strong under most assumptions. Yet a number of uncertainties can play a determining role in the analysis. These include: base agricultural yields, yield improvements

MEASURING GAINS FROM SOIL PROTECTION



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realized. valuation of labor and farmer perceptions of benefits. For these reasons, probability analysis of the results was judged a useful tool in gauging the liklihood that the project will prove attractive to the typical Fifth Region farmer. This analysis is carried out in Appendix.

Economic Analysis

The following changes are made as against the financial analysis: off-peak adult labor is valued at 70 CFA, and off peak child labor is given no economic value; peak season labor rates remain unchanged; the social infrastructure costs of supporting the tree planting project for the five hectare family farm are 12,000 CFA in the first year, 3,000 CFA per year for the next five years and 3,500 CFA per year thereafter; the economic value of agricultural output is taken to be the cost of imported food grains, estimated at approximately 120 CFA per kilogram.

Table II.3 summarizes the economic rates of return for the base case and the 8 alternative cases analyzed. The reduction in imputed labor values in the economic analysis lowers the investment and recurrent costs which occur in labor time. However, it lowers the value of labor saved even more. This appears to be an accurate reflection of the economic perspective, from which it matters little if low-productivity labor is economized. On the other hand, the increased valuation of agricultural output (using the import cost of grains rather than the producer price) makes the economic case considerably more sensitive to changes in agricultural yield resulting from in-field tree planting. Once again, this finding confirms the reasonable expectation that society would place a high value on tangible output whose opportunity cost involves a recurrent drain on scarce foreign exchange resources.

2. WINDBREAKS AND HEDGEROWS:

Windbreaks and hedgerows are considered in this analysis as part of the same integrated package.

The arguments that underlie them are the same as those for agroforestry: to create a micro environment to protect specific agricultural land and to improve yields. The means by which these objectives are attained are different: reduction in wind erosion and in rates of evapotranspiration, and protection from animal intrusion.

Estimates of the protective and yield enhancing benefits are extremely speculative. They depend on a number of local circumstances about which it is difficult to generalize, including soil condition, windspeeds and seasonality, animal passage and so on. The analysis therefore assumes that this initiative will be tried only where local environmental

conditions appear appropriate. With this caveat, costs and benefits are estimated as for other projects evaluated.

All pricing and valuation estimates are equivalent to those used for in-field tree planting. The establishment cost for windbreaks/hedgerows are taken to be 20% higher than the per hectare establishment costs of in-field tree planting with sixty trees per hectare. However, the recurrent labor costs are estimated at only 50% of those of in-field planting, as their is no need to spread mulch, prune trees, etc. Wood yields are assumed to be the same, with the much lower areas planted compensated by the greater planting density. The base case assumes a 5% agricultural yield improvement as of year 6. Economic assumptions are as in the in-field tree planting case.

Table II.4 summarizes the results of the financial and economic analysis for seven cases analysed. Where local conditions warrant, the approach is both financially and economically attractive and requires little or no cash expenditure..

3. COMMERCIAL URBAN COOKSTOVES

The Importance of Urban Consumption

Figure II.2 shows a map of the Fifth Region indicating the location of urban centers and major transport axes to each. The urban wood supply zones are roughly as shown.

Table II.5 provides the 1982 breakdown of transactions and exploitation revenues to the forest service in the Fifth Region. Table II.6 further breaks down forest exploitation revenues into bois de service, bois d'oeuvre and bois de chauffe/charbon de bois, and shows the cost per unit for each category of wood taken from the forest. Total "forest exploitation" revenues in 1982 were 14,565,750 Malian francs (2 MF = 1 CFA). At the unit permit prices given, this translates into roughly 70,000 steres of wood <u>officially</u> removed from the forest for commercial sale in 1982. Converting this number to cubic meters (at 2 steres = 1 cubic meter), we have 35,000 m^3.

There have been no detailed studies of commercial forest exploitation and woodflows in the Mopti Region, and it is therefore not possible to make a reliable judgement of what the actual (vs. officially registered) volumes are. However, an extremely detailed study around the Bamako area completed in 1985 estimates that only about 20% of the actual flows are officially recorded. If we assume the same percent of unrecorded flows in Mopti, it would suggest that as much as 175,000 m^3 of wood were taken from the surrounding forest for commercial sale. Allowing for 3% annual population growth,

TABLE II.4

Rates of Return for Financial and Economic Analysis
Windbreaks and Hedgerows

FINANCIAL	IRR
Base Case	36.52%
Case 1 (No Increase in Agric Yields)	18.42%
Case 2 (10% Improvement in Agric Yield)	49.37%
Case 3 (15% Improvement in Agric Yield)	59.84%
Case 4 (Base Agric Yields of 430/Kgs/Ha)	33.42%
Case 5 (Base Agric Yields of 650/Kgs/Ha)	39.39%
Case 6 (Potentially Declining Agric Yields)	68.10%
ECONOMIC	
Base Case	32.36%
Case 1 (No Increase in Agric Yields)	7.38%
Case 2 (10% Improvement in Agric Yield)	47.62%
Case 3 (15% Improvement in Agric Yield)	59.61%
Case 4 (Base Agric Yields of 430/Kgs/Ha)	28.50%
Case 5 (Base Agric Yields of 650/Kgs/Ha)	35.80%
Case 6 (Potentially Declining Agric Yields)	66.37%

TABLE II.5
Exploitation and Transactions Revenues in the Region of Mopti
(Malian Francs)

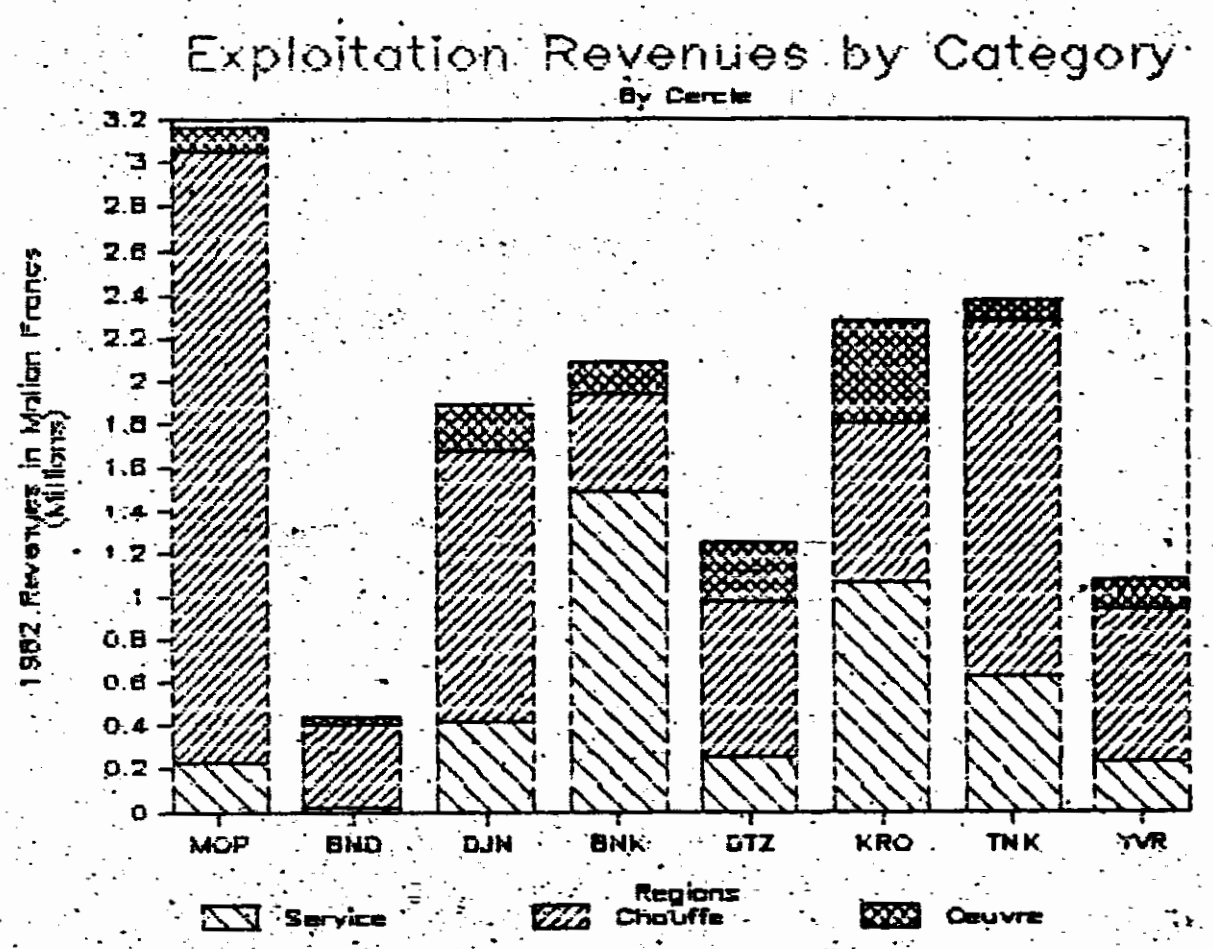
	1982	Percent
Exploitation		
Forets	14,565,750	9.9%
Chasse	90,500	0.1%
Peche	25,145,000	17.1%
SUBTOTAL	39,801,250	27.1%
Transactions		
Forets	104,404,310	71.1%
Chasse	281,250	0.2%
Peche	2,364,000	1.6%
SUBTOTAL	107,049,560	72.9%
TOTAL	146,850,810	100.0%

TABLE II.6
Breakdown of Exploitation Revenues in the Mopti Region
(Malian Francs)

	Bois d'Oeuvre	Bois de Service	Bois de Chauffe/ Charb de Bois	Totals
MOPTI	114,500	234,000	2,816,500	3,165,000
BANDIAGARA	37,500	21,000	390,000	448,500
DJENNE	208,000	418,500	1,258,500	1,885,000
BANKASS	147,500	1,487,350	454,500	2,089,350
DOUENTZA	278,500	252,000	726,000	1,256,500
KORO	473,000	1,069,700	730,200	2,272,900
TENENKOU	109,000	632,500	1,635,000	2,376,500
YOUVAROU	126,000	236,000	710,000	1,072,000
Totals	1,494,000	4,351,050	8,720,700	14,565,750

UNIT PRICES PER PERMIT

Category	Unit	Price (MF)
Bois de Chauffe	Stere	200
Charbon de Bois	Quintal	250
Bois d'Oeuvre	Pied	1,500 - 12,000
Bois de Service	Pied	1,000 - 3,000



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the 1985 figure would be somewhere in the order of 190,000 m^3.

In the absence of a detailed study around Mopti -- which is recommended as an early undertaking of the FSDP project -- the only means of verifying this estimate is to compare it with the total urban populations of the Fifth Region, given in Table II.7. The implied per capita wood consumption in urban areas which results from comparing these two sets of numbers is 1.15 m^3 per year.

Therefore, it would appear reasonable to estimate that between 150,000 and 175,000m^3 of commercial wood is exploited annually in the Fifth Region.

For a number of reasons that are treated in detail in Section IV of this paper, it is easier to influence commercial wood exploitation and consumption in urban areas than to influence non-monetized woodflows in rural areas. The principal policy and institutional mechanisms available in commercialized urban markets include: granting of permis de coupe, setting the cost of permis de coupe, control of wood traffic along a very limited number of supply routes, influencing urban woodfuels prices and tapping urban cash incentives to improve wood conversion efficiencies.

Financial Incentives to Efficiency Improvement

Commercial wood prices in Mopti are estimated at 20 CFA/kilogram. Ninety five percent of woodfuels use is firewood, and five percent charcoal. The majority of urban firewood users rely on the traditional three stone stove, for which we estimate a conversion efficiency of 7.5%. A small but growing number of people use an improved ceramic stove (produced by Bozo artisans), with an estimated, but untested, efficiency of 12%. The base model of the Bozo stove costs 150 CFA, but prices can range as high as 500 CFA.

Table II.8 shows the assumptions for the financial analysis. Of the 175,000 m^3 of commercial wood sold in urban markets, roughly 60% is fuelwood (105,000 m^3). Assuming per capita consumption of 1m^3 and an urban household size of 6, this corresponds to 17,500 households, each consuming approximately 69kg of firewood per week. At a cost of 20 CFA/kg, average weekly household expenditure for wood is 1,380 CFA. If each household uses two stoves, then the payback period for a 150 CFA Bozo stove with 12% efficiency is under one week. The payback period in converting from three stone to an improved metal stove (LESO's current stove model costs 2000 CFA and gets 26% in the lab -- the analysis assumes 20% in the field) would be roughly five weeks. Finally, choosing a 20% efficient metal stove over the ceramic stove would pay back in approximately eleven weeks. The calculations for these numbers are shown in Table II.8.

