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Guest Editors:

George F. Taylor II

Edouard G. Bonkoungou

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INTRODUCTION

George F. Taylor II
Forestry Advisor, USAID,
Nepal

Edouard G. Bonkoungou
Director, IRBET,
Burkina Faso

Forests and forestry play a wide range of varied roles in the West African Sahel.[1] In addition to a multidimensional protective function, they serve important productive functions in farming systems across the region. Principal elements include: fuelwood and charcoal representing more than 90 percent of rural energy consumption, building poles and construction timber, substantial although as yet poorly quantified contributions to both human and animal nutrition, as well as medicinal plants and a range of other important nonwood products. Considerable attention and substantial resources have been devoted to forestry development in the Sahel over the past decade, attention based on the role of foresty in addressing interrelated concerns of environmental degradation (or "desertification") and the "other energy crisis." It has become increasingly clear over the past several years that much of what was being attempted was not working well. A good deal of effort has now gone into assessing the experience with forestry development across the region. This is reflected in a rapidly expanding literature of country and regional sector studies, issue-specific analyses, and project evaluations.[2]

We have sought in this issue of *Rural Africana* to use the experience gained over the past decade in forestry development as a point of departure for exploring in as much detail as is possible in a volume of this size selected issues that are considered key to placing future forestry programs in the West African Sahel on a more sound and secure footing. As is to be expected, these issues are not uncontroversial–some are currently subjects of considerable discussion and debate. It is hoped that the presentations here will serve to enrich that discussion and debate by contributing to a clearer understanding of both the options and the challenges that lie ahead.

The volume has been divided into three parts. The Introduction briefly sketches the role(s) of forests and forestry in the West African Sahel and raises

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Note: The views expressed in the papers in this issue are the authors' and do not necessarily represent those of either the organizations for which they work or of the editors.

a number of the issues facing forestry development at present. As noted in the paper by Taylor and Soumare, these issues include the need for substantive policy review and reformulation; strengthened sector planning, including expanded research capabilities; long-term institution building with a careful eye to both pace (absorptive capacity) and sustainability (recurrent costs); and more systematic and sustained attention to both the social dimensions of forestry development and to the forestry/agriculture interface. Underlying these issues is the need for fundamental change in the relationship between foresters and Sahelian populations, on the one hand, and between foresters and Sahelian forests, on the other. Results of the many different types of forestry interventions attempted across the Sahel to date make it clear that *how* forestry development is done will be at least as important as *what* is done.

Having set the stage in the Introduction, Section II narrows the focus to a selected series of themes and issues of regional importance, including forestry research (Bonkoungou), fuelwood and forest products pricing and marketing (Bertrand), forest policy reform (Shaikh), and the contributions of indigenous silviculture to rural forestry (Montagne). The first of these papers presents a descriptive synthesis of pioneering work on the development and institutionalization of forestry research in Burkina Faso. The other three papers are each important contributions in their own right—exploring issues central to ongoing discussions and debate on the nature and direction of future forestry programs across the West African Sahel.

In Section III the focus narrows further to a series of case studies. While the details of these may be specific to a project or country, the cases have been selected on the basis of the wider applicability of their elements and/or results. Thus, the work in Guesselbodi (Niger) reported by Heermans and results from Ouahigouya (Burkina Faso) reported by Wright and Bonkoungou represent innovative and important work in the areas of natural forest management and rural forestry, respectively. Both cases are a mix of pragmatic field programs linked to practical research designed to provide firmer answers and clearer directions upon which future programs can be based. They also illustrate the primordial importance of the forestry/agriculture interface as a point of departure for forestry development in the Sahel. The paper by Freeman and Resch presents results from one of the large-scale plantation projects (Bandia in Senegal), findings that call into question the viability of this approach across much of the Sahel. The final two papers cover forestry planning in Senegal (Lai) and field agent level forestry training in Burkina Faso (Winterbottom and Linehan). There are important lessons to be learned from both, lessons that tie back to the need for strengthened sector planning and long-term institution building noted earlier.

Forestry in the Sahel, as Heermans notes, is far more complex than the "definitive solutions" that have been attempted to date. As readers of *Rural*

Africana are well aware, a similar observation could be made regarding development efforts in many sectors of the rural landscape in Africa. While it is clear that forests and forestry will continue to have an active and important role to play in rural development efforts across the West African Sahel, it is equally clear that forestry programs, if they are to be more successful, will need to move beyond "definitive solutions" and grapple with both the complexity and variability of rural production systems at the micro level as well as with some fundamental rethinking of sector policy and strategy at the macro level. In so doing, future forestry programs will be placed on a sounder and more secure footing. It is our hope that this collection of essays will contribute in some small way to that process.

NOTES

[1]The Sahel is used in this context to refer to the eight countries that joined together in 1973 to form the Comité Permanent Interétat de Lutte Contre la Secheresse dans le Sahel (CILSS), namely, Cape Verde, Senegal, Gambia, Mauritania, Mali, Burkina Faso (formerly Upper Volta), Niger, and Chad.

[2]Readers interested in pursuing the growing literature on forests and forestry in the Sahel are referred to George F. Taylor II and Beth Ann Taylor, comps., *Forests and Forestry in the West African Sahel: A Selected Bibliography* (Bamako, Mali: RESADOC/Institut du Sahel and USAID/Sahel Development Planning Team, 1984), pp. 207 (1,481 cits.), available from Centre de Documentation/RESADOC, Institut du Sahel, B.P. 1530 Bamako, Mali, or OECD/Club du Sahel, 2 rue André Pascal, 75775 Paris Cedex 16, France.

a number of the issues facing forestry development at present. As noted in the paper by Taylor and Soumare, these issues include the need for substantive policy review and reformulation; strengthened sector planning, including expanded research capabilities; long-term institution building with a careful eye to both pace (absorptive capacity) and sustainability (recurrent costs); and more systematic and sustained attention to both the social dimensions of forestry development and to the forestry/agriculture interface. Underlying these issues is the need for fundamental change in the relationship between foresters and Sahelian populations, on the one hand, and between foresters and Sahelian forests, on the other. Results of the many different types of forestry interventions attempted across the Sahel to date make it clear that *how* forestry development is done will be at least as important as *what* is done.

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STRATEGIES FOR FORESTRY DEVELOPMENT IN THE WEST AFRICAN SAHEL: AN OVERVIEW

George F. Taylor II
Forestry Advisor, USAID

Moustapha Soumare
Ministry of Rural Development, Mali

A wide variety of forestry projects have been launched across the West African Sahel in recent years, part of the broader development assistance program established in response to the last Sahelian drought. Although many of these efforts are less than five years old, there are already important lessons to be learned, lessons that call for a profound review of strategies adopted thus far, lessons that point the way toward new approaches to forestry development across the region.[1]

Only a brief review of forestry strategy and experience to date will be possible in this overview. Details regarding many of the points raised will be found in Sections II and III of this special issue of *Rural Africana.* After defining the region and briefly outlining the multiple role of forests and forestry, the paper will review strategies used in forestry development in the Sahel, examine selected initial results, and outline elements of the reorientation that will be needed to place future sector development on a sounder footing.

THE SAHEL: BIOCLIMATIC ZONE AND POLITICAL REGION

The Sahel, derived from an Arabic word meaning "shore" or "border," is an area subject to a number of potentially confusing and contradictory definitions. In its strictest sense the term refers to a distinct bioclimatic zone that stretches from Mauritania across Africa to the Red Sea and lies between the true Sahara, to its north, and the savanna or sudan zone to its south. In its more widely used political sense, the term refers to those countries that lie along the southern fringe of the Sahara, countries that encompass various bioclimatic zones ranging from true desert through the Sahel and Sudan zones to the Sudano-Guinean woodland. There is, in addition, a more restricted definition used to refer to the

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Note: This paper is based on an invited paper delivered at the International Symposium on Strategies and Designs for Afforestation, Reforestation and Tree Planting, Wageningen, Netherlands, 19-23 September 1983 (Taylor and Soumare 1984).

eight countries that joined together in 1973 to form CILSS: Comité Permanent Interétat de Lutte contre la Secheresse dans le Sahel. It is this Sahel that will be the subject of the examination of strategies for forestry development that follows.

As noted, the Sahel as a political region includes a number of distinct ecological or bioclimatic zones (Conde 1983). Agricultural production systems vary as a function of bioclimatic zone, with pastoral production predominating in the drier northern areas, mixed farming in a transition zone, and rainfed agriculture farther south. Man has exerted a profound influence on Sahelian vegetation, particularly through the use of fire and the selective retention of three species as an integral part of agricultural production systems (Pullan 1974; Pelissier 1966, 1980). The roles of forests and forestry vary according to ecological zone and production system, and strategies for forestry development must be tailored to these important differences.

Superimposed over these general patterns of biogeography and agricultural production systems are two features of the Sahel that must play a key role in development planning: heterogeneity and variability. The latter is most clearly seen in rainfall across the Sahel, which is low and variable. The development potential of the area is limited not only by the low total amount but also by particular characteristics of the rainfall, which include extreme variability in time and space (ranging at individual stations from 15 percent in the southern areas to more than 50 percent in the arid north); spottiness, with 40 or even 50 percent of the individual stations receiving below normal rainfall, even in a "normal" year; the tendency for the number of below normal years to exceed the number of wet ones (with the "mean" rainfall inflated by a few extremely excessive years); the occurrence of rainfall in the warm season when evaporation is greatest; and abnormal conditions (droughts or wet periods) during several years that may persist for one or even two decades (NAS 1983a). The other feature, heterogeneity, is derived from a number of factors, including the rainfall variability and its effect on both the natural and human environments, the mosaic of the physical environments in the region, and perhaps most important the human mosaic of ethnic and occupational groups that both influences and is profoundly influenced by the physical environments. Both variability and heterogeneity set boundaries for strategies for forestry development, among them the inappropriateness of "standardized solutions" and the need to use species and techniques adapted to the variability that constitutes a fundamental component of the natural environment.

FORESTS AND FORESTRY IN THE SAHEL

Forests (trees and shrubs in various steppe and woodland as well as closed forest formations) play a number of roles in the Sahel. In addition to their multidimensional protective function, they have an important place in the

region's economies as sources of fuelwood and charcoal (representing about 90 percent of energy consumed), building poles and construction timber, nutrition for humans and animals, medicinal plants, and a wide range of other nonwood products (IDRC 1980; Le Houerou 1980; Poulsen 1981; Von Maydell 1983).

An important feature of many tree species in the Sahel is that they serve multiple uses simultaneously. Much work remains to be done to quantify adequately the diverse functions of these many species, but initial indications, for the most part subjective, are that the overall contribution has been substantially underestimated. A few figures allowing order-of-magnitude comparisons are beginning to surface. For example, it is estimated that in Burkina Faso the retail value of fuelwood sold in 1980 was almost double that of the country's major export, cotton (CILSS 1982a, e). FAO calculations in 1981 indicated that the value of fuelwood and charcoal to the national economies of Mali and Burkina Faso measured as a percentage of GDP was 8 and 11 percent, respectively. Among the implications is the need for a strategy of considerable breadth and flexibility in which the multiple uses of many species are seen not simply as an interesting feature but as an essential component of most forestry interventions.

EXPERIENCE TO DATE

Numerous forestry projects, funded at about $160 million, have been launched across the Sahel over the past seven years (Weber 1982). Early in 1981 CILSS and the Club du Sahel initiated a review of forestry sector programs on a systematic country-by-country basis, resulting in a series of country bilan-programme documents (CILSS/Club 1981a, b and 1982a, b, c, d). In addition, regional studies were commissioned on issues of central importance to sector development, including recurrent costs (DeMontigny and Thibault 1983), the economics of forestry projects (Morel and Pajor 1982), forestry research (Catinot 1982), rural land use (Bah 1983), local participation (Thomson 1983), and natural forest management (Jackson and others 1983). Other studies and analyses on various facets of sector development have been prepared over the past few years (see, for example, Bailly and others 1982; J. Keita 1980; M. Keita 1982; Senegal 1980; Taylor 1982; Winckler 1982; Winterbottom 1980), and project evaluations have begun to address some of the same questions in a more detailed context (for example, Freeman and others 1983).

The overriding theme to emerge is that initial expectations about forestry programs have in many instances been unrealistic and that the constraints to be overcome are both more numerous and often more complex than was originally recognized. Among the questions to arise from these reviews are those concerning the social viability of the programs (including the important issues of absorptive capacity and the need for active local participation in forestry projects), the appropriate role of foresters and forest services in sector development activities,

the degree to which a process was being set in motion that could be self-sustaining once external funding was no longer available, and what lessons could be drawn from experience to date that would help put both on-going and future efforts on a sounder footing. Sahelian and expatriate foresters working in the region have been wrestling with all these issues over the last few years.

This is *not* to say that the picture is uniformly gloomy; far from it. Much valuable experience has been gained during the seven years since the initial CILSS/UNSO/FAO Consultation on the Role of Forestry in the Sahel. Certain approaches have been tried and found inappropriate; others are working. In some areas local initiative alone has yielded impressive results. Important strides have also been made in gaining a deeper and more refined understanding of the sector, in training, and in strengthening the capability of forest services to perform the many and varied tasks that have now been set for them. At the same time, in both the Sahelian and development assistance communities there is an increasingly clear sense that the direction of forestry programs in the Sahel needs to be both carefully and critically reevaluated.

THE ROAD AHEAD

Forestry development in the Sahel has reached a turning point. Based on an analysis of results to date, it is clear that emphasis must now be given to certain types of projects over others and that careful attention will need to be paid to program and pan-sectoral concerns with a direct bearing on the implementation of forestry projects. Important modifications are called for in the strategy for forestry development. In this section, future directions for forestry will be explored, areas for priority attention identified, and an initial outline of future forestry strategy proposed.

Process and Context: Keys to Improved Project Performance

An important lesson is that there is a need for relatively less emphasis on projects *per se* and more attention to a number of broader factors that affect program success, factors that revolve in the first instance around project process and context.

Experience has clearly shown a need to sort out the *process* by which forestry development is to be undertaken without worrying unduly (initially, at any rate) about the number of trees or hectares planted. While the concern that talk about forestry needs to be translated into concrete action on the ground continues to be valid, excessive preoccupation with project outputs can confuse short-term objectives with long-term goals. What is important is not simply how much is achieved (or not achieved) in quantitative terms, but *how* it is achieved and whether a process is set in motion that will likely be continued following the termination of project funding (Taylor 1982). Reforestation on any substantial

scale in the Sahel will take place only if and when the Sahelian populations decide to undertake it themselves. This does not negate the importance of either externally funded or pilot efforts, far from it, but it *does* underline the importance of the process started by a program, rather than its "success." As noted in a perceptive critique of the project process in the Sahel, experience in all sectors points to the need for longer commitments to allow time for adequate attention to process, including more cautious beginnings, closer attention to training coupled with more realistic assumptions about the availability of skilled manpower, and increased emphasis on long-term institution building (Berg 1983).

In terms of context, among the most important weaknesses of forestry programs as a whole has been the lack of attention to a range of issues, some broader than forestry *per se*, all broader than a particular project. These issues include absorptive capacity, the ability and willingness of Sahelian governments to meet recurrent costs, forest policy review and reform, economic issues of forest product pricing and marketing, and issues of public administration, including the orientation of forestry departments and incentive structures for their personnel, to cite a few examples. A case in point: Although it is an issue that affects virtually all forestry projects, little work has been done on the pricing and marketing of fuelwood and other forest products (for a recent exception that proves the rule, see Mali 1984).

Government Commitment: An Issue for Sahelian and Development Organizations Alike

While most Sahelian governments have emphasized the important role of forestry in their overall development strategies, funding for this sector has often been meager. Before infusing large amounts of additional external aid, this contradiction merits careful scrutiny. At issue is not simply financial resolve (although that is an important indicator of the *de facto* priority assigned to the sector), but related issues of absorptive capacity and the ability of Sahelian governments both to meet and manage the recurrent costs of the programs set in motion.

The matter of government commitment is not simply a Sahelian issue but applies to the development assistance community as well. Given the long-term horizons with which foresters and forestry projects must work, those providing assistance should be prepared to make commitments over at least a decade and have the staff capability, technical and otherwise, to monitor such efforts effectively.

Absorptive Capacity and Recurrent Costs: The Twin Issues of Pace and Sustainability

Although the overall percentage of foreign resource flows devoted to forestry

has remained relatively modest (less than 2 percent), the average annual rate of growth in commitments has been high (71 percent for 1975-1980). This is starting to strain the institutions charged with managing these funds and implementing the multitude of projects for which they are intended. This situation is, of course, hardly unique to forestry. In 1981 the government of Burkina Faso received 340 official delegations wanting to discuss various aspects of development assistance (Eicher 1983). Forestry officials working at national headquarters are spending inordinate time meeting with and catering to a long stream of "experts" of one sort or another.

One theme in recent discussions about recurrent costs has centered around the use of forestry funds as part of a national forestry strategy. Set up in a number of countries, the purpose of these funds is to recycle forest-derived revenues (permit fees, fines, and so forth) back into sector development. In Mali, for example, all permit fees and 75 percent of fines now go into the Fonds Forestier. This is a significant step toward the long-term goal of financing forestry development from "within."

The difficulties in meeting recurrent costs or in assuring the sustainability of externally funded initiatives must not be underestimated. An overwhelming proportion of annual budgets of Sahelian forest services is used to pay salaries, leaving precious little with which to work (Thomson and others 1983). In 1980, in Mali, 82 percent and 93 percent of overall resources were devoted to salary payments from the national and regional budgets, respectively (CILSS 1982b). As a result, caution must be exercised in any planned expansion of Sahelian forest services, and careful reflection is needed on the relative merits of public and private sector involvement, with greater emphasis on nurturing private initiative where it exists and in shifting appropriate tasks from the public to the private sector as part of public sector involvement in forestry development.

Private Initiative and Forestry Development: A Neglected Resource

Development efforts in the Sahel over the past decade, in forestry and otherwise, have focused predominantly on strengthening and working through public sector institutions. Given the lackluster performance of many of these and considering the issues of "process" and recurrent costs outlined above, there is a growing consensus that the private sector can and should be given a larger role. (See, for example, Niger 1983). Forestry offers a number of interesting areas for initiative in this regard: seedling production and distribution, forest product processing and marketing (already predominantly in private hands), community-based forest management, and the development and marketing of "improved" stoves and other forestry related technologies, to cite a few examples.

Development through Projects: Skirting the Issues of Bureaucratic Reform and Institution Building

While efforts have been undertaken at both the regional and national level to formulate sector strategy and then design projects in conformance with it, in most cases the *de facto* strategy has consisted of the sum of those programs that received external funding, plus those that could be undertaken with external funding, plus those that could be undertaken with limited domestic resources. As such, Sahelian governments and foreign assistance organizations alike made "the project" the primary modality for rural development efforts. Although the rationale is compelling on a number of counts (clearly defined spatial and temporal boundaries; closer control of programming, personnel, and expenditures; easier monitoring of progress and effect; and an ability to bypass certain inefficiencies in existing structures, among others), the proliferation of projects, each an island unto itself, operating with substantial autonomy, has led to a new series of problems. Among these are a proverbial lack of coordination and communication between projects, competition for quality personnel that leads to the proliferation of *primes* and other perks, and a growing web of special conditions attached by the various funding organizations in an attempt to ensure the success of "their project."

The far-reaching effects have now become quite clear. Due to their extraordinary budgetary resources, expatriate technical assistance, and autonomy, projects have tended to become "exceptional and expensive islands of flexibility and sophisticated management" that cannot be absorbed or continued following their "completion" (that is, termination of external funding) (Berg 1983). At the same time, unless they are able to find a willing "donor," government departments face the prospect of becoming quiet backwaters, places where those not fortunate or aggressive enough to get project jobs are sent to pass their time. More important, emphasis on projects and the enormous amount of time and effort required in their design and implementation have meant that less attention has been devoted to fundamental pan-sectoral issues such as policy reform, changes in personnel incentives, or long-term institution building.

As a result of "development-through-projects," short-term advantages in efficiency have been gained at the expense of long-term program viability. This approach must now be reviewed, with an eye to the broader picture and the longer term. Careful attention to policy review and the reformulation of legislation are certain to have a greater and more lasting effect on tree planting than is a whole series of expensive tree planting "projects."

The Social Dimensions of Forestry Development

Experience points to the need for more systematic and sustained attention to the social dimensions of forestry development. Among the elements deserving priority attention are the identification of local populations interested in

forestry programs, the careful assessment of the "felt needs" of these groups and the priority they assign forestry in relation to other needs, and the identification of specific interventions that individuals and communities are willing and able to undertake. In addition, more systematic attention is needed to identify constraints to forestry development (land and labor availability, land and tree tenure, local institutional constraints, the role of women, distribution of benefits, and so forth) and to outline concrete ways of addressing those constraints (Bah 1983; DEVRES 1980; Hoskins 1979; LeBris and others 1982; J. Keita 1983; Thomson 1983). At the center of current preoccupations with the social dimensions of forestry development stands local participation (or the lack thereof), and a growing literature points to the need for it in areas ranging from decision making at key stages of project design and implementation to the evaluation of project results (Gellar 1982). Unless and until these elements are more effectively addressed, it is reasonable to assume that projects will fail to generate either much local enthusiasm or participation.

Tied to local involvement in project design is the need for systematic inclusion of indigenous understanding of the natural and social environments at that stage. Projects, including many resource inventory and mapping efforts, have been greatly remiss in this regard (Brokensha and others 1980; USAID/SDPT 1982). In addition, forestry projects have not been particularly innovative in seeking out and working through key "actors" in the society. There is great scope for creative work in this domain, for identifying centers of influence and using various elements of the population to help promote forestry programs (school children, political and religious organizations, the army, to cite a few examples) (Colvin 1983).

The Neem and the Mango: Paradigms for the Future

Azadirachta indica, or neem, was introduced into Senegal in 1944 and into Mali in 1953 (Giffard 1974; CILSS 1982b). Its spread to other parts of the Sahel is not well documented but is unlikely to have occurred earlier except in selected localities along the borders with Sudan (where the species had been brought from India in 1925) and Nigeria (introduced from Sudan in 1935). Over the past four decades the species has spread throughout the Sahel and has become one of the more common species, particularly around human habitation. How did it spread? Precise details are sketchy. Forest service nurseries started the process, and the people took it from there. Demand for neem seedlings continues to be high, with small private nurseries now a going concern around various urban centers. The process begun by man is now being assumed by nature, with birds and bats spreading seed and assisting in natural regeneration. The process that was started with *Azadirachta indica* in 1944 is currently being repeated with another introduced species, the grafted mango. Demand is so

high that at appropriate times of the year large numbers of seedlings are transported by merchants from Bobo Dioulasso, Burkina Faso, to Bamako, Mali, about 550 km away. The lesson is clear: If the species being offered does in fact meet a "felt need," it will be produced, planted, and cared for.

Forestry in the Sahel: Broad Vision, Selective Focus

Based on experience to date, a careful review of the scope of forestry programs in the Sahel is called for. While sector strategies developed in the past have been sweeping in scope (the six subprograms of the CILSS strategy, for example), implementation has tended to focus narrowly on relatively few elements, most notably tree planting. As noted earlier, forests and forestry play a wide range of roles in the various production and social systems across the Sahel. This range should form the primordial base from which forestry strategy is developed and from which forestry planning starts. As such, the initial vision that nurtures forestry strategy needs to be broad and must pay particularly close attention to the interface between forestry and agriculture (Taylor 1981). In the identification of program emphases and particular projects, however, a rigorously selective focus is required: narrowing in on priority problem areas for "punctual" interventions while concentrating on processes that will lead toward self-sustaining programs of environmental rehabilitation.

Beyond Tree Planting: From Symptom to Cause

Great attention has been given to tree planting in sector programs, but there is a growing feeling that this aspect of forestry programs has been overemphasized relative to other aspects (policy reform, planning, research and training, for example). Symptom and cause have been confused, and in many instances tree planting has been addressing the former rather than the latter: using reforestation as an antidote to "deforestation" without sufficient analysis of the underlying causes of that deforestation. Popular notions, not uncommon in development circles as well as among Sahelian populations as a result of forestry project "sensibilization," include a variety of nearly miraculous effects associated with tree planting. Among the more common: Trees are reputed to stop advancing deserts and to produce more rain. Many tree planting efforts have been launched under these and similar banners. The result, according to an assessment by a seasoned observer, is that two out of three trees planted in the Sahel have either died or been severely stunted before they were five years old (Weber 1982). Another observer has noted: "Reforestation measures achieved to date have had no influence on desertification causes and processes, and, on the other hand, have had a much smaller protective effect than that of natural forest" (Winckler 1982).

The Forestry/Agriculture Interface

Although the need to integrate forestry interventions more closely with agriculture has been clear for some years now, building on the roles of trees and tree crops in agricultural production systems, only in rare instances has practice followed theory. Even in the so-called integrated rural development projects, forestry components (when included) have been little different from other forestry programs. At the same time, agricultural development efforts have tended in most instances to ignore the forestry components. Instead of viewing rural production systems in a relatively holistic way, each discipline has concentrated on its particular bailiwick: the trees, the crops, or the livestok (J. Keita 1983). There are encouraging signs that this situation is beginning to change, including the more active interest of agricultural research centers in trees and tree crops and increased emphasis on agroforestry and farming systems research.

Agroforestry has become something of a "buzz" word in international forestry circles in recent years, as has farming systems research in the agricultural development community. Both terms are increasingly finding their way into proposals and strategies in the Sahel. Attention to these areas offers an important opportunity for seriously studying the forestry/agriculture interface and for basing future interventions in rural production systems on a sounder understanding of the dynamics of those systems. However, caution is in order. Although firmly grounded in a search for a more "holistic" approach to rural development, both agroforestry and farming research suffer from a tendency toward a narrowness of conception that betrays their origins: Agroforestry is what foresters talk about, while farming systems research is what agricultural researchers talk about. It is imperative, if development buzz words are to be translated into more effective programs, that those involved in these two approaches begin to talk seriously with one another and that the programs designed as a result truly transcend the narrow sectoral boundaries which have characterized all too many approaches to date.

A second area that offers considerable potential over the long run for added understanding of and attention to the forestry/agriculture interface is natural forest management. As a CILSS paper noted, attention needs to be devoted to getting active forest management under way across the region (Jackson and others 1983). Once this work is more advanced, a synthesis of results from forest management, agroforestry, and farming systems research will provide a more comprehensive picture of the full continuum of vegetation utilization and management and rural land use.

Forestry in the Sahel has been moving through a period of review, evaluation, and reflection over the past few years. Although the full outline has not yet emerged, elements of a revised strategy for forestry development have begun to appear. Some of these are outlined below.

Review and Reformulation: Lynchpin to a Revised Strategy

Forest policy and legislation across the Sahel are for the most part out of date and do not constructively address the changing circumstances surrounding either the relationship between foresters and Sahelian populations or the role of foresters in relation to Sahelian forests.

A consensus has been building in recent years on the need both for a basic transformation in the role of the forest service and for foresters to stop being exclusively rural policemen charged with the impossible task of enforcing current codes and to start working much more closely with rural communities as technical extension agents. There is also a need to remove disincentives to tree planting and other forest management activities from current legislation and substitute incentives in their place.

As noted by the director of Mali's Forestry Service:

> The major problem is a lack of understanding, of trust, and even hostility between foresters and those whom forest services wish to help, that is, the local populations. I have said before and I repeat that 6 million Malians can more effectively fight against desertification than 600 foresters. This is the basis for our new policy....I will therefore recommend at the 6th National Forestry Conference that forestry legislation and regulations be reformulated in order to make them more educational and incentive-oriented rather than repressive (Anon 1983).

Among the constraints to be overcome is the funding bind of Sahelian forestry services, which has a significant effect on the perpetuation of repressive activities. As noted in a perceptive section of Senegal's *Plan Directeur*, "in spite of all the efforts presently being made by the forest service to show local populations that its actions are not limited to repression, the limited resources given to foresters lead them to place priority on repressive actions even in spite of themselves. Given these conditions (i.e., low salaries and a chance to substantially augment income through fining), they can hardly be blamed" (Senegal 1981).