TABLE II.7

Estimate of Urban Population Purchasing Wood Commercially

Cercle	1976 Population	1985 Population	Percent Commercial	Total Commercial
MOPTI	51,488	102,925	100%	102,925
BANDIAGARA	8,809	13,666	60%	8,199
BANKASS	3,186	4,943	0%	0
DJENNE	14,224	22,066	80%	17,653
DOUENTZA	6,931	10,752	60%	6,451
KORO	11,298	17,527	60%	10,516
TENENKOU	15,691	24,342	80%	19,474
YOUVARU	2,055	3,188	0%	0
Totals	113,682	199,408	--	165,218

TABLE II.8

Payback Periods for Improved Stove Efficiencies

General Assumptions

Household Size	PerCap Cons(Kg)	Wood Price/Kg	CFA/Week/ Household	EFFICIENCIES Trad	Bozo	Metal
6	600	20	1385	7.5%	12.0%	20.0%
			Stove Price	0	150	2000

Payback Periods in Weeks (Assuming Two Stoves Per Household)

Wood Price	Trad to Bozo	Trad to Metal	Bozo to Metal
10	1.16	9.24	21.38
12	0.96	7.70	17.81
14	0.83	6.60	15.27
16	0.72	5.78	13.36
18	0.64	5.14	11.88
20	0.58	4.62	10.69
22	0.53	4.20	9.72
24	0.48	3.85	8.91

We can conclude from the above that, given the perception of these benefits and given sufficient resources to invest in improved stoves, the financial incentives to improve conversion efficiencies in urban areas is excellent. The savings to be realized are all in cash and would flow relatively quickly. The average family now spends somewhere in the order of $160 per year (1380/week x 52 weeks @ 450 CFA/$) on cooking energy. This is between 25-30% of total income. If all cooking were done on improved metal stoves, potential savings could be as much as $96 per year -- which is between 15-18% of total household income, and probably a much higher percent of cash incomes of poorer households.

Limited perception of benefits, adverse economic conditions and extreme cash scarcity all inhibit the more rapid spread of improved stoves, although the Bozo ceramic stoves establish that the public's demand and the private sector initiative needed to satisfy that demand will grow even without government assistance. The approach of the FSDP project should be to provide the most efficient support it can to encouraging a process which is already underway, and which is known to be financially attractive and in the social interest.

Economic Analysis

It seems unecessary to establish that improving stove efficiencies is an economically sound undertaking, given its financial attractiveness and the potentially strong role of the private sector. The real purpose of any economic analysis (as opposed to financial analysis) is to compare a given effort to the opportunity costs for society as a whole. From this perspective, it is useful to ask what the economic tradeoffs would be between wood conservation as against other wood supply/demand measures.

If every one of the 17,500 households were given, free of charge, two improved metal stoves, and if each stove cost the public sector a wholesale price of 1500 CFA, the total cost would be $116,000. If all the stoves were used, the annual wood savings would be 63,000 m^3. To produce an equivalent amount of wood per year would require at least 50,000 Hectares of woodlots. If all the woodlots were completely successful, if all were established without any foreign technical assistance personnel and without the need for digging a well, establishment cost alone would be $10,000,000 ($200/Ha), with a 5 to 7 year lead time before full production.

Conclusion

There is a strong case for emphasizing efficiency improvement as the least cost means of improving supply-demand imbalances for woodfuels in the Fifth Region. This does not suggest that efficiency improvement will bring

about supply-demand equilibrium -- it will not -- nor that supply side measures are not worthwhile; they are simply a more costly way of meeting energy needs. Analysis elsewhere in this paper also shows that tree growing interventions may be more urgently needed for soil and water conservation rather than for energy production.

Giving away stoves is not proposed as the most efficient means of bringing about their use. Given the relative costs of foreign technical assistance personnel and of stoves, it may be more efficient than some of the other options which have been tried in Africa, but the best approach should be determined by field personnel. Any one of a number of alternatives can be examined: providing stoves to women in exchange for some social, political or community service; subsidizing stoves to promote sales; creative small-scale financing mechanisms; providing technical assistance to Bozo stove makers to improve their stove efficiencies, or, simply providing the necessary support to the market process that is already underway without subsidy.

In all cases, sensitization efforts aimed at consumers and at production, marketing and financial intermediaries will be necessary, and should properly be included in the costs of a stoves program.

Finally, while it is not a recommendation of this paper that a rural cookstoves program be an explicit part of the FSDP, it should be noted that the urban stoves being discussed burn wood, not charcoal. Therefore, they are potentially useable in rural areas as well. The possible demonstration effects from urban to rural areas are strong, and warrant close monitoring to find opportunities for encouraging rural diffusion in later years.

4. NATURAL FOREST MANAGEMENT

The first step in the analysis of this option is a definition of what technical measures it would involve. However, there is no history of natural forest management in the formal sense in the Fifth Region. Moreover, experience in other Sahelian countries has shown that there are numerous combinations of measures which can be considered, depending upon the management objectives and on what is appropriate in the specific area.

At this stage in the FSDP design, the economic analysis must establish what kinds of management approaches, if any, would be cost-effective. Accordingly, two "base case" scenarios have been constructed. Each of these, plus seven sensitivity cases, has been tested from the economic and the financial perspective.

Table II.9 shows the base 1 and base 2 assumptions. Typical data and management system options are drawn from the Dinderesso Managed project (Burkina Faso) and the Guesselbodi Forest (Niger). A number of management insights are drawn from meetings in Bamako with Dr. Kjell Christofferson, Project Director of the Dinderesso Project, and from John Heermans, Technical Advisor for Guesselbodi.

Base 1 assumes that wood will be exploited for commercial sale, and that no forest by-products will be sold. Establishment costs per hectare include fencing and firebreaks. Recurrent costs include a combination of commercial and village labor. Village labor is paid in-kind with 30% of the wood harvested by such labor. Average transport distance to market is an important determinant of financial viability. The base case (both base 1 and base 2) assumes this distance to be 100 kilometers, but the effect of changing transport distances is treated explicitly below.

Base 2 is the "minimum management" case. It is similar to the aproach currently being tried, with some success, in Guesselbodi. It involves managing only those sub-areas with sufficient forest stands to manage (rather than managing and protecting an entire rectangular space). No fencing is used. Therefore, the only investment costs are some site preparation and firebreaks. Recurrent costs include around the clock guard protection. In this case, wood products are largely non-commercialized (60%).

Financial Analysis

This analysis is fundamentally different from that of the other initiatives (in-field tree planting, windbreaks, cookstoves) considered, in that the financial analysis is not carried out from the perspective of the villager, simply because he is not the investor. Instead, it examines the cash cost-benefit implications for forest management, and therefore becomes an indicator of the sustainability of operations without continued public subsidy.

In practical terms, this implies that village labor obtained in exchange for wood is not given a monetary value. In the same way, the wood provided villagers for their collection work is simply deducted from the overall quantity of wood which is sold commercially. The financial analysis does not assume that the public sector is the only possible management agent, however. Both Dinderesso and Guesselbodi are experimenting with cooperative village management systems, with cash return as well as environmental stabilization being the principal objectives of the coops.

In base 1, the IRR is 8.57%, if 70% of the wood is commercialized, with an average transport distance to market of 100 Km. If real wood prices in Mopti increase by 3% per year (case 2), then IRR rises to 13.35%. Case 3 shows the

TABLE II.9
NATURAL FOREST MANAGEMENT

	BASE 1	BASE 2
ESTABLISHMENT COST PER HECTARE (CFA)		
Fencing	15,000	0
Site Preparation	12,500	12,500
Other	4,000	4,000
RECURRENT COSTS		
Percent Village Labor	50%	100%
Village Labor Rate (% of wood)	30%	60%
Percent Commercial Labor	50%	0%
Commercial Labor Rate (CFA/day)	600	300
Collection time/m3 (hrs)	30	30
Guards (2 shifts/ 365 days per year)(CFA	NA	32,850
Other Recurrent Costs/Ha (CFA)	2,000	1,000
GENERAL ASSUMPTIONS		
Hectares Managed	500	100
Ex-forest wood price (CFA/Kg)	8	8
Average transport distance (Km)	100	100
Village wood price (CFA/Kg)	NA	4
Wood price growth rate (%/p.a.)	0	0
Unmanaged forest yield (m3/ha)	1	1
Managed forest yield (m3/ha)	1.7	1.3
Managed forest yield (St/ha)	3.4	2.6
Degradation rate w/o management (%)	0.03	0.03
Time to Improved Yield (years)	1	1

effect of commercializing by-products (fruit, karite, etc) in the value of 2000 CFA per hectare (.75 kilograms per tree, 600 trees per hectare, 5 CFA per kilogram producer price before transport). Because many of the minor forest products do not in fact have well established commercial markets, case 4 examines the option of using such products to pay village labor, leaving the entire wood harvest available for commercial sale. Case 3 has an IRR of 15.5%, and Case 4 shows an IRR of 12.9%. Case 5 retains all Base 1 assumptions, except that 100% of collection is done by village labor, with the 30/70 output split as before. The results of the financial analysis for base 1 and cases 2-5 are shown in Table II.10.

Base 2 assumes no fencing, increased guard labor and 100% village labor used for collection. This case assumes that only 40% of the wood is sent to commercial urban markets, and that the remainder is used by villagers. The value of wood not sold on commercial markets substantially exceeds the value of village labor. This is a direct profit for the village coop, but does not occur in cash terms. Yet the sustainability of forest management in this model depends on at least meeting cash flow requirements. Accordingly, both the overall financial IRR (where non-commercial wood retained as the coop's profit is valued -- at half the commercial producer price), and the cash IRR are calculated. The cash IRR is approximately 0, suggesting that the project would not be profitable from a cash perspective. The overall IRR, on the other hand, is 10.5%.

Case 7 assumes a 3% annual increase in wood prices, given the base 2 framework. IRR is 5.2% for cash and 13.7% overall. Case 8 adds 1000 CFA/Ha of commercialized by-products, raising the overall IRR to 16.6% and the cash return to 5%. Case 9 examines the effect of 50% lower guard costs. This assumes that some of the guard services are provided on a non-commercial basis by members of the coop. Overall IRR is 17.3%, while cash IRR is 4.1%. Table II.10 also summarizes the financial returns for Base 2 and Cases 7, 8 and 9.

Figure II.3 shows the effects on the Base 1 and Base 2 rates of return of changing transport distance assumptions. Because of its lower reliance on commercial markets, base 2 is shown to be less sensitive to transport distance. This underscores the fact that base 2 is a more appropriate management mode for relatively isolated environments.

Finally, because yield is a major untested assumption in the analysis, a series of cases were run to calculate the impacts of different yield levels on both base case rates of return. The results of twenty sensitivities performed (ten for each base case) are plotted in Figure II.4.

Economic Analysis

Four basic changes are made in the economic analysis:

o commercial labor is valued at 60% of the rate used in the financial analysis

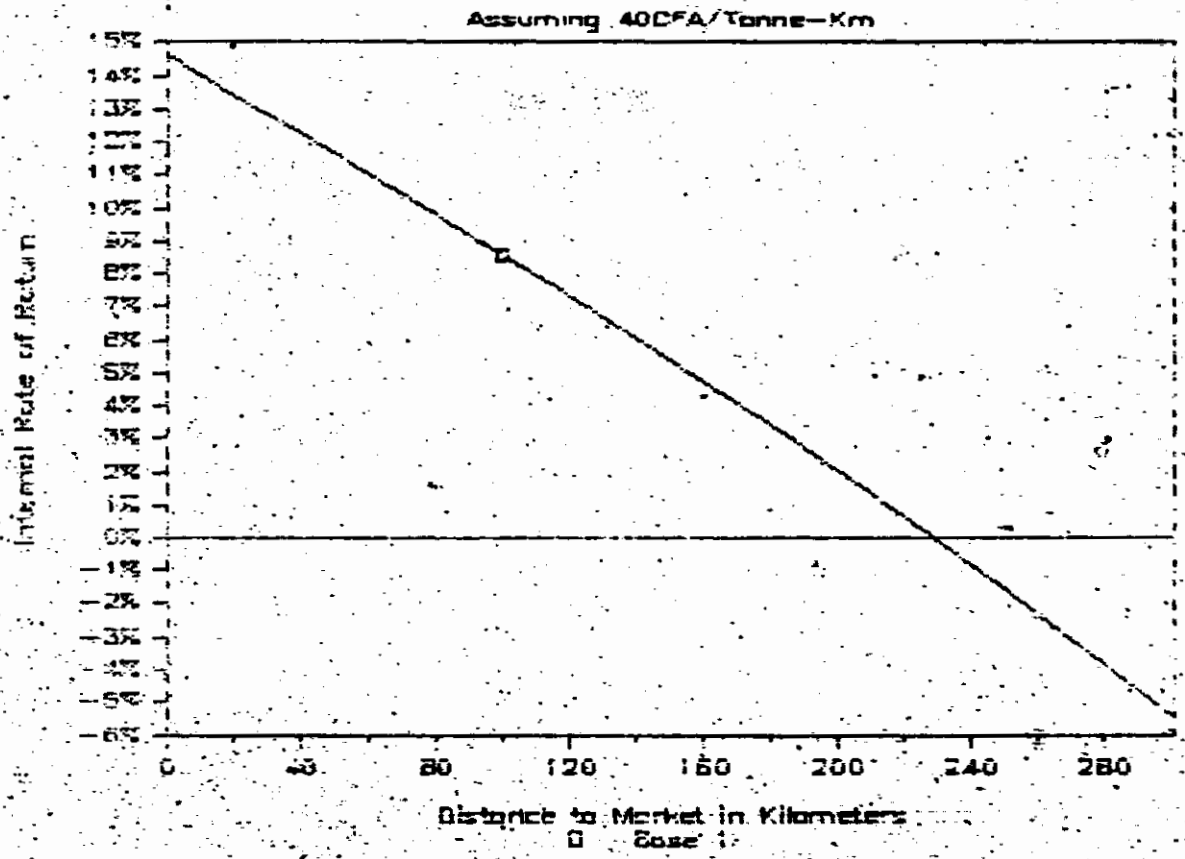
TABLE II.10
Summary of Financial Analyis Results