It is clear that changes of this magnitude do not occur overnight and that there will need to be a gradual institutionalization of new approaches, but it is equally clear that forestry projects have failed in no small measure because these issues were not faced earlier.

Foresters and Sahelian Forests: From Protection to Active Utilization and Management

In addition to the need for fundamental change in the relationship between foresters and Sahelian populations, there is also a need for change in the role of foresters in relation to Sahelian forests. Current policy has fostered a role that is essentially one of protection and conservation, whereas a shift to active utilization and management is called for. This, in turn, will require review of

many facets of forestry legislation, including pricing policies (stumpage prices, permit fees, government subsidies for fuelwood and charcoal pricing, pricing policies for tree seedlings and other technical services); marketing (including analytical work on market structure and operations as well as an examination of possibilities for private sector involvement, forest product cooperatives, and the development of forest product-based cottage industries); possibilities for forest-based revenue generation, including the use of these revenues to promote forestry development through a forestry fund or similar mechanism; and possibilities for the management of natural forests by local communities.

Policy review is already under way in a number of countries in the region. This process will need to be nurtured and continued. Ideas for new approaches are being developed and discussed. It is clear that certain elements of sector programs will need substantially more attention in the immediate future, among them planning, management, research, and training in addition to a range of forestry interventions "on the ground." These elements will be treated in various papers in this issue of *Rural Africana.* It is also clear that the question of *how* forestry development is done will be at least as important as the question of *what* is done.

CONCLUSION: FORESTRY IN THE SAHEL AT A TURNING POINT

Forests and forestry have played and will continue to play an active and important role in Sahelian development. Born amid considerable enthusiasm and high expectations, forestry projects launched across the region over the past decade have, for numerous reasons, not lived up to expectations. This has led to review, evaluation, and reflection on important lessons learned from experience and on the nature and direction of future programs. As a result, forestry in the Sahel is at a turning point. New approaches, more closely in line with the natural and social realities of the region and more carefully linked to broader issues of process and context, are beginning to emerge. These will help chart future directions, put future forestry development on a sounder footing, and ensure that the forest resources of the region are used, to the greatest extent possible, to meet the broader goals of Sahelian development.

NOTE

[1] For details on the various strategies for forestry development and the results of different types of interventions, see Taylor and Soumare (1984, pp. 141-50).

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FORESTRY RESEARCH IN THE SAHEL: PROCESS AND PRIORITIES

Edouard G. Bonkoungou
Director, IRBET,
Burkina Faso

Forestry programs in most countries of the Sahel region were initially developed during colonial times. This was done by expatriates trained in their European home countries, where forestry meant mainly–if not solely–the growing of timber. As a result, the forestry sector failed to recognize and/or to take due account of the facts that most tree species in the Sahel serve multiple uses and that local people depend on the forest not just for wood but also for a multitude of nonwood forest products which are an important and integral component of the rural economy.

Following the severe drought of 1968-1974, however, fuelwood shortages and increased environmental degradation in the Sahel prompted many individual scientists and agencies involved in Sahelian forestry to call for a reappraisal of concepts and priorities. There has since been a growing need for the rehabilitation of the multipurpose role of Sahelian forests, but this shift in forestry development toward new areas of concern has not been matched by an expansion of research to cover these new topics.

This paper presents a summary of forestry research activities in the Sahel. After a review of historical development and the present situation, the paper explores some of the subjects generally regarded as priority areas for future research and presents a case study of efforts under way to promote forestry research in Burkina Faso.

HISTORICAL DEVELOPMENT

Most forestry services in the region were created in the 1930s and 1940s. Programs during that period were mainly directed toward protecting natural forests and establishing plantations of fast-growing exotic species.

Research during the early stages of forestry development in Africa was almost entirely devoted to the humid tropics, where the rainforest provided valuable species for such quality industrial products as lumber, woodbased panels, and paper products. There is evidence that perhaps more than 90 percent of global forestry research expenditures were still directed to these activities in the 1970s (World Bank and FAO 1981, p. 6).

International concern about environmental degradation in the Sahel dates from the late 1930s, when France and the United Kingdom joined in a field mission to study the advance of the Sahara desert (Morel and Pajor 1982, p. 9). Forestry research in the region has been minimal, however, since environmental

conditions severely restrict forest productivity in the Sahel, making such research unattractive to colonial authorities or funding agencies. As a result, very little work has been directed toward the natural forests of the arid and semi-arid zones.

The situation did not change greatly after political independence was obtained during the 1950s and 1960s, and if anything, it worsened. Because the new governments had to set up priorities for socioeconomic development, the forestry sector, which is not considered a productive one in these countries, suffered severe cuts in funds and personnel.

During the 1970s, however, when fuelwood became scarce and expensive, the forestry sector came to be viewed as having an important role. This increased consciousness prompted many external funding sources to support programs in the Sahel. After helping to solve the most urgent needs by supplying food, various agencies began to direct their efforts to problems of overall environmental degradation, with the forestry sector as a key target.

Unfortunately, the rather euphoric and somewhat naive intervention programs launched during that period resulted in much confusion and many disappointments. The purpose of this paper is to examine the general situation as it stands today.

MAJOR CONSTRAINTS OF THE FORESTRY SECTOR

A main characteristic of the present situation of forestry in the Sahel is an increasing level of awareness and consciousness on the part of governments, the general public, and external donor agencies. Despite strong political commitments, however, results to date are rather meager. Fuelwood prices keep climbing and take as much as 30 percent of family income in some urban areas. Woodlots where fuelwood can be collected are sometimes as far away as 60 to 100 km from major cities and keep retreating at an alarming rate, yielding to land degradation and desertification.

These disappointing results indicate that the main constraints to the development of forestry either have not been clearly identified or have not been addressed correctly. Reasons for the failures should therefore be identified as precisely as possible so that future actions can avoid the same mistakes. Some constraints commonly mentioned include insufficient knowledge of the Sahelian environment, failure clearly to identify the real needs of local people, insufficient funding, poor project planning leading to unbearable recurrent costs for local governments, and poor standards of project evaluation that put undue stress on the number of trees or hectares planted.

Another major constraint is often overlooked. Taylor (1982) pointed out that given the rapidly expanding portfolio of forestry projects, on the one hand, and the relative scarcity of tested technical packages, on the other, forestry research is an essential prerequisite to a more effective project intervention, and

it must be given the emphasis it deserves.

Major limitations to the development of forestry research in the Sahel have been reviewed by Catinot (1982). The most severe ones are examined here and include infrastructure, funding, training, dissemination of scientific information, and technical programs.

Research Infrastructure

Although forestry research infrastructures were established in some countries 15 to 20 years ago, others in the region still do not have any. As the detailed review presented by Catinot (1982) clearly indicated, the situation varies greatly. Notwithstanding such important differences among countries, it has been shown by Taylor and Soumare (1983, p. 32) that "with the notable exception of Senegal, the forestry research infrastructure in place and currently operational across the Sahel is so small as to be virtually nonexistant." This appears, therefore, to be a serious constraint to research development in the region.

Funding

At present, allocations for research and training amount to only 5 percent of overall funding for CILSS programs in the Sahel (Taylor and Soumare 1983, p. 7).[1] At the national level, the situation is worse. Even in countries where a research infrastructure is operational, national financial support is at best equal to external aid, and much less in most cases (Catinot 1982, p. 4). As a result, none of the Sahel countries can sustain adequate funding of long-term research programs. Given that external aid is likely to be affected by the current global economic crisis, funding must therefore be regarded as another important constraint. Jackson and others (1983, p. 63) pointed out that help may still be expected through international technical assistance, but there must be some assurance that when the project ends the host government has the financial and administrative capacity to continue it.

Training

Most trained personnel currently in charge of forestry research in the Sahel are expatriates, with the notable exception of Mali. In addition to an insufficient number of trained research scientists, there is also the problem of adequate preparation for foresters. Most are taught how to grow trees and how to enforce forestry policy rules, but not how to deal adequately with people (Delwaulle 1975).

Although this situation has no direct bearing on research, it must be realized that the new type of forestry advocated for the Sahel requires that technical research programs take full account of the real needs of the local population and actively seek its cooperation. This in turn will require that the research scientist be trained to deal with forestry more holistically than has been the case so far.

Dissemination of Scientific Information

Until recently, forestry research in Francophone countries of the region was conducted and coordinated by the Centre Technique Forestier Tropical (CTFT), a French institute. Information on progress was disseminated through a network under the control of CTFT. After the establishment of research infrastructures at national levels following independence, no coordinating body was set up to replace this network, and today even neighboring countries are not adequately informed about research on the other side of their borders. In recent years the Institut du Sahel has made significant progress toward establishing a regional network,[2] but this is still at an early stage, and the sharing of information remains a serious constraint to the development of forestry research in the region.

Technical Programs

A review of forestry research programs conducted in the Sahel has been compiled by Catinot (1982). His detailed study indicates that progress varies widely among countries and among research topics. Whereas the identification of forest tree species and reforestation techniques are well advanced in most countries, other areas are much less so, such as sylvics of indigenous species, management of natural forests, and wood technology.

A major problem with all these programs is that they were designed in relation to priorities defined outside the region, by European research institutions, without a clear perception of the real needs of local populations. Another problem is that they do not necessarily take into account the poor research infrastructure in the countries concerned, since most data analyses were programmed to be conducted overseas. Most countries are unable to continue these programs once external assistance stops.

From this brief review of major constraints it appears that although forestry research should be regarded as a first priority, not a single country in the Sahel as yet possesses a critical mass of well-trained scientists with adequate funding to do significant research. Future needs are examined below in the light of this general situation.

RESEARCH NEEDS FOR THE FUTURE

Although the necessity to seek fresh approaches to forestry development in the Sahel has become compelling, there has not yet been a clear identification of specific priorities. In trying to identify these it is important to realize that, notwithstanding the importance of technical programs, the research agenda should expand beyond them to include the socioeconomic context, which determines overall research capability. It should also be pointed out that work in the region would benefit from coordination among several countries to avoid unnecessary duplication and to ensure prompt dissemination of results. Specific

details on project components, however, will probably have to be worked out at the national level in relation to the socioeconomic context and the felt needs of local populations. Topics generally regarded as priority areas for future research are discussed below.

Socioeconomic and Institutional Matters

In line with the conclusion of the joint study by the World Bank and the FAO (1981), a major consideration is how to improve the local social and economic framework within which a forestry activity must function. A first priority should be given to strengthening national research institutions in the developing countries themselves, since most are weak and have been severely constrained by lack of staff and funding. As the study (1981, p. 2) reported, well-conceived national research is likely to be more enduring than imported efforts.

Serious thought also should be given to arranging more systematic funding mechanisms to enable scientists from developing countries to participate in international research meetings.

Priorities in terms of training should take into account not only the content of technical disciplines but also the social component, so that the repressive image of foresters is reduced and future research scientists are able to identify programs in relation to the overall social context.

Recommendations made by the World Bank and the FAO (1981) for developing countries in general apply quite well to the specific case of the Sahel. These include the creation of a small International Forestry Research Secretariat, among whose functions would be: (1) monitoring the progress of forestry research, (2) assisting the countries in broadening the emphasis of forestry research toward new areas of concern, (3) ensuring more effective participation by researchers from developing countries in international meetings concerned with these topics, and (4) ensuring that research results are effectively disseminated.

Technical Programs

Various studies have compiled long lists of priority topics for developing countries in general (Pieters 1981; World Bank and FAO 1981). Topics also have been identified for immediate consideration in the African context as part of the strategy for the economic development of Africa (OAU 1981). An agenda for the Sahel has been discussed by Taylor (1982), Catinot (1982), Taylor and Soumare (1983), and Institut du Sahel (n.d.). A cross-examination of the various lists indicates that the proposed topics for the Sahel revolve around three main areas, loosely described as follows: (1) research into energy-related forestry; (2) research into the silvics of indigenous species and silviculture of natural forests; and (3) research into farming systems incorporating trees.

These areas are examined below with the purpose of providing a basis for

discussion rather than laying down definitive prescriptions. No effort is made toward the difficult separation as between applied and basic research. Finally, the items listed here should be regarded as research objectives, not specific research programs. These broad objectives will need to be translated into specifics to fit local realities in terms of forestry priorities and research capabilities.

Energy-Related Forestry. The main research objective in this area should be to help ease the "other energy crisis." The questions to ask, then, are how to produce more wood with higher calorific value per unit time per unit area with the least negative effect on site quality and how to decrease fuelwood consumption through developing economically affordable and socially acceptable alternative energy sources. Numerous plantations of fast-growing exotic species have been established at great cost across the region with the intent to provide fuelwood, but the results to date have not been satisfactory.

Research to increase production has so far concentrated on two main lines: silvicultural treatments and genetic improvement. Whereas programs of the first sort have made significant progress, those related to the second will probably need a reappraisal. Current breeding programs have tended to emphasize growth rate at the expense of other traits, but environmental conditions in the Sahel are so severe and unpredictable that survival under abnormal conditions is probably of paramount importance. Although traditional programs on species and provenance trials should be continued, new efforts need to include selection for resistance to drought and fire.

Field mensuration standards to assess species performance should also be revised in order adequately to reflect total biomass production in terms of fuelwood requirements, not just yield as measured on straight boles in traditional forestry.

A pending question with all these plantations is the long-term effect on site quality of the conversion of natural vegetation to intensively managed monocultures of fast-growing exotic species. Root biomass studies of natural forests and plantations in the humid tropics have clearly indicated that the nutrient trapping under plantations cannot reasonably be as efficient as under natural forest (Lundgren 1980). Although the implications of this for site quality have not yet been clearly established (Chijioke 1982), such information is totally lacking for the Sahel. Research programs in this vein should be encouraged.

Efforts to reduce fuelwood consumption have mostly concentrated on technological research to develop improved stoves for wood and charcoal and to identify more efficient ways to convert wood into charcoal. A recent review of the issue concluded that the process as a whole has raised more questions than it has answered, however, and there is growing concern that the move from prototype development to dissemination has been premature (Taylor and Soumare 1983, p. 14).

In most countries, research into how to reduce fuelwood consumption is usually conducted by professional institutions specializing in energy problems. Programs developed by foresters should be done in close connection with those institutions.

Indigenous Species and Natural Forest. Apart from broad botanical descriptions and geographic distribution, very little is known of the biology of indigenous species. Given the increasing interest in them, more effort should be directed to understanding their biology and breeding potential. Topics for consideration should include the various on-going programs on silviculture and genetic improvement developed for the exotic species.

Natural forest productivity and long-term dynamics also have been little studied. Jackson and others (1983) discussed at length natural forest management in the Sahel. The research priorities they identified revolve around determining present productivity and how it can be increased. Technical programs related to present productivity should include more studies on forest inventory and growth rates as measured on permanent plots, growth ring data, or any other reliable techniques (Clement 1982; Jackson and others 1983). As to increasing productivity, relevant research questions could include the following ones raised by Jackson and others (1983): What is the best rotation for optimum yield? What increased yield can be obtained from protection against fire and grazing? What other methods can be used to increase yield?

The long-term dynamics of the natural forest in the Sahel are much in need of further study. The general opinion is that fenced plots protected from burning and grazing should revert eventually to a more closed forest with more and larger trees. Recent preliminary data from northern Burkina Faso suggest this is not necessarily so. Fenced plots to study the dynamics of natural vegetation, mostly *Acacia seyal*, became refuge areas for small mammals that began to chew the bark so badly that many of the trees died. This result sheds a different light on forest dynamics under protected conditions and deserves further study across the region.

Farming Systems Incorporating Trees. This area of research relates to how forests and trees can help increase agricultural productivity and ensure sound and stable land use. Traditional systems of incorporating trees into farming systems are found in a number of areas in the Sahel. Because good land has become increasingly unavailable to permit farming and tree planting to be conducted separately, there has been greater interest in combining both activities in various ways. Considerable effort by the International Council for Research in Agroforestry has contributed to promoting the idea of agroforestry in the Sahel. Information available to date, however, is based more on scientific reasoning than on actual data. More field trials are needed, and several issues deserve further research.

In designing agroforestry experiments it must be realized that when trees are interplanted with crops, foresters must assess a wider range of characteristics than are commonly evaluated and consequently are unfamiliar to traditional foresters. When dealing with live fences, for example, the desirable traits are no longer the usual straight bole with fine braches, but rather low branching, coarse branches, and spreading canopy to keep livestock out of the farmland.

When trees are expected to serve purposes other than just wood production, new techniques of mensuration and assessment of tree performance will have to be developed. Burley and Huxley (1984, p. 4) indicate that emphasis will then be on stem and branch volume in coppiced and lopped species, as well as on such other characteristics as fodder, fruits, and seeds. The production of animal fodder from leaves is indeed a major consideration in many Sahelian countries.

Canopy structure and root system also should be studied to address the question of how to reduce above- and below-ground competition in the farm. Burley and Huxley (1984, p. 6) suggest that possibly the most important set of root characters in multipurpose trees with which traditional foresters are unfamiliar is the group of microbial and symbiotic association. With nitrogen-fixing trees it is necessary to determine the location, quantity, and seasonality of nodules and their effects.

Finally, the controversial and much debated issue of allelopathy should be explored to evaluate the compatibility of various trees/crops when grown simultaneously on the same land or in rotation.

In closing this brief review of research needs for the future, it is worth emphasizing again that although the topics chosen for discussion represent the personal views of the author, it is not debatable that the overall forestry research capability of the region is extremely weak and needs to be strengthened if research is to make any significant contribution.

BURKINA FASO: A CASE STUDY

Countries of the Sahel face difficult problems in coordinating domestic scientific activities. Within a given country, institutions in related disciplines often work in total ignorance of one another. Researchers may write up their proposals solely along scholarly lines without consulting planners. The latter may launch ambitious projects on untested hypotheses and make no attempt to seek input from research institutions.

Burkina Faso is no exception in this regard. Until recently, forestry research there had been the responsibility of the Centre Technique Forestier Tropical (CTFT), and as for all Francophone countries, programs were developed at CTFT headquarters in France. Although some touched upon relevant topics, such as the silvics of indigenous species, productivity of natural forests, and soil and water conservation, the main efforts were devoted to species and provenance trials, mostly on teak (*Tectona grandis*), eucalyptus (*Eucalyptus sp.*),

Gmelina (*Gmelina arborea*), cassia (*Cassia siamea*), and neem (*Azadirachta indica*). The objective was to identify suitable species for reforestation programs. A review of the results of these early programs in Burkina Faso has been compiled by Toni (1975).

In 1981 a research institution was created within the Ministry of Higher Education and Scientific Research to coordinate work in biology, forestry, and ecology. The CTFT in Burkina Faso came under the control of the new institution, the Institut de Recherche en Biologie et Ecologie Tropicale (IRBET). The Forestry Service itself is under a different ministry. Regrettably enough, all these institutions used to work with no close links among them. This lack of coordination prompted IRBET to investigate setting up a coordinating body to help bridge the gap between research institutions and the Forestry Service.

A national committee for forestry research was established and is now operational. Its executive bureau has representatives of research and training institutions as well as forestry development planners. The committee has successfully established itself as a reliable and efficient institutional tool to promote forestry research in Burkina Faso.

In addition to annual meetings, highly technical panels are sometimes convened to discuss specific proposals. Although such technical discussions are of primary importance in ensuring that projects are developed on a sound scientific basis, by far the most important achievement of the committee is its contribution to cooperative endeavors. The two cases presented below illustrate the problem-solving approach taken by the committee.

During the 1982 annual meeting of the committee, the Forestry Service reported severe dieback and heavy mortality in some plantations of *Cassia siamea*, one of the exotic species widely used in reforestation programs in Burkina Faso. The Department of Phytopathology at the university presented data indicating that the damage was caused by pathogens which only become destructive under severe environmental conditions.[3] On that basis the committee adopted a recommendation to ban the use of cassia in commercial plantations outside certain defined climatic limits. The Forestry Service immediately took measures to comply.

This example illustrates one aspect of the positive contribution of the committee as a scientific forum. Although the Forestry Service had been aware of the damage in cassia plantations, it did not know the cause and could not take appropriate measures. Phytopathologists at the university had been working on the problem for quite some time, but because of poor dissemination of information other agencies were not fully informed. The committee provided the needed forum, leading to remedial action on a practical problem.

Another case is a special meeting held by the committee on the question of forest fires, a great hazard in Burkina Faso. Colonial law totally prohibited fire,

but the Forestry Service lacked equipment and manpower to enforce it; the local population had not been involved in decision making and showed open hostility to and noncompliance with the law.

The committee critically reviewed the current forestry code on fire and emphasized the need to consider more fully the social parameters. It requested that the Department of Sociology at the university and an institution in charge of socioeconomic research carry out field studies and prepare background papers on traditional practices and customary laws on forest fires. Representatives of rural people from various parts of the country were invited to a discussion panel. It is too early to assess how much will effectively be achieved to reduce fire hazards as a result of this meeting. What is quite clear, however, is that without the contribution of the committee there would have been little chance for such a meeting to be held. Research institutions are quite aware of the voluminous literature on fire, but they do not have the kind of extension services that were instrumental in obtaining local participation. Although the Forestry Service has more contact with rural populations, given its repressive image and relative unfamiliarity with the scientific complexities of the topic, it probably would have had serious difficulty in getting all the relevant contributions.

Although it is too early for definitive conclusions, results to date from Burkina Faso's Forestry Research Committee are quite encouraging, and this type of forum is probably worth trying in other countries of the region.

CONCLUSION

Fuelwood scarcity and continued environmental degradation have led national governments and external donor agencies to consider the forestry sector as having an important role in the Sahel. Unfortunately, this has not been matched by an expansion of research to cover the new areas of interest. The main conclusion to be derived from a review of forestry research in the Sahel is that the overall capability is so weak as to be virtually nonexistent.

Research should play a much larger role in the future as a prerequisite to forestry development in the region. For this to become a reality, action must be taken to improve research capability and redefine technical research programs to address topics more relevant to the basic needs of local populations and specific problems of the fragile ecosystem of the Sahel region. The following priorities have been identified: (1) energy-related forestry, (2) the silvics of indigenous species and the silviculture of natural forests, and (3) agroforestry.

The road ahead is still long. Forestry research is a very time-consuming process. How soon research will begin to contribute significantly to forestry development in the region will depend on how soon the research capability of the region is strengthened and relevant research programs are started. Anything that can be done must be done just as soon as possible.

NOTES

[1]CILSS stands for Comite permanent Inter-états de Lutte contre la Secheresse dans le Sahel, an intergovernmental committee created in September 1973 by the following eight member states: Cape Verde, Chad, Gambia, Mali, Mauritania, Niger, Senegal, and Burkina Faso. The objective of CILSS is to coordinate technical and financial interventions in the region. The Executive Secretariat is located in Ouagadougou, Burkina Faso.

[2]Institute du Sahel is a technical Department of CILSS created in 1976 to collect, coordinate, and disseminate information on scientific and technological research. Its headquarters are in Bamako, Mali.

[3]The pathogens are fungi of the genera *Rhizoctonia* and *Fusarium*.

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MARKETING NETWORKS FOR FOREST FUELS TO SUPPLY URBAN CENTERS IN THE SAHEL

Alain Bertrand
Forest Economist, CTFT
France

The significance of forest fuels (firewood and to a much lesser extent charcoal) is well known as regards the energy consumption of the countries in the Sahel-Sudan region, where these fuels still account for more than 80 percent and generally for about 90 percent of total consumption. The overall picture is one of overfelling of forests as compared to what is ecologically sound within the region as a whole. This results in a mosaic of areas in which shortages are more or less acute and more or less apparent, coupled with varying degrees of degradation of forest formations. Extensive areas reach more advanced stages of degradation, particularly in the vicinity of (or in places connected with) large cities (Goudet 1984).

The magnitude of fuel requirements in large cities and the rate of growth of these requirements (often about 7 percent per year), which follows population growth rates, leads to overfelling in production areas and to rapid and irreversible degradation of forests. The consumption in rural areas is also partly responsible for the overexploitation of available resources. If it were not for urban requirements, however, rural needs could fairly easily be made to fit in with a rational use of available wood resources (except in a very small number of densely populated areas).

There is another basic distinction to be made between urban and rural consumption of forest fuels. In rural areas, firewood is virtually the only fuel utilized (except for some locations where population density is high and shortages are severe), and it is used on a self-supply basis, with housewives carrying out the tiring and time-consuming chore of collection. In urban areas, forest fuels are market products, and self-supply seldom occurs. Consequently, knowledge of supply channels and marketing systems for wood fuels in urban areas is prerequisite to attempting to solve the problems of forestry and desertification.

FOREST FUEL MARKETING CHANNELS

The wood fuel trade is part of the so-called informal sector, that is, the livelier, more active, and more changeable portion of the economy in the countries of the Sahel. The organizational patterns of these trading channels

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Note: For the French original on which this article is based see *Les Filieres d'Approvisionnement en Combustibles Forestiers des Villes de la Zone Sahelo-Soudanienne.* Nogent-sur-Marne: Centre Technique Forestier Tropical, 1984.

are in many respects similar to those of other traditional trade networks, some of which have been analyzed elsewhere. It is often difficult to understand these circuits because of their informal financial relations or trading structures, often involving family-related, ethnic, and traditional influences. These considerations make it necessary to look more particularly into sociological parameters when doing an economic analysis. Reviewing the types of products processed and routed to the end-user along forest fuel marketing channels reveals that the articles concerned are remarkably well defined and standardized. It is possible to identify products very clearly despite their apparently great variety and the countless interlocking microchannels. This may seem surprising in view of the heterogeneousness and considerable variations in the raw materials supplied by forest formations (in terms of species, sizes, and so forth). For example, a distinction can be made among firewood product types, shown in Table 1, as regards transport between rural areas and the city of Bamako.

Table 1. FIREWOOD PRODUCT TYPES IN BAMAKO

Roadside sales outside Bamako[a]	Sales within the city[b]
Small bundles of sticks	Faggots of large sawn logs
Large bundles of sticks	Faggots of medium-size unsawn logs
Medium-size timber faggots	Bundles of sticks
Three split log faggots	Large stacks of sawn timber
Large split log faggots	Medium-size stacks of large logs
	Small stacks of large logs
	Wood chips

[a] A. Bertrand, *Management of the Volta Valleys: Logging and Marketing Plantation Products (Poles and Fuelwood) in the Wagen Reserved Forest* (Nogent-sur-Marne: Centre Technique Forestier Tropical/Transenberg, 1983).

[b] From an FAO-IPR survey made in 1978.

Each of the types of products identified actually fits in a specific microchannel where circuits, economic agents, and resource flows are well defined (for additional details on the material in this section, see Bertrand and others 1984). In practical terms, a preliminary division of products occurs as early as the harvesting stage, depending on whether (1) the wood is harvested in non- or little-degraded natural formations or in fallow areas that are being exploited again, or (2) it is harvested by farmers (with occasional differences between men and women) or by salaried fellers or laborers working for firms or state-owned or community organizations.

Each form of operation results in the preparation of different products. It

should be noted, however, that more often than not, certain wood products are in fact neglected because they require too much work in relation to the low levels of final value achieved. This applies to tree trunks too large for easy sawing (except for certain species, such as *Burkea africana, Prosopis africana,* or *Afrormosia laxiflora,* used in the production of charcoal), as well as twigs, which are of slight interest to users given their low heating value. Consequently, it is clear that the wood resources are not fully exploited and that the improved management of forest formations should combine well-defined management methods, improved felling methods, and efficient protection against fire (for fire often destroys new growth of pollarded trees).

Thus it appears that each operational type and each type of product preparation (and consequently each microchannel) involves a very specific area of coverage: Every main road around towns and every line of communication (such as rivers or railways) supports one or several organizational patterns for the microchannels. This calls for great efforts in optimizing methods and maximizing profitability for all categories of agents involved in producing,transporting, and distributing forest fuels. In actual fact, the informal sector is highly structured, which also reflects the limited profit margin for all the agents.