	Total IRR
Base 1	8.6%
Case 2 (Wood Price Rises 3% per Year)	13.4%
Case 3 (By-products of 2,000 CFA/Ha)	15.5%
Case 4 (Villagers Paid with By-Products)	12.9%
Case 5 (All Village Labor)	11.0%

	Cash IRR	Total IRR
Base 2	0.0%	10.5%
Case 7 (Wood Price Rises 3% per Year)	5.2%	13.7%
Case 8 (Non-Commercial By-products)	5.1%	16.6%
Case 9 (50% Lower Guard Costs)	4.1%	17.3%

EFFECT OF TRANSPORT DISTANCE ON IRR

Assuming 40CFA/Tonne-Km



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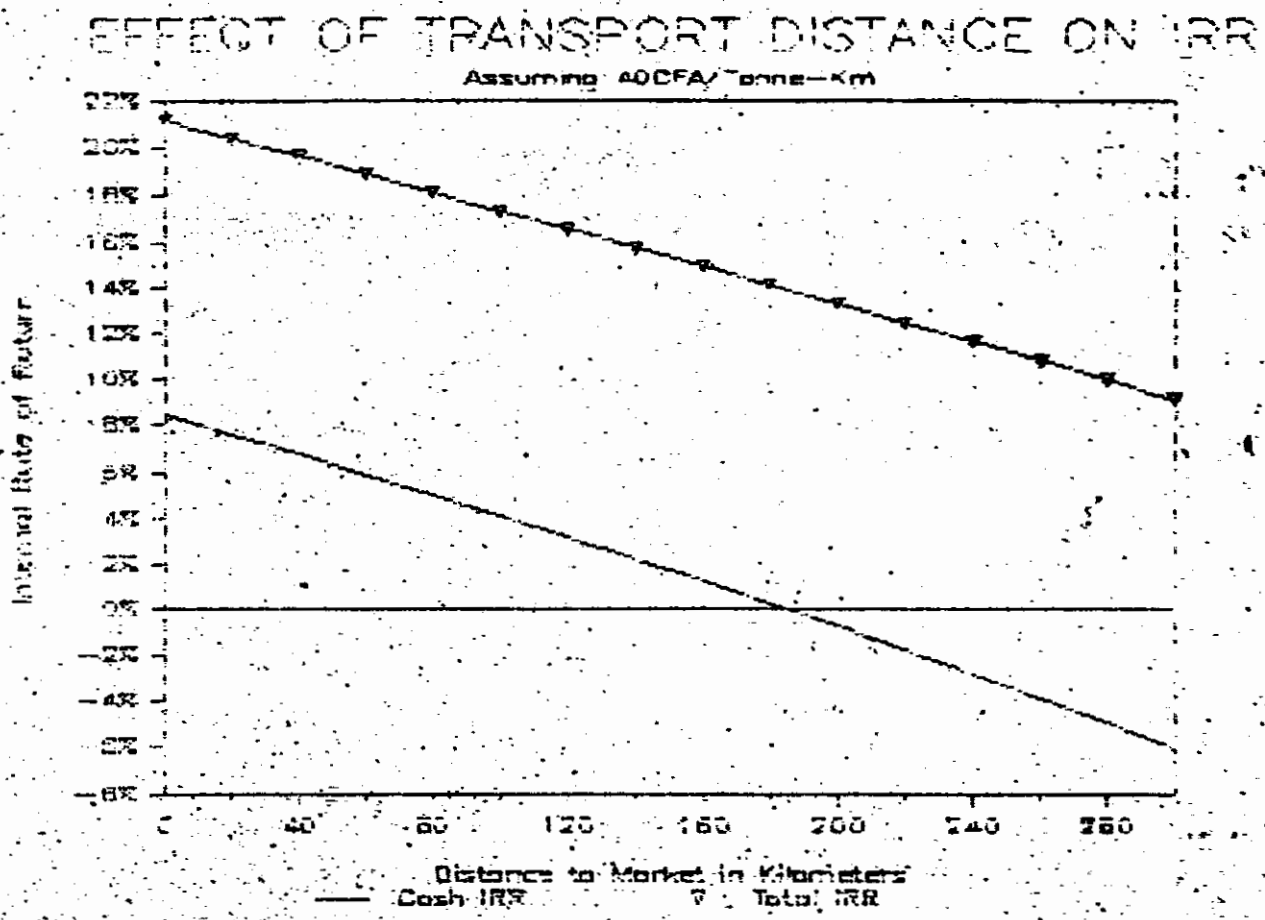

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o the "value of wood", as measured in the financial analysis by commercial market producer prices, is estimated at 15 CFA/kg. This figure is an estimate of the long term sustainable cost of wood production in the Fifth Region. It reflects a delivered market price considerably in excess of current prices, which are based on collection of wood as a free good.

o commercial fencing is assumed to be imported, and is shadow priced at 30% higher than the financial cost. This 30% figure does not represent a "best guess" technical estimate of the shadow price of foreign exchange in Mali, for a number of reasons. First, there is insufficient data on the Malian economy (including the impacts of its participation in the franc zone) to make such a determination; second, we were unable to obtain accurate data on import duties, which should properly be removed from the financial cost before applying the shadow price of foreing exchange; third, the estimated cost of fencing is itself drawn from non-Malian sources. Therefore, the implied shadow price in this assumption is between 30-50%, which is thought to be on the higher end of the probable range.

o the output of forest management is no longer measured, as in the financial analyses, as the total yield per hectare. The net gain to society is only the incremental yield which comes from managing the forest. However, this reduction (from total to incremental) is offset -- over time -- by the further assumption that in the absence of management the forests would be degraded at the rate of 3% per year.

The results of the economic analysis of Base 1, Base 2 and the related sensitivity cases are summarized in Table II.11. As that table indicates, the base 1 (and sensitivities) IRRs vary between 14.8% and 20.7%. Base 2 (and sensitivities) IRR vary between 26.4% and 31.8%. All the natural forest management options considered are highly profitable from a social perspective.

Conclusions

Formal management (base 1) is likely to be at least marginally viable from a financial standpoint, and clearly profitable from an economic one. Any one of a number of reasonable scenarios (such as case 2) would make it financially attractive. More importantly, management variations (cases 4 and 5) would make it financially profitable.

Minimum management systems (base 2) are both financially and economically attractive. However, there is likely to be a problem in gaining sufficient cash income to offset cash costs (both investment and recurrent). Guard costs are the principal recurrent cash outlay, and cooperative management systems which succeed in lowering those costs can give the

TABLE II.11
Summary of Economic Analyis Results

	Total IRR
Base 1	14.8%
Case 2 (Wood Price Rises 3% per Year)	19.0%
Case 3 (By-products of 2,000 CFA/Ha)	20.7%
Case 4 (Villagers Paid with By-Products)	--
Case 5 (All Village Labor)	18.2%

	Total IRR
Base 2	26.4%
Case 7 (Wood Price Rises 3% per Year)	29.3%
Case 8 (Non-Commercial By-products)	31.8%
Case 9 (50% Lower Guard Costs)	28.1%

project cash self-sufficiency while also achieving a very attractive overall financial IRR.

5. VILLAGE WOODLOTS

A number of uncertainties dominate the analysis of village woodlots. Experience in the AID Village Reforestation Project in the Fifth Region has shown very slow adoption of woodlots, low sustained interest and very low survival rates, for both seedlings and project initiatives.

This experience necessarily colors the financial analysis, but it focusses on trying to determine under what conditions financial incentive may be higher, rather than building in the assumption that it is low.

Financial Analysis

The investment costs occur in terms of village labor, materials and equipment (tools, fencing, well), and land (which may or may not have agricultural potential). The benefits can be viewed in a variety of ways: labor saved on wood collection, other direct benefits to villagers (fruit, medicines, construction materials), cash income (from any or all forest products, including firewood, other wood, fruit, etc.) and the perceived benefit of an improved environment.

The base case assumptions are laid out in Table II.12. It assumes commercial fencing, no well, use of land close to the village, with agricultural potential of 541 kg/ha valued at 70 CFA/kg (50% fallow), no commercial by-products, wood yields of 1.5 m^3/ha and village autoconsumption of all output (this implies that output is valued in terms of time savings). Labor valuations are as in the agroforestry cases and are shown in Table II.12. The results of the economic and financial analysis of village woodlots are shown in Table II.13. The base case is clearly uneconomic, with an IRR of -2.8%.

Case 2 slashes investment costs by replacing commercial fencing with live fencing and using non-agricultural land. Even if it assumed that the non-agricultural land is not so far from the village as to increase collection labor time and not so poor as to decrease yield, the IRR remains negative (-1.9%).

Case 3 looks at the impact of adding a well. We assume land which is not suitable for rainfed agriculture is used, thereby reducing the land cost. Expected yields are assumed to rise to 2.5 m^3. The increased yield substantially improves IRR, but the cost of the well still hold returns well below estimated peasant discount rates (IRR is 4.8%).

Case 4 adds to the case 3 assumptions commercial

TABLE II.12
Base Case Financial Assumptions for Village Woodlots

INPUTS		OUTPUTS	
Investment Inputs		Wood	
Labor		Kg/Yr/Total	16,200
Peak	300		
Off-Peak	1200	Labor Saved	
		Adult Labor	
Recurrent Inputs		Peak	164
Adult Labor		Off-Peak	748
Peak	58	Child Labor	
Off-Peak	1450	Peak	70
Child Labor		Off-Peak	187
Peak	57		
Off-Peak	231	PROJECT LIFE	
		Years	20
Land		Years to Full	
Total Ha	18	Production	6
Kg/Ha/Yr	541		
Price/Kg	70	LABOR VALUATIONS	
% Fallow	50%	Adult Labor	
Total Land		Peak	1400
Value (@ 10%)	1,704,150	Off-Peak	125
		Child Labor	
FENCING		Peak	840
CFA/Meter	975	Off-Peak	75
Total Meters	1700		

Labor inputs and savings in days. Labor values in CFA/day.
Land value = [18 Ha x 541 kg/Ha x 70F/Kg x .5 (% fallow)]
Above divided by .20 (financial discount rate)

TABLE II.13
Results Village Wood Lots

	Financial	Economic
Base Case	-2.79%	-5.67%
Case 2 (Non-ag Land)	-1.88%	-7.77%
Case 3 (Well, higher yld)	4.82%	2.29%
Case 4 (Fruit)	10.34%	7.31%
Case 5 (Fruit + By-prod)	15.73%	13.89%
Case 6 (Commercial Sale)	-8.26%	13.89%
Case 7 (Higher Cash Valuation)	2.92%	NA

production of 10,000 kilograms of fruit per year. Average price of fruit per kg is assumed to be 15CFA. net of transport. IRR is approximately 10%. Case 5 adds other forest products for commercial production, whose value is equal to that of 10,000 kgs of fruit. IRR rises to 15.7% but remains below the 20 percent level at which we estimate peasant discount rates.

The assumptions of cases 4 and 5 are optimistic if viewed in terms of replication. It is unlikely that the commercial market for fruit and forest products could sustain prices if large numbers of villages were engaged in commercial production. However, the value of the cases is to underscore that at present the market can provide incentives to those who supply it first.

Case 6 retains all case 5 assumptions and adds the assumption that all wood produced is sold commercially. This is thought to be especially relevant for farmers around Mopti who could supply a commercial urban fuelwood market. It is extremely interesting to note that IRR goes down very sharply in this scenario. While it is, of course, possible that this implies an overvaluation of labor time (i.e. that the analysis assumes the labor saved in autoconsumption of wood is worth more than the income derived in selling it), a more convincing argument seems to be that commercial market prices do not now allow for the costs of wood production. For prices to cover production cost, they would have to increase from 20 CFA per kilo to something between 35-40 CFA/kg, with the entire increment going to the producer.

Even if we allow for the very realistic prospect that peasants value cash income much more than labor savings, and value cash at twice its equivalent labor value the IRR is only 2.9%.

Economic Analysis

The following changes are made in the economic analysis: non-peak adult labor is valued at 70 CFA and child labor is given no value. Peak season labor valuations remain the same. Wood output is valued at the stumpage value of wood (15 CFA/kg), shadow prices of imported equipment (fencing, well) are 30% higher than financial values, and, finally, extension costs for the 18 hectare woodlot are 45,000 CFA in the first year, 20,000 CFA per year for the next five years and 10,000 CFA per year thereafter.

In the first instance, "externalities" are not valued. These are addressed explicitly below, however.

The addition of shadow prices and public extension costs reduce the economic rate of return relative to the financial. The use of stumpage value rather than labor savings, on the other hand, makes little difference to the overall rate of

return, except when it is compared to case 6 (commercial sale of wood). This is because the market price of wood is well below the peasant cost of production and the stumpage value is approximately equal to the peasant cost of production. Finally, the reduced valuation of labor slightly lowers investment and recurrent cost. This is, however, offset by the shadow prices and extension needs.

The overall effect of these changes is to make the economic IRR lower than the financial in all cases, except case 6, when external benefits are not valued.

In the base case, to achieve a 10% economic rate of return, external benefits would have to be valued at 570,000 CFA (32,000 CFA per hectare). This is over twice the economic stumpage value of the wood produced. It seems high given that the woodlot will not specifically protect agricultural land and that there are not likely to be sufficient hectares planted to reverse overall environmental degradation.

Conclusions

Financially, village woodlots are not attractive except when producing large amounts of by-products for which there are commercial outlets. If production of fruit or other forest products is justified by local market conditions, this is an option which should be investigated further. It should also be compared with production of food, for which the need is likely to be even stronger.