The way in which operations are organized as a whole is described below, with a distinction made between firewood and charcoal.

Firewood is seldom taken from the site immediately after felling because irregular shapes affect the means of transport (great numbers of low-density loads). This situation used to prevail and still does to some extent, as around Ouagadougou, where donkey carts are used, and on the Logone and the Chari rivers at N'Djamena, where rafts of firewood were floated downriver accompanied by canoes.

Generally, firewood is cut into saw logs, split logs, or faggots by the fellers, although this work sometimes is done at the roadside point of sale to transporters by women or older farmers (preparation and binding of faggots).

Distances between felling sites and roads can be of various lengths, from a few hundred meters to eight kilometers, the average distances being three to five kilometers. The wood usually is transported to the road by donkey cart, but it is sometimes carried on people's backs (over distances that never exceed four kilometers).

Roadside loads are routed by the transporters toward the towns and are generally sold to traders, usually primary or secondary wholesalers. In some towns of the region, certain vehicle owners (mostly small-capacity vehicles such as carts or tarpaulin-covered Peugeots) peddle their loads around the towns (as in Ouagadougou and Bamako).

Within the towns, the marketing networks are complex, involving many individuals from primary wholesalers to micoretailers who sell small volumes of wood chips measured by the "plate." Housewives can often get laborers to split

the wood to their requirements. Firewood trade and distribution in the towns thus provides a livelihood for many people. In Ouagadougou, De Baker (1982) estimated that 16,000 persons derived an income from the firewood networks, 6,500 persons in Bobo Dioulasso.

Charcoal is an important fuel in economic terms only in Senegal, in the urban part of the Cape Verde peninsula around Dakar, where it is now used intensively because of the exhaustion of nearby forest resources and because of urban lifestyles.

The whole Sahel region (including Senegal) produces charcoal by the traditional kiln-in-the-ground method, which gives weight yields on the order of 15 percent and never more than 18 percent, even if it is "improved," as in the "Casamance kiln." Given the respective average levels of thermal efficiency (4 therms/kg for wood and 7.5 therms/kg for charcoal), a 15 percent yield means maximum heat efficiency levels of 30 percent (compared to an equivalent weight of firewood) and consequently losses of 70 percent, which in turn implies unduly large harvests of forest products. The implication is that wherever social and economic conditions do not call for compulsory consumption of charcoal (as is the case in Senegal's Cape Verde peninsula), the use of charcoal should be limited if overfelling is to be reduced and if desertification is to be controlled.

Charcoal operators are usually professionals belonging to associations or cooperatives working in connection with traders. In addition, small-scale charcoal production by blacksmiths can be found locally throughout the region.

Charcoal is always transported to the towns in bags loaded on trucks (with the occasional exception of some rail transport). Within the towns, the trade is organized along far simpler lines than wood trade (the range of products is extremely small). The charcoal is sold in bags or "by weight." There are no real wholesalers for charcoal, but there are networks of depots distributed around the towns.

TWO DIFFERENT STANDARD SITUATIONS FOR FOREST FUEL TRANSPORT

Crucial to the organization and structuring of the microchannels is the means of transport, the major parameters being (1) the nature of the means of transport and (2) its use (whether exclusively for forest fuel transport), and consequently what role and linkages transporters have to the other agents of the network. In the Sahel, a practical distinction can be made between two standard situations basically different in nature, depending on whether the predominant means of transport (usually trucks) is used on a specialized basis, or whether forest fuels are carried by general goods carriers.

Specialized transport applies to what can be described as the "poorer channels." When all transport operations, including those involving trucks as the

major means, use vehicles specially designated for firewood and charcoal, the cost of transport as a share of the average retail price of the product becomes so substantial that it considerably affects the way channels are organized and the relationships among the economic agents involved in them.

Two competing modes, tarpaulin-covered vehicles and donkey carts, are encountered on the outskirts of towns, wherever early and intensive overfelling has led to reduced volumes of available wood. These scattered resources are usually found in fallow areas reopened for development.

Donkey carts play a major role in Ouagadougou, where they accounted for about 40 percent of the wood carried in 1975 (Bertrand 1975). This share has been gradually decreasing, as neighboring supply zones became exhausted and felling areas had to be found farther away. According to De Baker (1982), the share of donkey carts was 30 percent in 1982.

Other nonautomotive forms of transport operate very much like the carts in the wood product channels. They include pedestrians, animals such as camels or donkeys (as can be seen in Niamey), and cyclists.

Tarpaulin-covered vehicles are usually Peugeot pick-ups, whose shabby condition indicates long years of service. They are in many cases bought second hand from the government or from individuals after they become unsuitable for personal transport and are used for about three years to carry wood, by which time they are ready for the scrap-heap.

These means of transport, used to carry relatively small loads over short distances (not exceeding 20 to 30 kilometers), are usually found providing commercial supplies to medium-size urban areas. A considerable quantity of the wood consumed in these areas is self-supplied. De Baker (1982) estimates the amount in semiurban areas at 28 percent.

Trucks designated for wood or charcoal transport are used primarily for wood, since the charcoal for urban consumption on the Cape Verde peninsula is carried on a subcontracting basis by carriers who use their vehicles for a variety of goods, depending on supply and demand (Laurent and others 1981). The share of charcoal, forunately, remains marginal in other large urban areas.

Trucks specializing in wood transport serve relatively unpopulated felling zones (or areas where the population is scattered, without small urban settlements) and/or locations where the major economic activity (agriculture) is too poor to justify goods being transported from the city to the country (cement, additional foods, and so forth), thereby providing an opportunity to carry wood back to the town. In this sense, this specialized transport channel can be described as "poor." Such a situation can be observed in places like Niamey, Ouagadougou, or N'Djamena (Bertrand 1976) and leads to several major consequences. First, the cost of transport is considerable, so that structural savings stemming from the use of large-capacity carriers are reduced (it is impossible to use semi-trailers), and profit margins distributed among the various agents

involved tend to shrink along the whole channel.

Second, the vehicles are in very poor condition due to low and sometimes very marginal profitability levels. Carriers find it impossible to purchase new equipment and difficult to buy even second-hand vehicles except under special conditions (when "retired" by the government). This helps explain the high proportion of active or retired civil servants who own these trucks.

Third, distances covered in economically acceptable terms are limited due to the cost of the town-to-country journey of the empty vehicles. These distances seldom exceed 80 to 100 kilometers.

Fourth, the carrier has a close relationship with the whole channel as he becomes an integral part of it. It is important to have a clear view of the consequences of specialized wood transport, which are of two types. On the one hand, often the carrier is himself or is closely connected with a trader (primary or secondary wholesaler) and tends to work his way up the distribution channel in order to set up salaried felling teams in forested areas. This occurs, for instance, in Niamey (Laurent and Madon 1984) and was also observed in N'Djamena (Bertrand 1976). One might describe this trend as the first step toward organizing forest operators into a true profession, but economic conditions do not seem conducive to a genuine conversion of the specialized wood carrier and trader into a full-fledged forestry operator. On the other hand, such a trend is obviously risky in view of present ownership patterns, inadequate rules and regulations in the field of forestry, and the low rate of recovery (a few percentage points only) of forestry taxes, even though these are unnaturally low. Indeed, salaried fellers are completely free to cut wood *anywhere*. This means that in places where village people once cut wood for their own purposes they now may find themselves deprived of the capacity to manage their environment and its resources—which are often vital for them or for other ecologically sensitive reasons (for example, areas prone to erosion). The consequences can be very serious not only from the viewpoint of forestry but also of livestock breeding in certain cases, and all the more so as prospects for developing regular silvicultural work in rural areas are thereby reduced to virtually nil.

Fifth, the specific pattern of self-supplied small urban manufacturing plants using wood (brickmaking, tobacco and match production, and so forth) or of self-supplied community organizations (such as prisons and hospitals) is similar to the one outlined above. But in this case there is no prospect for the development of truly professional forestry operators, since this wood product channel is integrated with industrial production but comprises only a very small part of it.

The second type of standard situation in the region, nonspecialized transport, is found in areas where both the economy as a whole and forestry in particular are in a more favorable position. In this case loads of wood and charcoal are simply return-journey freight, with the most competitive costs and means of transport being used.

The carrier either owns or rents his vehicle. Transport is his main line of business, and wood is only one of the goods hauled on a return journey, to be sold to a primary or secondary wholesaler in the town. Carriers virtually always buy the loads of firewood from farmers at the roadside, except when the specific requirements of small industrial units or of community institutions (hospitals, schools, and so forth) call for different treatment.

Vehicles used in nonspecialized transport are of the same type involved in larger scale general goods movement. In Bamako, for instance, semi-trailers with a capacity of more than 30 tons regularly transport wood and are in reasonably good condition.

Distances covered for firewood transport can be considerable, as the wood is a return journey freight that need cover only the direct transport costs in one direction. In 1984 distances often reached 150 to 170 kilometers in the area around Bamako. This is an advantage in forestry terms because the supply areas for urban zones can be extended. Furthermore, it should also be possible thereby to ensure better management of forest formations and to restrict overfelling in certain areas.

In charcoal transport, distances can be even greater, reaching 300 to 500 kilometers for supplies to Dakar coming from the Senegal River region or from Casamance. The carrier in this case is merely a contributor from outside the distribution channel, even if it is he who files the request for the "felling permit" (which, in fact, is a transport authorization) with the Forest Service and discusses the wood deals with villagers. He is by no means a professional in forestry operations. His relationship with the farmers who sell the wood does not mean he has any particular stake in the management of the village's forest assets.

Transporting forest fuels as return journey freight enables the carrier to gain increased profits from his vehicle. Consequently, carriers (and/or, in Senegal, the drivers' lobby) want to keep the market as it is. This provides an explanation, for example, for the opposition of road transport professionals in Senegal to the purchase of trucks by charcoal cooperatives.

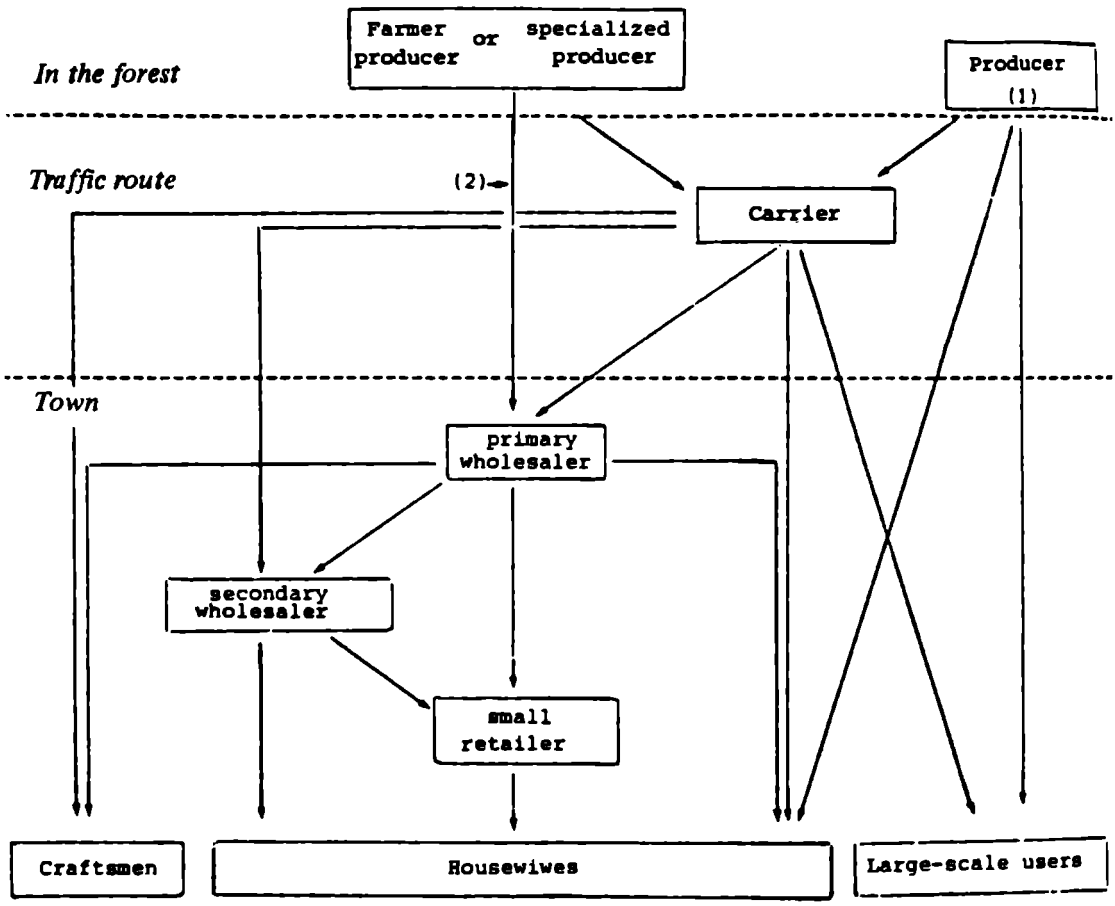
DISTRIBUTION STRUCTURES IN TOWNS

Figure 1 illustrates the complexity of distribution structures in towns and the variety of situations and existing micochannels, as can be observed in the case of Bamako. Outside the city the microchannels can easily be defined from the area point of view, but the position is totally different within the city, as they tend to merge or become interwoven.

The complicated picture applies mainly to firewood, as charcoal distribution operations are generally more streamlined. In Dakar, for example, there are short and long circuits that are standard distribution arrangements for charcoal. These are illustrated in Figure 2. Wood marketing is more complicated than the charcoal trade due to the various processing and repackaging operations

Figure 1

Firewood Marketing Circuit

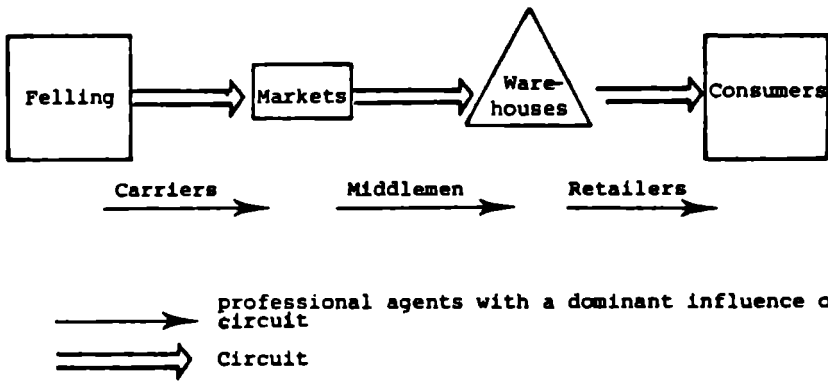


1. Administration-run units, and cases where producers or laborers are employees of major users.
2. Wholesalers using their own vehicle.

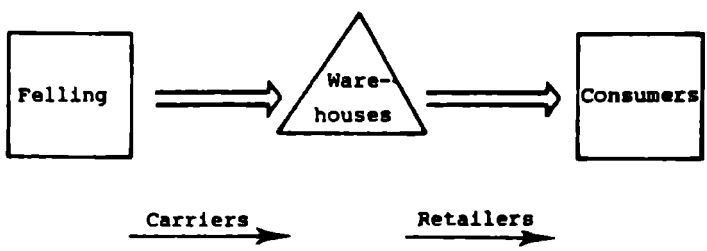
Source: Bertrand and others 1984.

Figure 2

REPRESENTATION OF THE LONG FIREWOOD OR CHARCOAL MARKETING CIRCUIT IN DAKAR



REPRESENTATION OF THE SHORT FOREWOOD OR CHARCOAL MARKETING CIRCUIT IN DAKAR



Source: Laurent and others 1981.

performed on the products supplied by carriers. As Gibert (1978) notes: "Faggots 'lose weight' in the town—which actually means that products suited to a specific raw material and to transport requirements (easy handling and stacking) are completely rearranged into a smaller number of products to meet the needs of urban consumption, which in the end seem rather standardized." Thus, it is important to list all the different products at the various stages and to define clear-cut product types as a preliminary step to studying the problems of firewood distribution channels.

Differences between primary and secondary wholesalers often are less perceptible than they seem to be in Figure 1, as traders generally try to multiply the number of medium-size points of sale (secondary wholesaling) rather than set up a single, larger, central depot. This difference is related more to business

volumes and to the wider range of activity of major traders (primary wholesalers) as compared to other participants in the distribution channels.

It is difficult to provide a brief description of forest fuel trade patterns in urban areas because of the considerable differences between the large cities in the area under review. The number, role, and position of agents in the chain of transactions or operations vary from city to city. Furthermore, changes necessarily occur over time and can be quite substantial.

In overall terms, three roles can be outlined. Primary wholesalers buy the wood from the carriers or act as carriers themselves; the same is true for secondary wholesalers, or they may buy the wood from primary wholesalers; retailers buy the wood from wholesalers but hold only very small stocks. There are many types of retailers, ranging from those holding places in markets to microretailers who sell wood "by the plate" (who work in the "6 meter zone" on the streets). There are also a great number of more or less permanent salaried employees for handling jobs and sometimes processing operations, such as splitting wood or bundling faggots. In addition there are some laborers who do splitting in households to the particular requirements of housewives. At various stages of the system, other middlemen can also come into play.

FOREST FUEL PRICING STRUCTURES

An in-depth study of distribution channels makes it possible to describe the social behavior patterns and relationships among the various agents, as well as assess corresponding monetary flows and price structures. Analyzing and comparing these structures in terms of time and space lead to some interesting conclusions.

Table 2 rather fully explores five pricing structures, three for firewood and two for charcoal. The following basic conclusions can be derived from the material. In terms of firewood, the portion of income and expenditure remaining in rural areas seems to be relatively high (about 30 percent of expenditure and 40-50 percent of income). Consequently, there are reduced portions remaining for carriers and city retailers. This contradicts the "myth" of firewood trade generating large amounts of income for the "traders." Such a generalization should be avoided because of the specific situation in each town, particularly as regards transport conditions. In Niamey, the relative influence of carriers, who are present at both ends of the distribution channel, appears considerable, and they seem to gain some advantage from this situation.

As for charcoal, since carbonization is necessarily carried out on the spot after felling, the rural share of pricing structures is, normally, larger than for firewood. At the same time, trading margins in urban areas appear to be distinctly greater than for wood; charcoal seems far more profitable, although the volume is small (except in Dakar). Another difference between the two products is that price levels for charcoal between Bamako and Dakar are quite

Table 2. COMPARISON OF PRICING STRUCTURES IN DIFFERENT SAHEL TOWNS

	Firewood						Charcoal			
	Bamako 1983		Ouagadougou 1983		Dakar 1980		Bamako 1983		Dakar 1980	
	MF/kg	%	CFA F/kg	%	CFA F/kg	%	MF/kg	%	CFA F/kg	%
Producer										
Costs	1.6	6.4			1.8		25.5	29.0	13.5	
Profit margin	11.2	44.8					19.5	22.2		
Roadside selling price	12.8	51.2	10	45.5			45.0	51.2		
Carrier										
Costs	5.2	20.8	6	27.3	6.3		8.0	9.1	9.5	
Profit margin	2.7	10.8					6.0	6.8		
Wholesale price in town	20.7	82.8	17	77.3			59.0	67.1		
Different stages of marketing in town										
Costs	0.5	2.0			2.9		14.0	15.8		
Profit margin	3.8	15.2					15.9	17.0		
Average retail price	25.0	100.0	22	100.0	20	100.0	88.0	100.0	40.0	
Forestry taxes	0.5	2.0				1.5	5.0	6.0	1.5	3.75

similar (40 CFA Francs = 80 Malian Francs [MF]), whereas wood prices differ considerably in the two cities (in the ratio of one to two).

Table 3 requires the following preliminary clarifications. First, it must be emphasized that the data are drawn from various sources and are of a general and consequently approximate nature. The aim of the table is chiefly to highlight a trend. Second, De Baker (1982) contributed the following details for 1980, which are included in Table 4. He gives a breakdown of production costs as follows: stumpage, 0.62 CFA F/kg; felling and sawing, 0.62 CFA F/kg; and transport to place of sale by the farmer, 1.25 CFA F/kg. Third, in Ouagadougou, a slowdown in relative wood price hikes can be noted in relation to overall consumer price increases. This can be explained by the fact that the demand side gradually becomes more sensitive to price increases for a basic necessity.

Table 3. TRENDS IN COST COMPONENTS OF FIREWOOD PRICES IN OUAGADOUGOU (1975-1983).

	1975 CFA F/kg of wood[a]		1980 CFA F/kg of wood[b]		1983 CFA F/kg of wood[c]		Average annual increase rate % 1975-1983
Average retail price	7.0	(100.0)	15.0	(100.0)	22	(100.0)	15.4
Wholesale price in town	5.0	(71.4)	10.0	(66.7)	17	(77.3)	16.5
Average transport costs[d] per truck[e]	1.5	(21.4)	3.8	(25.3)	6	(27.3)	18.9
Average roadside price paid to the producer	0.7	(10.0)	3.8	(25.3)	10	(45.5)	39.4
Gross margin of salesmen in town[f]	2.0	(29.6)	5.0	(33.3)	5	(22.7)	5.2
Net margin of carrier	2.8	(40.0)	2.5	(15.6)	1	(4.6)	- 12.1

[a]Bertrand 1975.

[b]De Baker 1982.

[c]Bertrand 1983.

[d]The average distance of transportation has necessarily become longer over the years.

[e]A different mode of computation, taking into account only automotive means of transport, leads to an assessment by De Baker of transport costs accounting for 18.7 percent of commercial value.

[f]The gross margin includes the additional splitting costs.

Some basic conclusions can be derived from Table 3. First, both in trade inside towns and in wood purchases in the bush, and then in transportation to the towns, profit margins that were substantial in 1975 have shrunk considerably in recent years. Earlier, carriers and urban salesmen had the leading role in pricing wood products, but later they were not in a position to raise the price paid by city-dwellers in proportion to the increases in their own roadside purchase prices in the bush. Second, the increase in production costs is certainly an important factor in rural forestry policies. Indeed, it seems that farmers in areas around towns are becoming more interested in firewood production, which can provide them with a reliable and regular flow of income so as to offset the disastrous effects of poor harvests. In Ouagadougou, farmers have apparently reacted against donkey-cart drivers who have been logging in forests against customary land and tree tenure rights. The farmers have become interested in cash income from wood collection. Consequently, it may be possible to make them more aware of the potential of wood as a "private income crop."

In the Sahel-Sudan region, wood, and particularly firewood, can be considered a staple agricultural commodity. It is similar in many ways to the staple grain crop, millet. It serves to symbolize relations between towns and rural areas, and it is so valuable that it is often used for gifts. It is noteworthy that, as with millet and other farm products, income distribution all along the channels changes constantly and depends on social relationships, on the way professionals are organized, and on techniques or solutions implemented, particularly as regards transport. Table 4 indicates the distribution of costs and margins for wood.

Table 4. DISTRIBUTION OF COSTS AND MARGINS ALONG THE WOOD DISTRIBUTION CHANNEL IN 1980 AROUND OUAGADOUGOU

	Economic contribution by sector and by kg (CFA F)						
Mode of transport	Production costs	Producers' profits	Cost of transport	Carriers' profits	Marketing costs	Marketing profits	Average price
Pedestrians	2.50	2.00	6.45	1.05	2.00	1.00	15
Bicycles	2.50	1.75	4.40	3.35	1.50	1.50	15
Carts	2.50	1.50	2.25	3.75	3.25	1.75	15
Vans	2.50	1.25	1.75	4.50	3.00	2.00	15
Trucks	2.50	1.00	3.80	2.50	2.70	2.50	15
Wood alone	2.50	1.30	2.83	3.49	2.83	2.01	15

Source: De Baker 1982.

The present organization of wood distribution channels is based on the virtually nonexistent value placed on natural forests, which are looked upon in overall terms as a gift from God, conveniently supplied by nature, and by definition endlessly renewable and renewed. However, people in rural areas are clearly aware of the gradual degradation of the environment and of the fact that it is often irreversible and is already producing negative effects.

The negligible value placed on natural vegetation is at present epitomized in financial terms by forestry taxes, which are dependent on the land ownership systems of the various countries. The low level of these taxes is an incentive for consumption, particularly in towns, which thereby becomes a "subsidized" form of consumption. This logically results in "overconsumption" (incompatible with available natural resources, and with the lack of response of society). In abstract terms, this "overexploitation" can be viewed as a form of disinvestment (the decline in forest and ecological assets), for the sake of immediate consumption, particularly in towns.

The "overconsumption" of wood is due to the growth in urban population and even more so to overall population levels. Its effects compound the problems due to lack of initiative and to low volumes of forestry investment in rural areas, which are determined by the present inadequate legislation in the various countries of the region (variations are very small from one country to another). This legislation has, as a general rule, changed very little over the past three or four decades; given rise to repressive relations between rural communities and forestry authorities; and deprived traditional authorities of their ancestral ecological role, thus acting as a disincentive on farmers' ability to take initiatives as well as on their individual and collective sense of responsibility. Forestry taxation has remained virtually unchanged over time. In Niger, for example, it has stayed at the same level for more than thirty years.

Consideration of natural forests crystallizes some of the basic contradictions of present-day Sahelian societies. Wooded areas are very much at the center of a land management dilemma, as they constitute simultaneously important reserves of both wood and agricultural land. The other major contradiction is a consequence of rapid population growth, which is not at present synchronized with parallel expansion in agricultural productivity.

Under these circumstances, land and forestry legislation has yielded the combined negative effects of making farmers feel less responsible for the management of their environment, as their customary rights are constantly being called into question, and depriving them of the economic legitimacy required to enhance the value of these products at a time of accelerated increase in their trading value.

GUIDELINES FOR ACTION

It would be useful in the medium term for farmers or village-based groups to

increase the value that they derive from forest products and for Sahelian governments to work toward the same goal by means of increased taxes on forest products. The latter would provide additional incentives for the use of improved stoves in urban areas and would make it possible to recover at least part of the savings in urban consumption derived from technological progress in the form of improved stoves to generate additional resources for rural investment.

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INITIATING FORESTRY REFORMS IN THE SAHEL: THE ROLE OF TRANSITIONAL FINANCING

Asif M. Shaikh
Energy/Development International
Abidjan, Ivory Coast

Even after a decade of major efforts in the Sahel and five years of intensive work, environmental degradation is growing. The threats to rural production, human well-being, and national economic health are well documented. We understand now that the scale of the needs is not incremental: To meet the wood needs of 25 percent of the rural population of Mali (roughly 1.3 million people) through village woodlots requires roughly 600,000 metric tons of wood per year. The minimum private capital costs to supply this are $50 million, plus enormous public institutional resources. Other options (such as managed natural forests) may be more cost effective but would tend to place a greater cash investment burden on the public sector.

We do not have the human or financial resources (nor will we in the near future) to restore completely the Sahelian environment using any proven models of technology, investment, participation, and incentives. This realization will be positive if we focus our efforts on pursuing the highest priority objectives attainable (such as soil protection) and on identifying the areas in which limited public resources can have their greatest effect. Even within this new strategy, the present scale of reforestation activity will have to be multiplied greatly.

Forestry services in the Sahel were not set up to do massive outreach (CILSS 1982a). Their paramilitary traditions and historic emphasis on single intervention protection/repression measures are not suited to present and future needs for sustained extension work. Existing legislative codes define the limits of exploitative practices but were not geared to promote tree planting.

Incentives within the administrative structure reflect the traditional roles of forestry administration and are an obstacle to the changes needed. Because wood is a freely available natural resource, its free market price is far less than society's cost of replacing it, and consumers have insufficient incentive to conserve. In the long run, there may be far less wood in the Sahel than there is now, no matter what we do. But the situation will never stabilize until producers can earn as much from growing wood as they can from collecting it, and until consumers pay enough for wood to cover replacement costs. A significant lesson of forestry efforts over the past several years has been that the nonenergy benefits from tree planting (sale of poles, fruit, and so forth; soil protection; and increased agricultural yields) will be central to making it financially attractive to grow trees.