Economically, woodlots are equally unviable, as they require an expenditure of private and public resources which exceeds the value of the output of wood. External benefits may alter the economic viability, but unless the case can be made that there are extremely large external benefits from isolated woodlots which serve no direct soil protection function, and that these benefits are greater than those from spending an equivalent amount on other supply or demand measures, further public expenditure on woodlots seems questionable in the Fifth Region.

III. GLOBAL IMPACTS FROM FSDP PROJECT

1. THE POTENTIAL

The prospect for long-term impact is an important criterion in focussing the FSDP, although it is recognized that the full potential from the kinds of measures initiated will not be realized during the project life.

Supply Options

Using the 1976 census data and estimated growth rates developed by OPAM and USAID, the total resident population present in the Fifth Region is thought to be approximately 1.34 million in 1985. Urban population is calculated to be roughly 200,000, or 15% of the total. Continuing at

historical growth rates, total population by 1996 will be 1.75 million and urban population will reach 334,000 (21%).

Figure III.1 plots the historical and projected shifts in urban and rural population from 1976-1996. The sustainable yields of the natural forest in the region are estimated to be less than 50% of demand, leading to rapid forest depletion.

If the objective of forestry policy were to maintain the current ratio of sustainable yield to demand, then the yield would have to grow at least at the same rate as population. In fact, even this would not suffice to hold the supply-demand ratio constant, because the excess demand which already exists would continue to deplete the forests and lower future yields. Even abstracting from this extremely important issue, however, what would it take to grow enough wood to keep pace with increasing population?

Two alternative means of achieving the desired yield are compared: village woodlots, with an assumed yield of 1.5 m^3/Ha, and natural forest management, with an assumed "incremental" yield of 0.7m^3/Ha.

In Table III.1, column 1 shows total population. Column 2 shows population increase from the previous year. Column 3 shows "incremental wood demand" (Column (2) x 1m^3). Columns 4 and 5 show additional hectares needed each year to keep pace. Even this rather depressing table, however, makes one important understatement: woodlots planted in 1985 will not be fully producing until 1990-91, when population will be that much higher.

The cumulative establishment cost alone is $67 million for woodlots and $50 million for natural forest management. Several observations are in order:

o first, it is not likely that that many hectares of forest could be found in good enough condition to manage without further investment. Woodlot planting levels would need to draw human and land resources which in any case will not be available.

o second, the long lead times for woodlots would allow forest degradation to continue for 5-6 years after planting began (even if we started out in equilibrium), and would require annual planting levels to be 17% higher than shown ((1.027)6).

o finally, the fact that supply-demand balances are not now in equilibrium would imply continued forest depletion even if and when planting objectives were attained.

The foregoing numbers present an extremely simplified

URBAN, RURAL AND TOTAL POPULATIONS

Historical and Projected

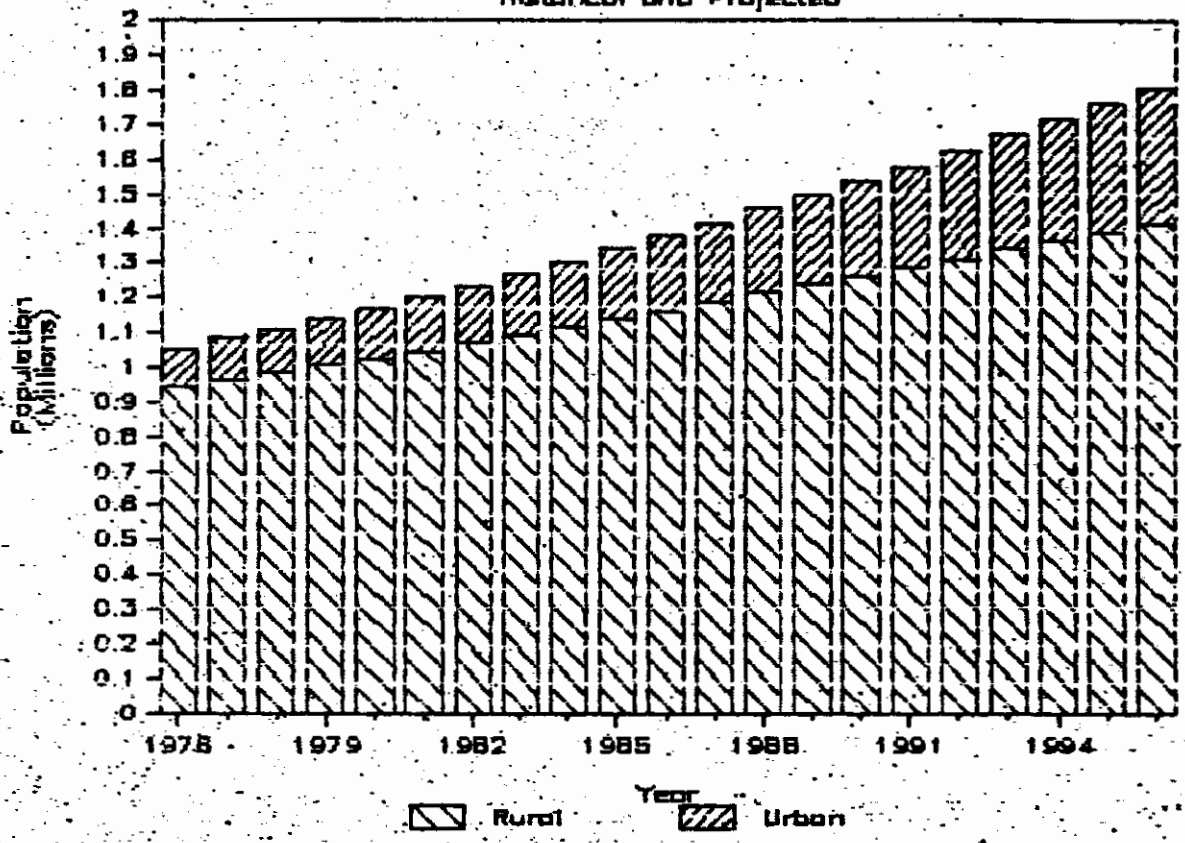

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TABLE III.1

Incremental Planting Requirement to Keep Pace with Population

Year	Population	Population Increase	Demand Increase	Increm Ha Woodlots	Increm Ha MgdFor
1985	1,341,000	36,207	36,207	24,138	51,724
1986	1,377,207	37,185	37,185	24,790	53,121
1987	1,414,392	38,189	38,189	25,459	54,555
1988	1,452,580	39,220	39,220	26,146	56,028
1989	1,491,800	40,279	40,279	26,852	57,541
1990	1,532,078	41,366	41,366	27,577	59,094
1991	1,573,445	42,483	42,483	28,322	60,690
1992	1,615,928	43,630	43,630	29,087	62,329
1993	1,659,558	44,808	44,808	29,872	64,012
1994	1,704,366	46,018	46,018	30,679	65,740
1995	1,750,384	47,260	47,260	31,507	67,515
1996	1,797,644	48,536	48,536	32,358	69,338
Cumulative Hectares Planted				336,787	721,686
Establishment Cost Per Hectare				$200	$70
Total Cumulative Establishment Cost				$67,357,367	$50,518,025

exposition of a very complex subject. However, detailed forestry sector projections carried out for several Sahelian countries using the Forest Resources Analysis and Planning Model (FRAP) confirm the same basic finding: in the best of scenarios, in already degraded environments in the under 600 mm rainfall zone, supply side measures are not likely to prevent forest degradation or to satisfy the wood demand of a growing population.

From an economic viewpoint, the cost of any effort must be measured not just in monetary terms, but in terms of what could be gained through the best alternative use of the same resources. This is known as the <u>opportunity cost</u>.

To gauge the opportunity cost of wood production, the starting premise is that the negative impact of excess demand for wood is forest depletion, from which two principal results flow: (1) increasing wood scarcity for the population and (2) destruction of the agricultural production base.

<u>Demand Options</u>

The 1985 Fifth Region urban population is approximately 200,000. If over five years the average cooking efficiency of urban households passed from 7.5% (estimated actually) to 15% (stoves already available get 26%. 35-40% efficiencies are plausible in the future); then as of year five, nearly 100,000 m^3 per year would be saved on a continuing basis (assuming that families replaced their stoves). This savings is almost three times as large as the incremental demand from popultion grown from 1985-1986. By 1996, the share of urban population will be over 20%, increasing the impact of urban efficiency improvement. If, over time, there were a spread of efficient woodburning stoves in rural areas as well, the savings potential is significantly greater.

There is some evidence that the demand for commercial metal stoves is promising throughout Mali, including in the Fifth Region. An excellent review of metal stoves efforts in Mali (Abbott, <u>et al</u>, November, 1984) reports on efforts in Mopti town, Diafarabe (in the Cercle of Tenenkou) and Bandiagara. It noted that, in Mopti, "as of yet, interest in the stoves is somewhat limited" but that "Mopti seems to be an especially interesting site for metal stoves as it has not only a relatively large professional population, but virtually everyone in the town buys their fuelwood". A later section on wood prices nationwide notes "Fuelwood prices throughout the country were found to be surprisingly homogeneous ranging from 1.250 to 1.500 CFA per donkeycart. It is interesting to note the firewood is so scarce in the town of Mopti, however, the full donkeycart loads are not for sale, and virtually the entire population is forced to buy their wood in small quantities, resulting in much higher monthly costs."

We do not know the cost of a successful cookstoves program. Many field workers feel that cost and success are inversely related. Certainly, to be successful, a program would rely on private artisans and/or commercial sale, keeping costs relatively low. The estimate used here -- with no scientific basis but with some programmatic insight -- is of a program cost between $1-2 million. Using this "order of magnitude" reasoning, $2 million would lead to annual wood savings about three times greater than in the woodlots/managed forest scenarios.

Two concluding points need to be clarified:

o the value of supply side initiatives is not limited to their impact on wood production. As treated explicitly in the microeconomic evaluations, fruit, medicines and services must also be taken into account in a final decision process.

o the reason for looking first to urban wood consumption is not in order to provide greater assistance to urban populations than to rural. It is because urban stoves will be easier to spread, <u>and the forests saved thereby are rural forests</u>.

<u>Agricultural Flows</u>

Hecatares planted for agriculture in the Fifth Region are probably somewhere between 500,000 and 600,000. As the best available measure, we use OPAM estimates of population and kilograms of grain needed per person to obtain an estimated total output of 272 million kilograms. Using an average yield of 500 kgs/Ha (the 1950-81 average was 541. Recent years are much lower, but are hoped not to be representative), this translates to 545,000 Ha planted. The official 1985 OPAM producer price for sorghum/millet is 70 CFA/kg. However, free market producer prices range upwards of 115 CFA. Since OPAM controls only a small share of the coarse grains market, we use an average producer price of 90 CFA/kg.

Based on these values, Table III.2 projects the value of agricultural production in the Fifth Region, assuming that average yields remain constant. At the establishment cost for on-farm tree planting of about $45/Ha, it would cost $24.5 million to bring all the agricultural land in the region under agroforestry. Annual costs to keep pace with growing population would be roughly $720,000. From 1985-1996, the cumulative costs would be $31.8 million. This compares with the cumulative woodlot cost of $67 million, which still does not bring wood supply-demand anywhere near equilibrium.

Applying the microeconomic assumptions used for in-field tree planting to the global analysis, we find that with a 5% increase in yields from agroforestry, and a 3% annual decline in yields without it, the net annual benefits start at $2.5 million and rise to over $20 million per year. The cumulative

TABLE III.2
Projected Agricultural Production

	Hectares Planted	Yield (Kg/Ha)	Output (MT)	Producer Price (CFA)	Output Value (US$)
1985	545,000	500	272,500	90	$49,050,000
1986	555,900	500	277,950	91	$50,781,465
1987	567,018	500	283,509	93	$52,574,051
1988	578,358	500	289,179	94	$54,429,915
1989	589,926	500	294,963	96	$56,351,291
1990	601,724	500	300,862	97	$58,340,491
1991	613,759	500	306,879	98	$60,399,911
1992	626,034	500	313,017	100	$62,532,027
1993	638,554	500	319,277	101	$64,739,408
1994	651,325	500	325,663	103	$67,024,709
1995	664,352	500	332,176	104	$69,390,681
1996	677,639	500	338,819	106	$71,840,172

Table II.9 shows the base 1 and base 2 assumptions. Typical data and management system options are drawn from the Dinderesso Managed project (Burkina Faso) and the Guesselbodi Forest (Niger). A number of management insights are drawn from meetings in Bamako with Dr. Kjell Christofferson, Project Director of the Dinderesso Project, and from John Heermans, Technical Advisor for Guesselbodi.

Base 1 assumes that wood will be exploited for commercial sale, and that no forest by-products will be sold. Establishment costs per hectare include fencing and firebreaks. Recurrent costs include a combination of commercial and village labor. Village labor is paid in-kind with 30% of the wood harvested by such labor. Average transport distance to market is an important determinant of financial viability. The base case (both base 1 and base 2) assumes this distance to be 100 kilometers, but the effect of changing transport distances is treated explicitly below.

Base 2 is the "minimum management" case. It is similar to the approach currently being tried, with some success, in Guesselbodi. It involves managing only those sub-areas with sufficient forest stands to manage (rather than managing and protecting an entire rectangular space). No fencing is used. Therefore, the only investment costs are some site preparation and firebreaks. Recurrent costs include around the clock guard protection. In this case, wood products are largely non-commercialized (60%).