A PERIOD OF CHANGE

Throughout the Sahel, major transitions in forestry sector institutions and policies are taking shape. The government of Mali and major donors have been working together to define reforms in woodfuels prices, incentives to forestry agents, legislative codes, and uses of the Forestry Fund. In June 1984, the government of Niger sponsored a ministerial level conference to outline sector reforms and strategies in forestry. Senegal has recently increased the permit fees for collecting wood from government plantations from 120 CFA per stere to 2,000 CFA/stere and is contemplating similar increases for natural forest zones (Palmedo and others 1984, p. 9). Through summer and fall 1984, the government of Burkina Faso, in cooperation with U.S. and German projects, conducted an extensive review of marketing, pricing, and management systems for large managed natural forests around Ouagadougou and Bobo Dioulasso.

What can donors do to promote and support this transition? The most obvious answer, and one which is almost reflexive, is that they can help finance it. But two more fundamental questions immediately occur: What is the nature of the reforms to be financed? Can we separate transitional financing needs (to implement reforms) from the long-term needs to expand forestry programs and outreach? Despite certain obvious similarities, the diversity of demand and environmental relationships in the Sahel makes regional conclusions valuable only insofar as they draw on specific case examples. This paper is an attempt to develop one such, for Mali, and to identify specific institutional and policy reforms in three areas: management of the Forestry Fund, the role of the forestry agent, and woodfuels pricing.

THE FORESTRY FUND IN MALI

The Forestry Fund is the principal nonbudgetary source of domestic financing for forestry sector operations. Established in 1967, it draws two types of revenues. Transactions revenues come from fines on illegal woodcutting. The forestry code establishes upper and lower bounds for fines on various illegal practices. Current legislation allocates 25 percent of these to the reporting agent and to various levels of regional administration, and 75 percent to the Forestry Fund. Exploitation revenues arise from permit fees and taxes on legal woodcutting. The legislative framework is defined in the forestry code (Law no. 68-8 AN-RM). In general, rural wood collection for personal consumption is not subject to tax. The principal activity subject to fees is thus collection for resale, as defined in Articles 41-49 of the forestry code. In practice, such wood is destined primarily for urban markets. Permit fees are approximately 200 Malian Francs (MF) per stere. All exploitation revenues go to the Forestry Fund.

Important reform issues that will be addressed in coming years fall into three categories: clarification of allocation criteria, improved financial management

procedures, and accessibility of fund resources. As to the first, there are no accepted guidelines tying the percentage of fund resources expended in a given region to the percentage of revenues generated there. The result has been sometimes serious discrepancies between the two, which have acted as a disincentive to performance and to proper reporting (Taylor 1984). In terms of the second, to meet large-scale reforestation needs of the coming decades, the Forestry Fund will have to grow several fold, as will be detailed below. Current procedures are not suited to such large revenue flows and to complex financial management. Finally, even what monies now pass through the fund are not readily accessible because all revenues are deposited in the general treasury. Due to severe overall budgetary shortfalls (especially since 1981), funds never can be accessed quickly and sometimes not at all. The charter establishing the Forestry Fund explicitly sought to create a "flexible and easily mobilized" financial mechanism (CILSS 1982a, p. 98), but current practice prevents this. As long as revenues pass through the treasury, the problem is likely to persist. Yet, the risk in bypassing the treasury is also considerable since the fund does not have well-developed financial management procedures. Failure to create them might invite abuse, while the very attempt to create them may seriously tax limited institutional capacity.

THE ROLE OF THE FORESTRY AGENT

The Incentive Structure

Many observers have noted that forestry agents have continued to stress their role as policemen despite the increasing policy emphasis on extension (Bertrand and others 1984; Thomson and others 1984; CILSS 1982b). Historically, the importance of the policing (and often repressive) role is linked to policy objectives ("protection before development"), to service traditions (paramilitary), and to the lack of major projects requiring an extension role.

By 1980, a number of major forestry projects were under way, and the Direction Nationale des Eaux et Forêts (DNEF) committed itself to changing the role of the forestry agent (Shaikh 1981). There is broad agreement that the new role will increase extension without abandoning protection, and that repression does not serve the long-term interests of the environmental protection function.

The incentives to agents to continue repressive policing are monetary, political, administrative, and educational.

Under current law, a villager caught cutting or burning illegally is fined; 10 percent goes to the person who reports the offense (in practice always the forestry agent), 5 percent to the agent who writes it up, and 10 percent to management levels of the regional forestry service. The remaining 75 percent is deposited in the Forestry Fund. This incentive structure has three principal flaws: It is costly for the agent to devote more time to extension work (where he collects no fines to supplement his income); there is little incentive to report

fines (the agent keeps 100 percent of those unreported); there is no incentive for field agents to monitor one another.

There is consistent political pressure from national and regional authorities for agents to be more effective in controlling offenses. There has been a national campaign to suppress all forest fires, which many feel ignores some of their beneficial effects (Taylor 1984). Agents have been organized in larger teams and been given better transport to apprehend offenders (Berthe and Jean 1984). In the absence of any other practical suggestions, the only available measure of effectiveness is the number of fines imposed.

The institutional factor appears to be extremely complex, but the crux of the matter is that field agents receive very little institutional support in terms of budgets, programs, or management. It is much easier for an isolated agent to undertake fining than extension, for which he needs defined objectives, better training, technical backup, and some project resources. Interagency competition also is an important factor. In principle, both agriculture and livestock agents have a legitimate environmental function, but the negative role of enforcer is left to forestry agents. Because other services focus more on short-term production goals, they may even assist villagers in activities the forestry agent is trying to prevent.

There are serious deficiencies in training. It is well known that forestry agents must be sensitized to the needs of extension work, but this is hampered both by their paramilitary orientation and by their frequent repressive contact with villagers. The lexicon of forestry and environmental protection is much less familiar to peasants than are the vocabulary and agenda of the agricultural agent. Most seriously, the depth of skills which most forestry agents possess simply does not equip them to deal with the complex land management and soil protection issues that a long-term extension role must address. The new function requires a much more highly skilled agent.

Reform Options

Three major options for reforming monetary incentives have active proponents: Reduce the percentage of fines retained by the agent; eliminate the agent's incentive to fine altogether; or change the way fine revenues are distributed throughout the institutional structure. In many ways, these are variants on the same theme, but the differences have important implications.

The first option would make it less costly for the agent to devote more time to extension. But in the absence of countervailing measures, he may simply increase fining in order to maintain historical income expectations. The number of unreported fines may also increase. This option does not equilibrate the incentives to fining versus extension work. The effect on Forestry Fund revenues cannot be predicted. If (reported) fining were to increase, fund revenues would increase, but at the expense of policy objectives. If unreported

fines were to increase (relative to the total), both revenues and policy objectives would suffer.

The second option (eliminating the agent's percentage) would equilibrate the official incentives to protection and extension and would not lead to an increase in reported fines. It has two primary drawbacks: It would mistate the importance of the protection role if it were interpreted by agents or villagers as meaning that protection was no longer a priority, and it would very likely lead to a greater share of unreported fining.

The third option, now under active consideration by the government of Mali (Soumare 1984), involves two major departures from current practice. The 10 percent of fines now going to the reporter of the offense would only apply if the person were not a forestry agent, thereby increasing villager incentive to report offenses. The 10 percent now going to regional administration would be spread more broadly, such that all workers (including office staff and other agents) would get a share. The second provision would have two effects. Agents working more on extension would continue to get income from fines, and field agents would tend to pressure fining agents to report fines, because they stand to lose income if they do not. Experience suggests that field agents are well aware of the unreported fining that goes on but have no incentive to curtail such activity.

To the extent that the third option reduces the incentive to fine, Forestry Fund revenues would decrease. To the extent that reported fines would increase, revenues would rise. More important, this option appears to offer incentives, to all administrative levels, that are appropriate to policy objectives.

Specific recommendations for improving the quality of education and for institutional changes will result from detailed analyses, some of which are already planned (USAID 1984). However, it is interesting to note that for every reform proposed in monetary incentives, education, or other areas, there is an institutional dimension. The third option for monetary reform is particularly interesting because of its promise for mobilizing institutional incentives at all levels of administration.

An important institutional factor not discussed thus far is the relationship between the forestry service and peasants. Few of the latter understand the forestry codes under which they are fined. Many view fines as a tax for collecting wood rather than as an incentive to change their practices. Misapplication of laws by forestry agents merely reinforces this conception. It is of the highest priority that there be widespread efforts to explain the codes at the village level and to translate and diffuse appropriate sections in local languages.

WOODFUELS PRICING

Pricing and Market Structure

The woodfuels market is segmented. In general, rural wood is collected by

the final user, and urban woodfuels are commercially transacted. Rural collection is not subject to taxes or fees, and there are no realistic measures to influence rural woodfuel prices. Urban products (fuelwood and charcoal) typically involve a four-stage price structure and are subject to permit fees. Bertrand and others (1984) have estimated the costs and markups at each stage of the process, as shown in Table 1. Taxes are in the form of cutting permits (in theory imposed on the collector on the basis of type of wood, area, and product, but in fact paid by the transporter). Collections of firewood are taxed at 200 MF per stere.

Table 1. COSTS AND MARKUPS IN THE WOODFUELS MARKETING AND DISTRIBUTION SYSTEM
(Malian Francs–MF)

	Cost per kg	Revenue per kg	Margin
Producers	1.00	12.38	11.4
Transporters			
PFPB	21.6 - 27.9	23.4	-4.45 to +1.8
GFPB	15.8 - 22.05	23.3	1.25 to 7.5
FBM	18.04 - 21.24	18 - 22.5	-3.24 to +4.46
Buches	12.9 - 14.6	16	1.42 to 3.12
Retailers			
PFPB	23.9	28.1 - 30.5	4.2 to 6.6
GFPB	23.2 - 24.4	25 - 28	0.6 to 4.8
FBM	18.5 - 23	21.3 - 30	2.8 to 7
Buches	15.4 - 17.6	18.6	1 to 3.2

Source: Bertrand and others (1984), Tables 511-513, pp. 172-76.
Note: Producer prices are undifferentiated by type. Costs in column 1 include intermediate purchase cost (that is, transporter cost includes purchase from producer, and so forth). PFPB = petits fagots, petites branches (small sticks, small branches); GFPB = grands fagots, petites branches (large sticks, small branches); FBM = fagots/branches moyennes (medium sticks/branches); and Buches = fagots/buches (sticks/logs).

Approximately 27 percent of wood energy use in Mali supplies commercialized urban markets, primarily in Bamako. This percentage defines the portion of the market whose price can be influenced by government policy. Of the 880,000 metric tons (MT) of wood used to satisfy urban markets (1983 estimate), approximately 95 percent is consumed directly as firewood, the rest being used to produce charcoal. There are no government price controls at any stage in the woodfuels marketing and distribution process. Nominal wood and charcoal prices doubled between 1978 and 1981 (from 12 MF/kg to 25 MF/kg

and 51 MF/kg to 100 MF/kg, respectively), and prices vary seasonally by as much as 60 percent (Traoré 1984). The supply zone for Bamako appears to extend roughly 100-150 kilometers along four principal supply axes.

The upward movement of prices would be desirable for two reasons: better to reflect wood scarcity by raising the price to the point at which it covers the marginal cost of producing wood, and to promote adoption of more efficient conversion devices (kilns, woodstoves, charcoal stoves). A desirable pricing policy would be one which achieves these objectives, is easy to administer, and creates a minimum of market distortions.

Influencing Prices

Government can influence the price of woodfuels in urban areas by increasing the cost of cutting permits. The present 200 MF/stere translates into roughly .5 MF/kg, which is 2 percent of the current supply price, and thus even drastic increases would have limited effect on consumer prices. A tenfold increase (to 2,000 MF/stere) would result in a supply price of only 29.5 MF/kg; a twentyfold increase would only raise it to 34.5 MF/kg. Given that seasonal price variations can be as much as 60 percent, it is doubtful that any politically acceptable increase in permit fees will have a significant effect on the price incentive to conserve wood in urban areas in the near future.

Revenue Potential

There is great potential for augmenting Forestry Fund revenues by increasing the cost of permit fees and by extending their coverage. Each of these avenues is elaborated below.

Because of the negligible effect of higher permit fees on supply price, the only political constraint to raising them is the reaction of wood collectors, transporters, and distributors. To the extent that the pricing mechanism can encourage them to pass along tax increases to the urban consumer (which is socially desirable, in order to promote conservation), profits in the marketing and distribution system can be maintained and political opposition defused. Furthermore, tax increases can be implemented over several years to allow market adjustment. If fees rose to 2,000 MF/stere, Forestry Fund "exploitation revenues" could pass from 208 million MF to more than 2 billion MF per year; a 4,000 MF/stere fee could generate revenues of more than twice that. This considerable revenue source could be the basis for large-scale reforestation efforts in Mali.

Comparison of official records on the amount of wood taxed with estimates of urban woodfuel consumption suggests that less than 20 percent of the commercially exploited wood is now taxed (Shaikh 1984). Two factors explain why such a high percentage escapes taxation. First, control and verification are sporadic at best. Moreover, when a transaction is intercepted, under current

practices there is no way of knowing how much wood has previously been collected under the same permit, so a given permit can sustain a much larger number of transactions than was intended. Second, since permits are (in principle) issued at the point of collection, transporters are not required to carry papers showing that taxes have been paid; therefore there is no means of controlling wood moving along the major road axes.

Two approaches to increasing the coverage of the current tax system can be considered. (1) Intensify surveillance and control along the four major road axes around Bamako. The supply zone is not very large (3-4 kilometers on either side of the road, 150 km radius). However, to make increased monitoring effective, the permit system would have to be revised to allow the amount of wood collected under a given permit to be tracked cumulatively. (2) Control the "city gates" by establishing checkpoints along each major road. This would require only limited manpower. Driving off the road to avoid detection may be more costly than paying the tax.