Financial Analysis

This analysis is fundamentally different from that of the other initiatives (in-field tree planting, windbreaks, cookstoves) considered, in that the financial analysis is not carried out from the perspective of the villager, simply because he is not the investor. Instead, it examines the cash cost-benefit implications for forest management, and therefore becomes an indicator of the sustainability of operations without continued public subsidy.

In practical terms, this implies that village labor obtained in exchange for wood is not given a monetary value. In the same way, the wood provided villagers for their collection work is simply deducted from the overall quantity of wood which is sold commercially. The financial analysis does not assume that the public sector is the only possible management agent, however. Both Dinderesso and Guesselbodi are experimenting with cooperative village management systems, with cash return as well as environmental stabilization being the principal objectives of the coops.

In base 1, the IRR is 8.57%, if 70% of the wood is commercialized, with an average transport distance to market of 100 Km. If real wood prices in Mopti increase by 3% per year (case 2), then IRR rises to 13.35%. Case 3 shows the

benefits to agricultural production would be over $150 million (Table III.3).

Table III.4 takes the global estimates of potential impact made in this section and groups them for standardized comparison. It is to be stressed that none of these estimates reflects on what specifically would be accomplished under the FSDP, but on the levels of expenditure required to achieve major impacts through one of the approaches considered.

The ranking in Table III.4 suggests several things:

o that the payoff from pursuing a soil conservation/efficiency improvement strategy in the Fifth Region is much higher than from pursuing a wood supply strategy.

o that within this project's resources -- or, for that matter, any reasonable estimate of financing available from all sources for Fifth Region forestry efforts, a joint strategy (both soil conservation/efficiency improvement and wood supply) cannot be implemented.

o that important overall impacts could be achieved even with the limited FSDP resources if the soil conservation/efficiency improvement strategy is adopted.

2. GLOBAL TARGETS FOR FSDP

It is impossible to perform a rate of return analysis on an entire project such as the FSDP, simply because there are many components (research, studies, etc) which do not yield a specific return, and also because the heavy cost of long-term technical assistance does not reflect sustainable long-term costs.

Total project resources are $14 million over a ten year period. This is a nominal figure, and includes an amount of inflation that will be considerable. We impute the following total nominal costs (including research, studies, demonstration, pilot programs and outreach) to in-field tree planting and to stoves:

o in-field tree planting: $5,500,000

o stoves: $1,000,000

The bulk of the stoves expenditure is assumed to take place in the first three years, thus the nominal figure is converted to real dollars by dividing by 1.05^3 (5% inflation rate), yielding a real investment of about $850,000. Agroforestry expenses are distributed over seven years, placing the real investment at just under $4 million.

The issue addressed in this section is "What global

TABLE III.3
Potential Gains from In-Field Tree Planting

	Hectares Planted	Yield w/o Agrofor	Prod Price	Yield w/ Agrofor	Annual Savings	Cumulative Savings
1985	545,000	500	90	525	$2,452,500	$2,452,500
1986	555,900	485	91	525	$4,062,517	$6,515,017
1987	567,018	470	93	525	$5,735,829	$12,250,846
1988	578,358	456	94	525	$7,474,697	$19,725,543
1989	589,926	443	96	525	$9,281,463	$29,007,006
1990	601,724	429	97	525	$11,158,551	$40,165,557
1991	613,759	416	98	525	$13,108,471	$53,274,028
1992	626,034	404	100	525	$15,133,823	$68,407,852
1993	638,554	392	101	525	$17,237,297	$85,645,149
1994	651,325	380	103	525	$19,421,679	$105,066,828
1995	664,352	369	104	525	$21,689,853	$126,756,681
1996	677,639	358	106	525	$24,044,805	$150,801,486

TABLE III.4
Comparison of Alternative Approaches

Initiative	Total Cost	Total Benefits	Cost/ Benefits
URBAN STOVES	$2,000,000	$13,800,000	0.14
WOODLOTS	$67,000,000	$55,125,000	1.22
NATURAL FORMGMT	$50,500,000	$55,125,000	0.92
AGROFORESTRY	$31,800,000	$241,587,533	0.13

Note: Economic values are used for both wood and agricultural outputs (1 Kg wood = 15 CFA; 1 Kg Sorghum = 120 CFA) Total benefits refer to hypothetical cumulative impacts for the period 1985-1996. These are not estimates of what FSDP will or might achieve.

impacts should the project target as necessary to get a minimum return on the resources expended?"

Because of the heavy setup, testing and demonstration costs which will create benefits beyond the project life, we take the minimum acceptable rate of return to be 6% in real terms.

An important caveat is in order before proceeding: the FSDP approach stresses creating the preconditions for actions which will flow as much from private initiative as from public investment. It is therefore somewhat deceptive to assess the return on public investments, which presupposes that such investment will directly generate the benefits. However, we use this criterion on the premise that it would be worse to spend large sums of public money without any specification of what measurable benefits should accrue to the population within the project life.

Stoves

Table III.5 shows the annual production rate of stoves, which, if achieved by 1990 and maintained thereafter, would result in a 6% real rate of return for the $1 million of nominal program costs. It assumes that stoves are 20% efficient. Annual savings per stove are based on consumption of 1 m^3 per person per year, two stoves per household and an average household size of six. The "Wood Value" used is neither the producer price nor the urban retail price. Instead, it is an estimate of the economic stumpage value -- that is, the minimum replacement cost of the forest.

The annual production rate of 1300 stoves corresponds to 110 stoves per month, or roughly 4-5 stoves per day. This figure does not include replacement stoves, which would make production requirements in later years somewhat higher.

Agroforestry

Table III.6 performs the same calculation for agroforestry. Each project initiated is assumed to have a 20 year life, with a 50% terminal value. Only hectares planted during the FSDP project life are counted, although their benefits are tracked for a full twenty years after planting (this is the reason for which annual benefits in later years decline - as the first hectares planted reach the twenty year limit). Wood output is set at 0.3 m^3/Ha, as in the micro analysis, and is valued at the economic stumpage value. Real producer prices for grain are projected to rise at 1.5% per annum. Agricultural production gains are the same as in Table III.3.

FSDP expenditures on in-field tree planting, at an imputed nominal program cost of $5,500,000 (39% of total project resources) would achieve a 6% real rate of return if the new hectares brought under agroforestry achieved an

TABLE III.5
Urban Stoves Wood Savings

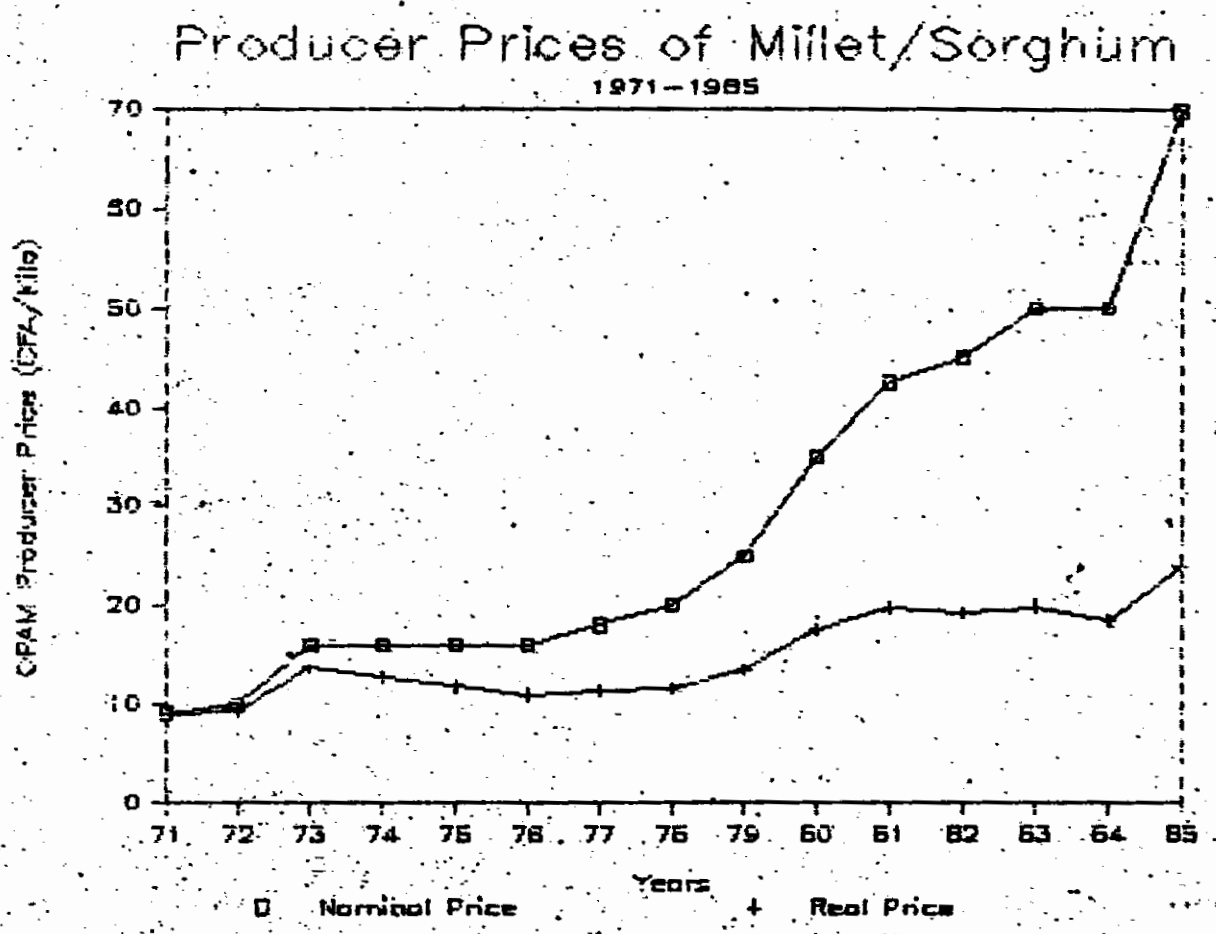
	Annual Production	Total Stoves	Saving/ Stove (M3)	Wood Val Per Kg (CFA)	Annual Saving	Cumulative Saving
1990	1300	1300	1.8	15	$42,120	$42,120
1991	1300	2600	1.8	15	$84,240	$126,360
1992	1300	3900	1.8	15	$126,360	$252,720
1993	1300	5200	1.8	15	$168,480	$421,200
1994	1300	6500	1.8	15	$210,600	$631,800
1995	1300	7800	1.8	15	$252,720	$884,520
1996	1300	9100	1.8	15	$294,840	$1,179,360

PROGRAM COST (NOMINAL DOLLARS) $1,000,000
INTERNAL RATE OF RETURN 6.56%

TABLE III.6
Planting Requirements for Viability of FSDP Expenditure

	Hectares Planted	Yield	Producer Price	Yield w/ Agrofor	Output Value	Agrofor Savings	Wood Value	Cumulative Savings
1985	800	500	90	525	$75,600	$3,600	$4,385	$3,600
1986	1,600	485	91	525	$153,468	$11,693	$8,770	$24,062
1987	2,400	470	93	525	$233,655	$24,278	$13,154	$61,495
1988	3,200	456	94	525	$316,213	$41,357	$17,539	$120,391
1989	4,000	443	96	525	$401,195	$62,933	$21,924	$205,248
1990	4,800	429	97	525	$488,656	$89,013	$26,309	$320,569
1991	5,600	416	98	525	$578,650	$119,603	$30,694	$470,866
1992	6,400	404	100	525	$671,234	$154,714	$35,078	$660,659
1993	7,200	392	101	525	$766,466	$194,359	$39,463	$894,481
1994	8,000	380	103	525	$864,403	$238,550	$43,848	$1,176,878
1995	8,800	369	104	525	$965,106	$287,304	$48,233	$1,512,415
1996	9,600	358	106	525	$1,068,635	$340,639	$52,618	$1,905,671
1997	9,600	347	108	525	$1,084,665	$367,916	$52,618	$2,326,204
1998	9,600	337	109	525	$1,100,935	$395,260	$52,618	$2,774,082
1999	9,600	326	111	525	$1,117,449	$422,676	$52,618	$3,249,376
2000	9,600	317	113	525	$1,134,211	$450,172	$52,618	$3,752,165
2001	9,600	307	114	525	$1,151,224	$477,754	$52,618	$4,282,537
2002	9,600	298	116	525	$1,168,492	$505,427	$52,618	$4,840,582
2003	9,600	289	118	525	$1,186,019	$533,199	$52,618	$5,426,398
2004	9,600	280	119	525	$1,203,810	$561,075	$52,618	$6,040,091
2005	9,600	272	121	525	$1,221,867	$589,063	$52,618	$6,681,772
2006	9,600	264	123	525	$1,240,195	$617,168	$52,618	$7,351,557
2007	8,800	256	125	525	$1,153,898	$591,613	$48,233	$7,991,403
2008	8,000	248	127	525	$1,064,733	$561,463	$43,848	$8,596,714
2009	7,200	241	129	525	$972,634	$526,688	$39,463	$9,162,865
2010	6,400	233	131	525	$877,532	$487,260	$35,078	$9,685,204
2011	5,600	226	133	525	$779,358	$443,146	$30,694	$10,159,044
2012	4,800	220	135	525	$678,041	$394,312	$26,309	$10,579,665

2013	4,000	213	137	525	$573,510	$340,722	$21,924	$10,942,311
2014	3,200	207	139	525	$465,690	$282,337	$17,539	$11,242,187
2015	2,400	201	141	525	$354,507	$219,116	$13,154	$11,474,458
2016	1,600	194	143	525	$239,883	$151,017	$8,770	$11,634,245
2017	800	189	145	525	$121,741	$77,994	$4,385	$11,716,624



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annual level of approximately 800. Since the expected increase in yields is an extremely uncertain number, we have tested the effects on rates of return if varying yield levels are assumed, as shown in Figure III.2.

IV. POLICY REFORMS AND RECURRENT COST ISSUES

1. PERMIT FEES

Estimating the Stumpage Value of Wood

The stumpage value of wood refers to the value of the resource at site, exclusive of transport and handling. The stumpage price refers to the price paid to gain access to the resource. The true stumpage value of wood from the forest is the cost of producing wood. A stumpage price below this level makes wood available at less than cost, and is therefore not sustainable.

Because forest resources are freely available to users, the financial cost of forest exploitation is necessarily well below the economic cost of reconstituting the forest. In isolated rural areas, it is virtually impossible to implement measures which reduce the gap between financial and economic costs. Around urban areas, however, taxes on commercial wood exploitation serve to recover a minimum stumpage value for each unit of wood removed from the forest for resale. In practice, this is achieved by granting permis de coupe which specify the duration, volume and cutting practices for wood exploitation. The current permit costs for firewood are approximately 100 CFA (200 MF) per stere.

Table IV.1 uses the microeconomic data of Section II to establish the minimum stumpage values of wood under alternative production options. The method consists of taking the net present cost of production per stere over the project cycle (twenty years). The table also shows the results of similar calculations made for commercial plantations and forest management in Senegal and Niger by Baah-Dwomoh for the World Bank. The minimum stumpage value of wood in the Fifth Region is 3100 CFA/stere. Because this represents the forest management option which presupposes that the natural forest is in good enough condition to manage (see Section II.4), it is thought to be an underestimate for urban supply zones. We therefore select 4500 CFA/stere as the estimated stumpage value used in this analysis.

The economic objectives of the permis de coupe are twofold: to provide a source of revenue to the forestry service with which to replenish the forests being exploited; to bring the financial cost of forest exploitation closer to the true resource cost. The current permit cost translates into a stumpage price of 100 CFA/ 300 Kgs = 0.3 CFA/kg. This

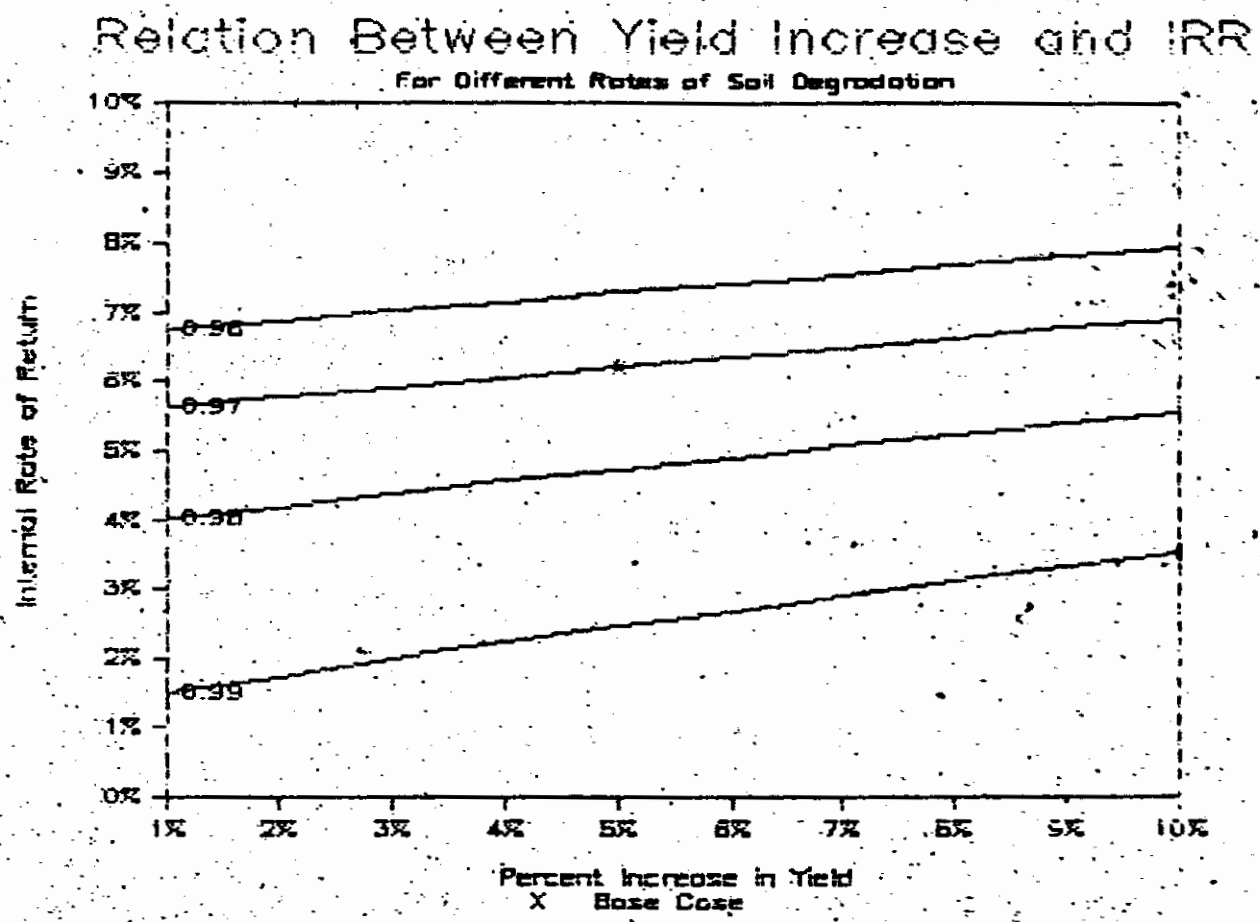

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TABLE IV.1
Estimated Stumpage Value of Wood in the Fifth Region

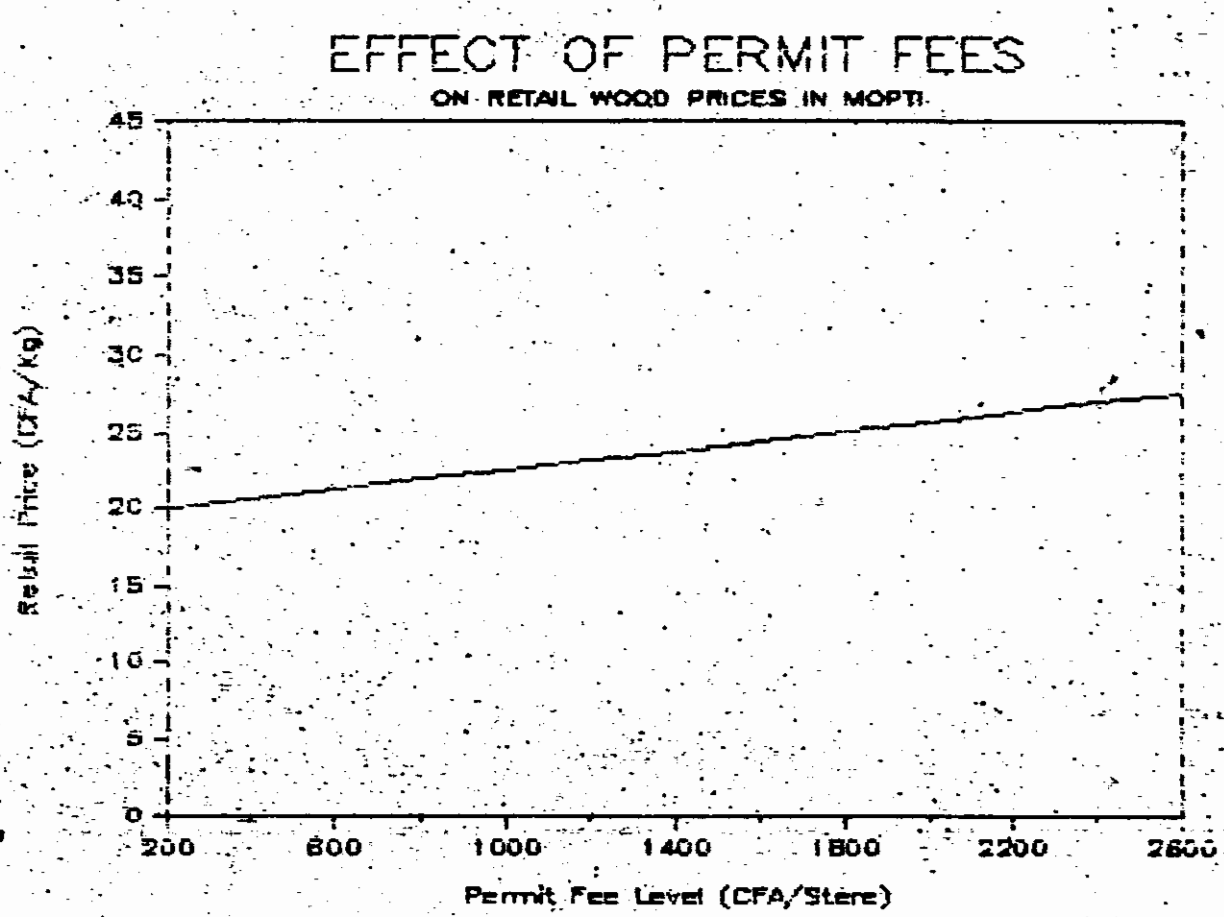
	Natural Forest Management	Village Woodlots
Establishment Cost (per hectare)	31,500	186,300
Recurrent Cost (per hectare)	11,700	18,000
Present Value of 20 Year Costs at 10% discount rate	117,450	306,450
Yield per Hectare (Kgs)	600	900
Total 20 Year Yield/Ha	11,100	14,850
Stumpage Value per Stere (300 kgs)	3,174	6,191
Stumpage Value per Kilogram	11	21

Baah-Dwomoh Estimates (World Bank - 1983)

	Senegal	Niger	Mali
Managed Forest			
Per Stere (400 kgs)	5,820	--	--
Per Kilogram	15	--	--
Plantations			
Per Stere (400 kgs)	5,780	8,510	3,855
Per Kilogram	14	21	10

TABLE IV.2
Impact of Higher Permit Fees on Payback for Improved Cooking Stoves

Permit Fee Level	Wood Price	Payback Period (Weeks) Trad to Bozo	Trad to Metal	Bozo to Metal
200	20.0	0.58	4.62	10.69
600	21.2	0.54	4.35	10.07
1000	22.5	0.51	4.11	9.50
1400	23.8	0.49	3.89	8.99
1800	25.0	0.46	3.69	8.54
2200	26.3	0.44	3.51	8.13
2600	27.6	0.42	3.35	7.75



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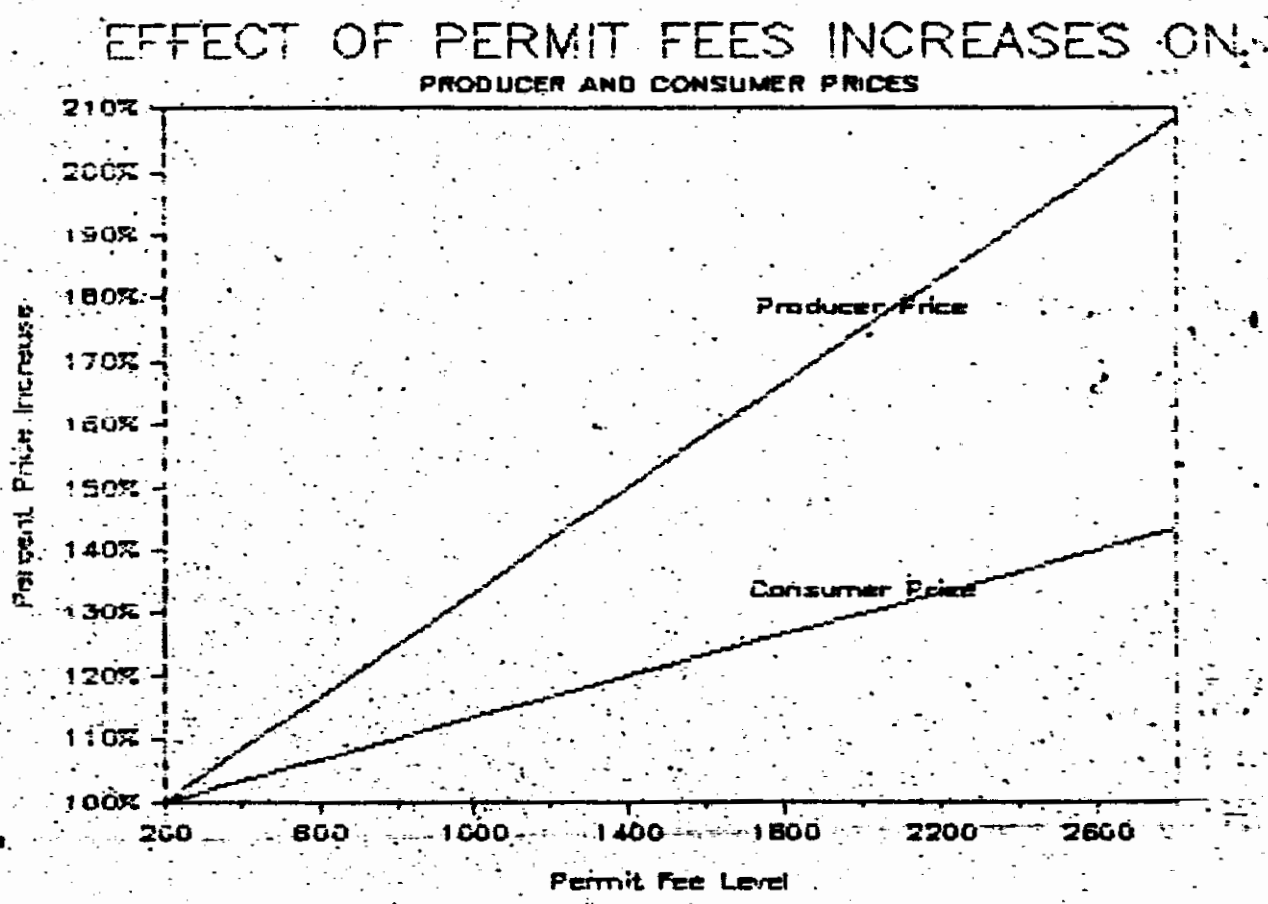

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Income Levels and Distribution

If all commercialized wood were effectively taxed, each 100% increase in permit fees over current levels would add about 20 CFA per week to the average household's weekly energy bill. A ten-fold increase would add 15% to energy costs - an increment equal to about 2.3% of average household income. This increased cost would, of course, be offset by an equivalent improvement in average energy efficiency (from 7.5% to 8.5%). Unfortunately, the state of technology does not allow incremental efficiency improvements for individual households. Those who have the cash to acquire improved stoves would more than offset the price increase. Those who do not would suffer a decline in real income.

The above figures assume that the production and distribution system will add on the increased tax costs even for wood which evades taxation (about 80% of commercial wood). If this were the case, then urban households in the region would pay approximately 260 million CFA per year in increased costs (which they may or may not offset by improved efficiency). Of this, roughly 208 million would go for increased production/distribution profits and 52 million for increased forestry fund revenues.

The net benefits which flow from these income transfers depend on several factors:

o the higher the proportion of wood effectively taxed, the greater the social benefit from the redistribution of income (by reducing intermediary profits in favor of wood production).

o if funds are used to support stove efficiency improvement, there is a three-fold benefit: real energy costs to urban users would decline, price incentives to wood production would increase and pressure on the natural forest would decrease

o to the extent that the extra profit on untaxed wood were retained by producers/collectors, the effect would be beneficial (greater incentive to produce). There is no a priori basis for determining that this will occur, however.

The Importance of Tax Coverage

The term "tax coverage" is used here to refer to the percent of commercialized wood flows which are effectively taxed, which we estimate at between 20-25% (Section II.3). This suggests that the effective stumpage price being paid for wood exploitation is only one fifth of the nominal stumpage price, and that the effective ratio of stumpage price to stumpage value is approximately four tenths of one percent (2% x .2). Baah-Dwomoh (1983) points out "the main

conclusion one can draw ... is that wood pricing practices in Sahelian countries are woefully inadequate". The conclusion is clearly valid in Mali as well.

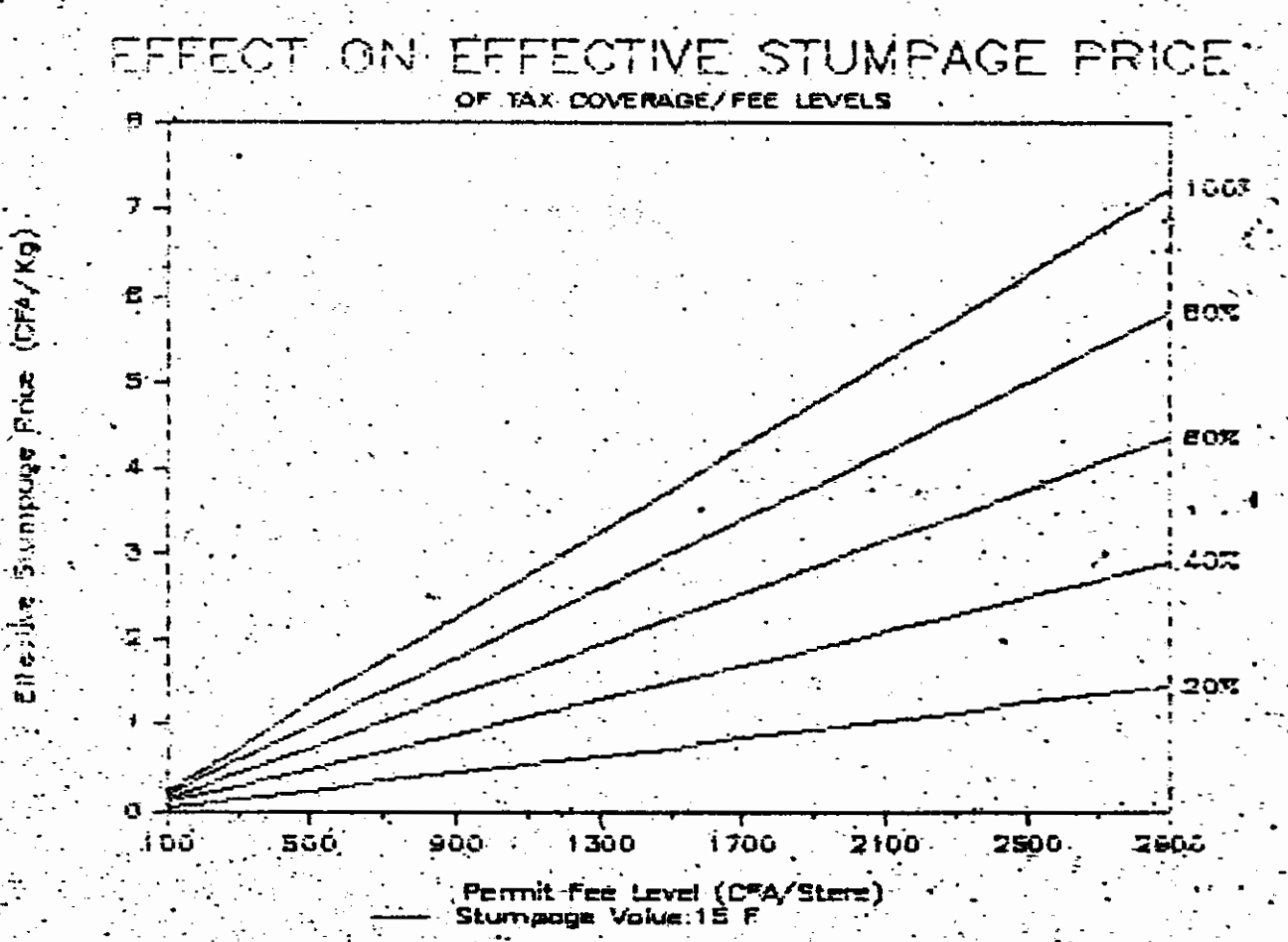
The objective of pricing policy should not be limited to increasing the nominal stumpage price (permit fees). It should be to increase the effective price (permit fees times the percent tax coverage). Alternatives for increasing tax coverage are discussed in Shaikh (1984). Figure IV.3 shows the impact on effective stumpage prices of different combinations of tax coverage and permit fee levels.

Conclusions

There is no realistic prospect of bringing the cost of forest exploitation into alignment with the costs of production. There are major economic advantages to bringing the two closer, however. The effective constraint to raising permit prices is likely to be political. If fees reflected the full cost of production, they would be 4500 CFA/stere, and urban wood prices would be 35CFA/kg (vs 20CFA now). While this would severely squeeze urban incomes, it should be noted that (a) using available, proven, cost-effective and financially attractive technologies, efficiency improvement can more than offset this cost increase in household budgets (b) the sooner the prices reflect production cost, the greater the prospect of achieving sustainable supply levels through market mechnanisms and (c) in the absence of appropriate pricing policies, wood prices are likely to rise to the same levels over time (increasing transport distances will add rapidly to the retail price), but without the necessary price incentives to production which would encourage sustainable supply.

Point (c) merits further comment: a 35 CFA retail price brought about through tax increases (with exemption for wood produced) could provide the incentive to make wood production very financially attractive. Results would flow in no less than 5-7 years after such incentives were in place (the lead time to production). The same price levels achieved because of increasing scarcity and greater transport distances may or may not provide incentives to increased production. They could also lead to increasing reliance on charcoal, because it is financially cheaper to ship charcoal than wood (see Figure IV.4). Widespread use of charcoal would devastate what forests are left in the Fifth Region.

Finally, a combined policy of increasing permit fees and improving tax coverage is the best way of raising stumpage prices while maximizing revenue flows to productive forestry investment.



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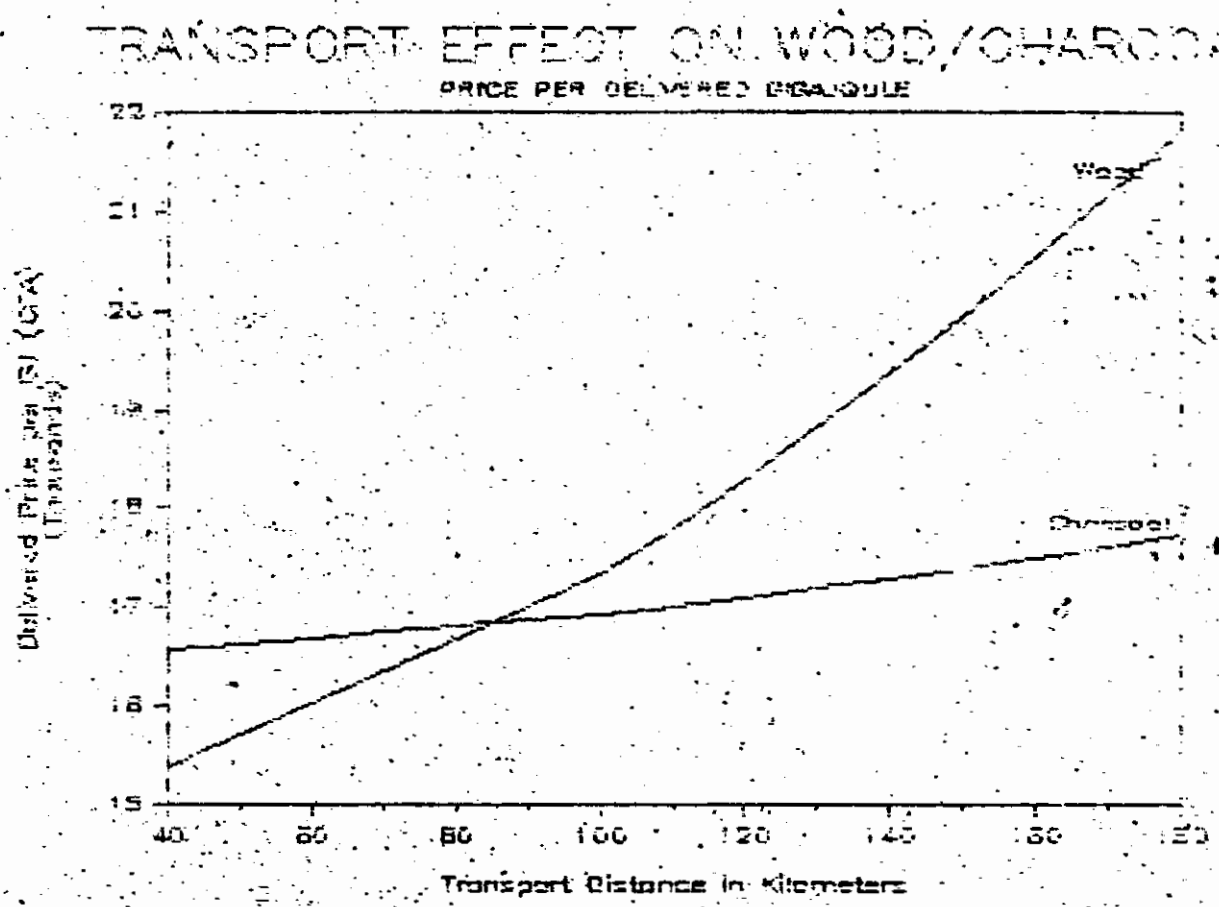

Assumes 30% distributor markups. Energy content wood 11.45 GJ/MT. Energy content of charcoal 28.5 GJ/MT. Base urban wood price 20 CFA/kg. Charcoal 80 CFA/kg. Charcoal stove efficiency 18%; Wood stove efficiency 8%.

Sources: E/DI Energy Conversions Card
Mali data for Fifth Region

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2. FORESTRY FUND REVENUES AND FSDP RECCURENT COSTS

This section addresses two issues:

o what might be the revenue implications of curtailing fining activities by forestry agents?

o what are the expected recurrent costs which would flow from the FSDP, and how might the necessary revenue be raised?

Transactions Revenues

Transactions revenues are obtained through fines on illegal practices. In 1982, transactions revenues from forestry fines were 104 million Malian francs (52 million CFA). The argument is widely accepted that while fines serve a useful protective function, there is widespread abuse by forestry agents. Abusive practices in the Fifth Region are now an impediment to rational resource management by villagers, and their curtailment may be a precondition (necessary but not necessarily sufficient) to successful tree planting activities. The possible reductions in forestry fund revenues which would result from curtailing abusive fining is therefore a valid economic concern.

Under current legislation, 75% of all reported fines go to the forestry fund. Thus the 104 million of revenues represents approximately 140 million MF of fines imposed <u>and reported</u>. Agents have great incentive not to report fines because they keep 100% of unreported levies. There is no information on the extent of unreported fining, but it is known to be widespread.

It would be simplistic to suppose that reducing abusive fines would necessarily imply a one to one reduction in reported fines and therefore in forestry fund revenues. Even in the absence of reliable data, it is reasonable to focus initial efforts on reducing <u>unreported</u> fines. If successful, this could both reduce the actual number of fines imposed and could possibly lead to an increase in reported fines (and in fund revenues).

If further reductions in fining were deemed useful, then we can calculate the following relationship, based on 1982 data:

o a ten percent decrease in transactions revenues would be offset by a .5 CFA/kg (150CFA/stere) increase in permit fees or

o by a 15% improvement in tax coverage (from 20% to 35% coverage)

Figure IV.5 shows the permit fee levels necessary to offset a given percentage decline in transactions revenues. The X-axis shows percent decreases in transactions revenues. The Y-axis shows permit fee levels. Each curve represents a different level of tax coverage, with the highest curve being 20% coverage and the lowest 100% coverage.

Figure IV.5 merely plots a quantitative relationship. It says nothing of the benefits or costs of reduced fining operations. If, however, the premise of the social analysis is proven in pilot tests, then Figure IV.5 overstates the need to compensate reduced transactions revenues because a further benefit would be the improved forest management that would not be possible without reducing fines. Leaving aside any issues about the possible injustice of abusive fines, a ten percent reduction in fine revenues would be compensated if it resulted in roughly 580 m^3 of extra wood output, given the economic stumpage value of 15 CFA/kg.

Recurrent Costs

Section III.4 establishes target hectarage levels for agroforestry and production levels for urban stoves. At those levels, the total imputed FSDP investments in those sectors would achieve a 6% real rate of return. These levels, plus hectarage targets for natural forest management, are summarized below:

MINIMUM FSDP ANNUAL TARGETS

Agroforestry	Management	Urban Stoves
800 Ha	400 Ha	1300 Stoves

If the same levels were maintained thereafter, what would the recurrent costs be? We note that the recurrent costs would be lower than total FSDP costs to achieve these target levels, because FSDP will have borne the investment costs.

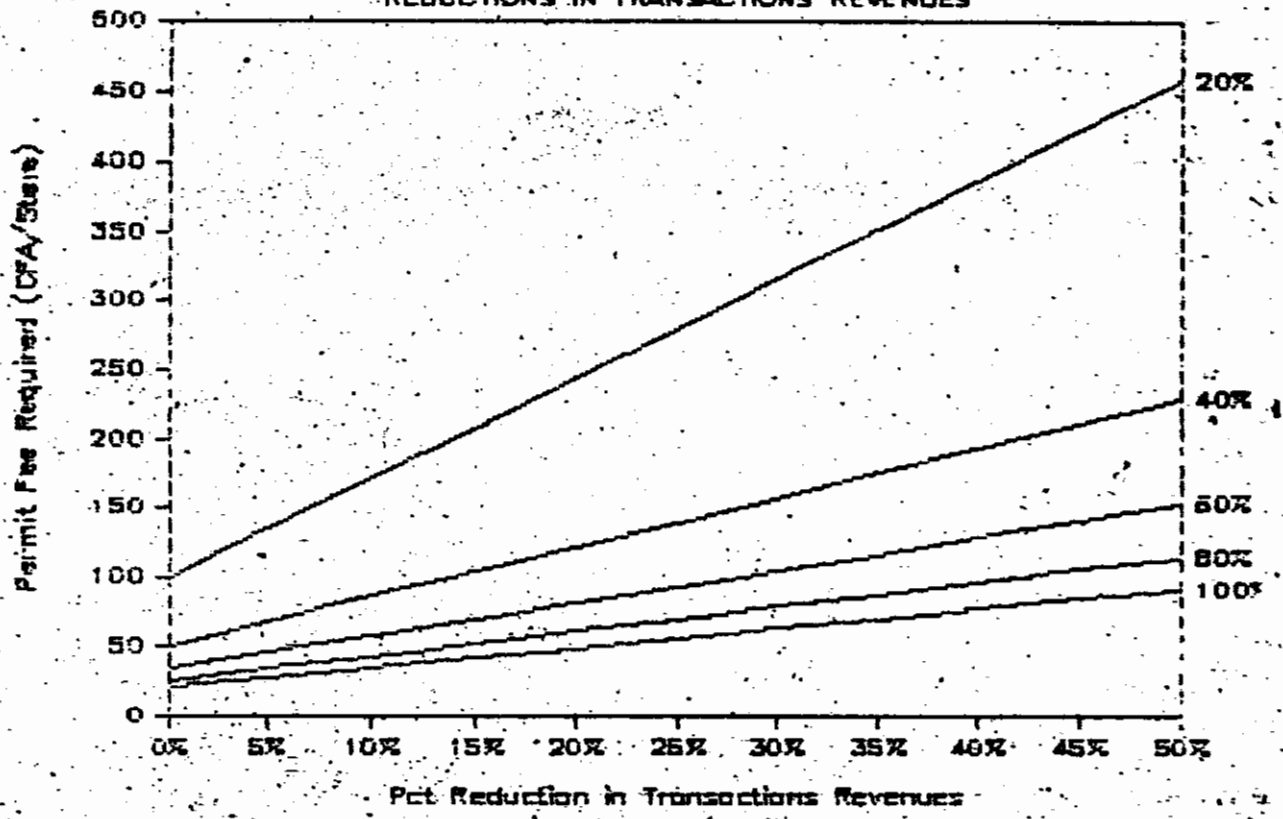
We use the following unit cost figures:

- o agroforestry : $45 per hectare
- o natural forest management: $70 per hectare
- o stoves: possibly negligeable (commercial production) but no higher than the retail price of the stove (2000 CFA).

For the target levels, total recurrent costs break down as follows:

PERMIT FEE LEVELS TO OFFSET

REDUCTIONS IN TRANSACTIONS REVENUES



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o Agroforestry: $36,000 per year

o Natural Forest Management: $28,000 per year

o Stoves: $0 to $6000 per year

TOTAL: $67,000 PER YEAR = 30.1 MILLION CFA

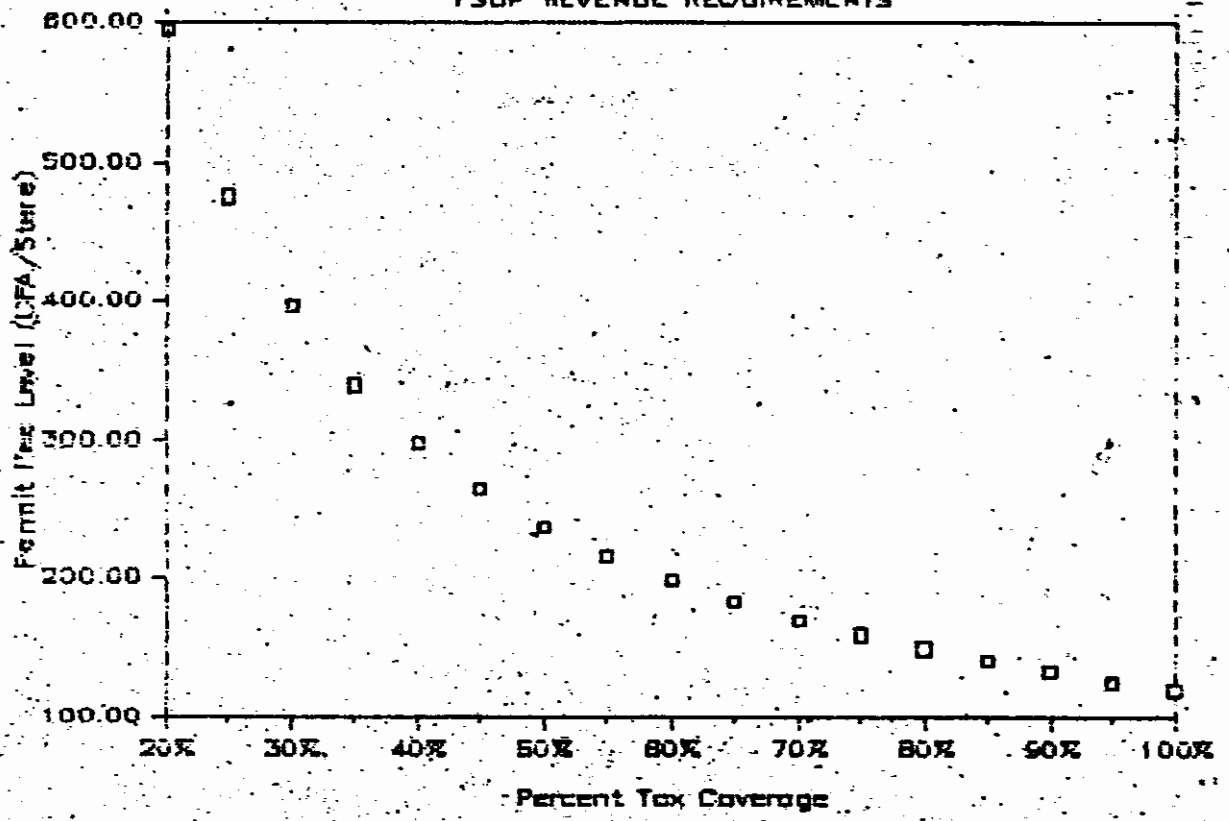
To this we add 20% in overheads, on-going training, etc, to reach roughly 36 million CFA per year.

Working from the premise that revenue generation is the appropriate means of meeting these recurrent costs, Figure III.7 shows the combination of permit fee levels and improved tax coverage which would achieve the objective. It establishes that, <u>if transactions revenues remained stable</u>, a number of reasonable combinations of taxes and coverage -- which are in themselves economically useful -- could potentially satisfy incremental financing needs. Figure IV.8 shows the financing requirement to offset the combination of increased recurrent costs <u>and decreased transactions revenues</u>.

It should be noted that all of the above figures are in <u>real</u> terms, and will have to be adjusted for inflation between now and the end of project life.

COVERAGE/FEE COMBINATIONS TO MEET

FSOP REVENUE REQUIREMENTS



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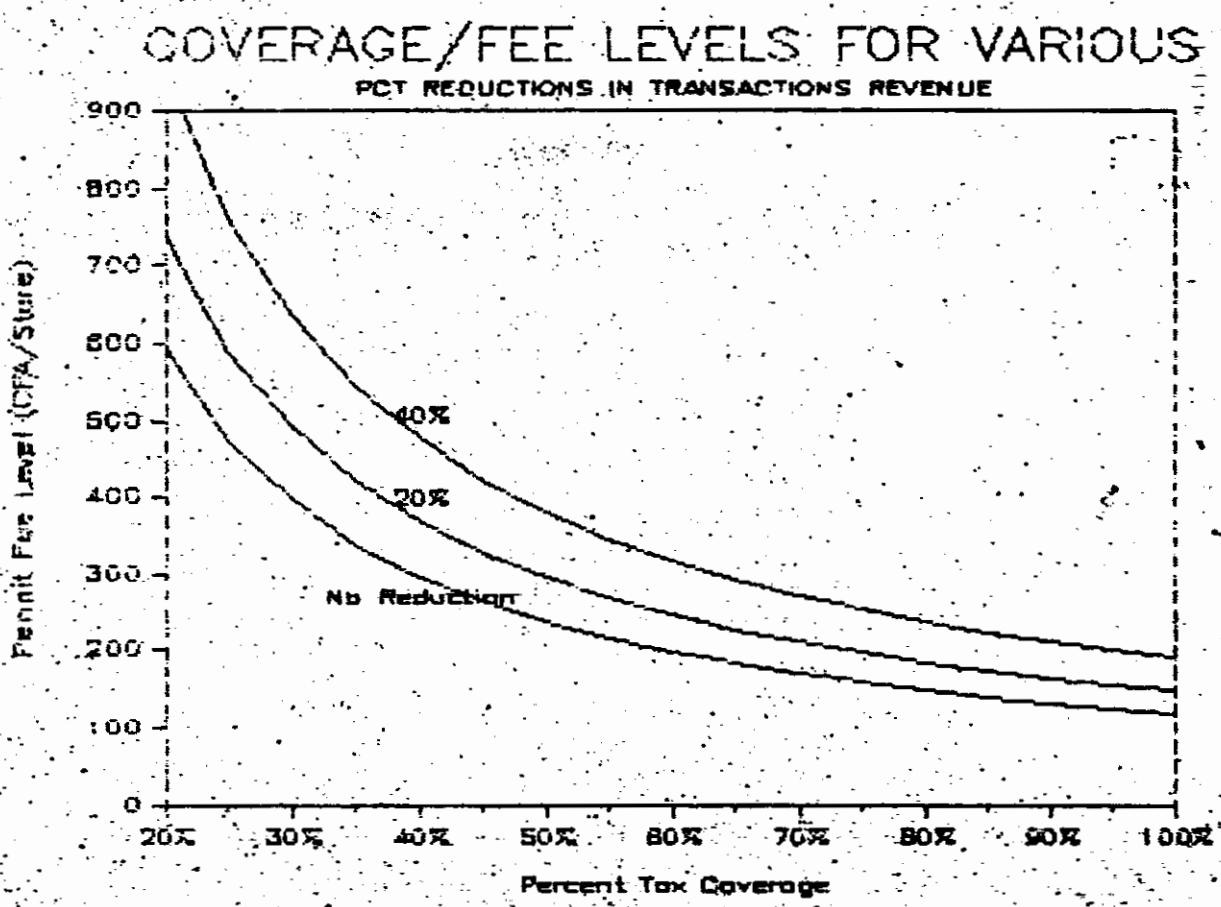

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