It should be noted that neither measure would do very much to improve the overall environment. The first would only affect a very limited geographic (ecological) zone, and the second would be a purely commercial tax that provides no direct incentives to improved forest management. Finally, it is not clear that the forestry service in fact has the legal jurisdiction to establish what amounts to an "internal customs duty" (second option); basic legislative changes might be needed. It is purely hypothetical to estimate how much extra revenue could be generated by increasing tax coverage. Forestry Fund revenues will rise roughly in proportion to any increase in tax coverage. If we assume a 50 percent increase in coverage (that the proportion of commercialized woodfuels effectively taxed passes from 20 percent to 30 percent), then at the current permit fee cost of 200 MF/stere, revenues would only increase by about 100 million MF per year. If permit fees were 2,000 MF/stere, the effect would be more than one billion MF per year.

The Incentive to Conserve

Even if the final supply price of woodfuels cannot be raised significantly, the price is already high enough to encourage conservation. At current wood prices in Bamako, an improved commercial stove with 20 percent efficiency and a cost of 2,000 MF would pay off in less than three months. A stove 15 percent efficient would pay off in less than four months, and even one costing 4,000 MF would have a payback of less than twenty-two weeks (Shaikh 1984). Selection of stove designs and, in particular, support for stove commercialization appear to be more important constraints than are wood prices at this time.

The Incentive to Grow Wood

Given the existing incentive to conserve, a primary policy objective should be

to raise producer prices sufficiently to make it worth producing wood, that is, to a point at which producer prices are equal to the marginal cost of supply. In practice, this would involve two stages. First, permit fees would rise to the point at which the sum of the price paid the collector plus the permit fee would be sufficient to allow a potential producer to earn the same return from growing wood as from collecting wood. Second, wood from replanting would be exempted from permit fees, while wood collected from the natural forest would not be.

Bertand and others (1984) estimate that it now costs farmers approximately one MF/kg to collect wood, against a revenue of about 12.4 MF/kg, leaving a margin of 11.4 MF/kg. If a supplier were allowed the same margin of 11.4 MF/kg, he would require 41.4 MF/kg as a producer price. Given that farmers now get 12.4 MF/kg, permit fees of 29 MF/kg (41.4-11.4) would be required to equalize incentives. This implies a permit fee of 11,600 MF per stere (29 MF/kg times 400 kg per stere).

It is clear from these simple calculations that even if the dual pricing system can be managed (that is, differential tax treatment for wood grown versus wood collected), it will be extremely difficult to get prices high enough to encourage reforestation for the sake of monetary income from energy production alone. This again reinforces the concept of viewing wood production as part of an overall agricultural system, with incentives linked to increased agricultural yields, soil protection, and marketing of by-products (fruit, poles, medicines, and so forth).

Moreover, even if direct and indirect financial incentives were sufficient to encourage tree planting, increased technical assistance, intensified surveillance, and better enforcement of existing legislative guidelines (which grant permits under much more stringent rules than are currently applied) would be required to bring about more rational forest exploitation.

Finally, it is worth taking account of one slightly more optimistic note: Even the 11,600 MF/stere permit fee cost cited above would only raise market prices for wood to 53.5 MF/kg, if the entire cost were passed along to the urban consumer. Such a price is not unthinkable, and it is highly desirable. It would vastly increase the incentive to conserve, provide production incentives, and effect a transfer of income from urban consumption to rural investment (through the Forestry Fund). If average stove efficiencies doubled to 20 percent (which is plausible), energy costs per urban household would, in fact, remain virtually unchanged.

AREAS OF POTENTIAL REFORM

The first area of reform concerns management of the Forestry Fund, including improved financial management and control and increased and more flexible access to fund resources.

Second, forestry agent incentives entail (1) change in monetary incentive structure, (2) improved programmatic and institutional field support, (3) more extension emphasis and greater technical depth in agent training, and (4) outreach effort better to inform rural populations on provisions of the forestry code.

The thrid area is woodfuels pricing and revenue generation. Here the focus should be on (1) major increases in the cost of permit fees, (2) intensified monitoring in urban supply zones, (3) differential price incentives for woodfuels production, (4) increased technical assistance for reforestation in urban supply zones, (5) change in administrative practices in granting permits, (6) measures to improve coverage of taxes on commercialized woodfuels, and (7) technical and commercialization support for diffusion of urban cookstoves.

FUNDING REQUIREMENTS

It is important to distinguish between transitional and long-term funding needs of the forestry sector in Mali. Transitional funding will be required for detailed specification of the above (or related) reforms and to implement specific activities, such as the outreach program to explain forestry codes to rural populations, Forestry Fund management reforms, and an initial commercialization effort for cookstoves. Long-term funding will be required to carry out major reforestation efforts, which can only succeed through large and recurrent inputs of public resources. To be sure, the case is convincing that rural participation and private initiative will hold the keys to success and that government will best play the role of catalyst. But even in the most optimistic scenario, public efforts for extension, publicity, technical support, project and program management, protection, and taxation will grow in quality and quantity for most of the remaining years of this century. At best, we can hope for a high multiplier: that each hour of public effort will stimulate several hours of private effort, that each dollar of public outlay will mobilize several dollars of private investment.

For there to be any chance of success, program management (and sufficient resources to assure it) must rest in the hands of national institutions. Donor inputs have too short a planning horizon; they respond to too many diverse constituencies; they are too costly to be replicated. This implies that the priorities for transitional funding are to (1) help create national institutional capability to manage long-term reforestation, (2) assist those institutions to define an agenda suited to the resources they will possess as against designing efforts that can only be successful with short-term, nonreplicable donor technical assistance, and (3) help out national institutions on a self-sustaining financial footing.

Donors remain extremely important. They can provide major funding (short and long term), manage specific short-term projects as part of the overall national program, and provide technical assistance. The transitional funding

needs in Mali provide a good example of a situation in which only donors are likely to be able to supply the "peak" financing required. But the example also underscores that the very nature of the "transition" is to create self-sustaining institutional and financial capacity within Mali.

CONCLUSIONS

The specific case example of Mali contributes to an understanding of the forestry sector transition throughout the Sahel. The regional issue is this: The first phase of reforestation efforts (testing, demonstration) is gradually giving way to large-scale implementation, not so much because we have found any answers as because time necessitates it. Phase two requires not only that we prove reforestation can work, but also that we be able to access resources on the same scale as the needs. This is the heart of the replicability issue, which was the dominant lesson of work over the past five years. Clearly, then, the transition is one during which local capacity is reinforced, because only that (assisted by donor inputs) can exist on a sufficient scale. Just as clearly, testing and demonstration projects, in particular research, will continue, although no longer as the primary focus. This transition is required in most Sahelian countries, but particular reforms can only be case specific.

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CONTRIBUTIONS OF INDIGENOUS SILVICULTURE TO FORESTRY DEVELOPMENT IN RURAL AREAS: EXAMPLES FROM NIGER AND MALI

Pierre Montagne
Forester, CTFT
Senegal

The slogan "planting and maintaining trees" that was adopted by Niger for its 1984 national reforestation campaign is a significant example of the efforts presently being made by a Sahelian country in its aim to provide for a less desolate environment. An initial reaction to the diminishing forest cover due to the combined pressure exerted on it for years by man, animals, and climate consists of increasing the production. Man, consequently, will reforest in order to protect the soil, to have firewood, and to enjoy the fruits from his trees. We have come to learn, during our visits in the Sahel, that man has, for a long time, been carrying out reforestation activities often on an exclusively individual basis. Some examples from Niger and Mali are described below.

INDIGENOUS SILVICULTURE: AN HISTORICAL EXAMPLE

The action undertaken by the sultans of Zinder, at the end of the nineteenth century, with respect to the protection of the "gaos" (*Acacia albida Del.*) is significant in that it illustrates the importance attributed to the tree that helped provide necessary food supplies to the sultanate. The sultans had a policy of executing anyone who cut down a gao tree. The farmed parkland in the region of Matamaya-Myrria-Magaria in Niger is a living example of their past efforts.[1] In addition, the high density of gaos and other species now found in the region of Damaguram bears witness to this protection. Such action, resulting from the initiative of indigenous authorities, shows that it is possible to undertake operations aimed at preserving the natural regeneration of the trees existing on village land. The method employed in this case, mainly repressive in nature, allowed the landscape in the region to change over four decades and become a beautiful park of *Acacia albida Del.* trees that have been fertilizing fields farmed without having to lie fallow for more than a century. This first example of indigenous silviculture shows, above all, that even when the peasant knows his land and the value of the trees growing on it, it is necessary to encourage him to preserve them.

If all the programs that have been carried out by forest services in recent years designed to make peasants sensitive to the need for preservation of natural resources are geared in the direction of encouragement, it is because the

repressive measures taken by these services since their creation in the mid-1930s have been incapable of preventing the deterioration of natural woody resources, otherwise aggravated by the deteriorating climatic situation of arid and semiarid areas. Comparing the failure registered by the repressive actions pursued by the forest services with the success met by those of the sultans of Zinder is a concrete sign of the power of conviction of the indigenous authorities, whose positive or negative intervention can contribute to the success (or otherwise) of reforestation and environmental protection programs.

This same example shows that, if local authorities are convinced of the necessity of preserving trees, scores of peasants can be encouraged to do so. Its multiplying effect is remarkable and represents an important point for any program based on action in rural areas. Consequently, forest development in rural areas will either be the result of actions of an authoritative nature set up by local officials or, if they are too weak, that of much more conciliatory actions calling upon "animation" and extension techniques. In this case, it will be necessary to rely on personal initiatives taken by those often in a better position to appreciate local needs and possibilities. In our opinion, these indigenous silvicultural techniques will essentially be based on individual initiatives which need to be identified, supported, and rewarded.

From our experience we have been able to extract a few interesting but not unique cases of indigenous silviculture in two different Sahelian countries. These are presented below. It would be both interesting and useful to intensify efforts to identify peasants engaged in indigenous silviculture on their own across the Sahel.

INDIGENOUS SILVICULTURE IN NIGER

The case of a peasant living in the Dosso Department is worth narrating. Garba Moussa is about 70 years old. When he was young, his father, who was both a farmer and a hunter, encouraged him to plant *Khaya senegalensis* and to propagate *Ficus* by cuttings. Later on, he planted up to 250 mango trees, 220 of which died from drought, but in 1983 26 were still alive. This planting effort is continuing with other species, such as *Parkinsonia aculeata* (36), *Parinari* (80), *Hyphaene thebaica* (22), and *Adansonia digitata* (140). All these plants have been produced in a mininursery ($1m^2$) with seeds sown at the coming of the rains. All the plants are produced "bare root" and immediately transplanted after germination. Garba Moussa is very aware of the need to protect plants from livestock grazing, and he erects a thick fence made of branches all around each plant, increasing the height as the plant grows. Recently, he dug up a four-metre high baobab tree in Dosso and transported it about ten kilometers to his village, where he planted it.

Unappreciated by his own village, where people think he is somewhat mad, Garba Moussa has been forsaken by his sons, who find his plantations

uninteresting. The government services (such as forestry and agriculture) take no notice of him and have never complied with his requests for insecticides or fencing materials. In order to mobilize his neighbors, Garba Moussa has provided them with forest or fruit tree plants (mango trees). The neighbors' plantations met with little success due to their lack of interest (mainly because they had not produced the plants by themselves). Nevertheless, they gather the fruits produced by the *Parinari* that have been planted by Garba. He was so discouraged by such behavior that he seriously thought of abandoning his plantations. Would it not be possible to encourage him by providing him with some basic equipment and by giving him moral support amid the mocking of his neighbors? Fostering such personal initiatives would seem to be fundamental in any program of forest development in rural areas.

INDIGENOUS SILVICULTURE IN MALI

Numerous examples could be cited of indigenous silviculture in Mali, but we shall select a few from among the interesting and little known initiatives recorded during a study carried out for the National Forestry Service.[2]

In large areas of Mali there is widespread preservation of such species as *Butyrospermum parkii* (Karite), *Parkia biglobosa* (Nere), and *Cordyla pinnata*, whose importance is in the fruits they produce. In particular, fruits from the first two are important for the extraction of karite butter and "soumbala," a condiment necessary in the preparation of sauces. The protection of such species is an important example of indigenous silviculture.

At N'Domi (Cercle de Dioila), villagers drew our attention to *Azadirachta indica* regenerating naturally in the bush. In the same village a peasant, after having created his own nursery, planted baobab trees for their leaves and fibers (the gathering of the latter from the bark takes place every two or three years in order not to kill the trees). The ropes twisted from the fibers are sold at 50 Malian francs per meter.

Near Koutiala, the Paysan Noir has produced and distributed fruit tree plants since 1950. His work was noticed early on, and the name Paysan Noir was given to him by a colonial governor in Mali. Every year he produces numerous plants (mango trees, citrus, banana trees, guava trees, and so forth) that are bought by local farmers. His nursery is quite exceptional and is an example to the whole region. The grafting techniques employed are varied, including inlay for mango trees and bud grafting for citrus. There is even a guava tree whose multiplication resulted from aerial layering! The Paysan Noir has fenced an area of his farm to control access and provide temporary protection of the vegetation from cutting and grazing. An inventory made with the help of a local forester assessed the growing stock at about 300 steres ($150m^3$).

In Somo (Cercle de San), a 30-tree plantation of baobabs has been set up by the villagers. In the Dogon region of Mali, traditional methods are used for the

management of the natural vegetation on their farmlands. It is forbidden for anyone to cut trees without permission from village authorities. In Natie (Cercle de Sikasso), before letting a plot of land lie fallow, peasants direct seed karite nuts in order to increase the number of trees. However, they refuse to plant *Parkia biglobosa* out of respect for tabus. The conception of a species as "exotic" and its use can be quite varied. Disseminated by the forestry service for the production of fuelwood and timber, exotic species are often planted and protected for other reasons: *Azadirachta indica* for its antimalarial qualities and *Eucalyptus* to treat cough.

In Banamba, there is another interesting case of indigenous silviculture. The peasant Sylla began producing plants in 1960 because administrative authorities emphasized the need for reforestation. Stock was produced in Bamako and transported to Banamba (150 kilometers), but the rate of survival was virtually nil. Sylla then established a small nursery, and production in recent years has been as follows: 1980, 2,000 *Azadirachta indica* (bare rooted stock); 1981, 2,680 *Azadirachta indica* and 840 nongrafted *Mangifera indica* (mango); 1982, 1,847 *Azadirachta indica* and 820 *Mangifera indica*; and 1983, 1,725 *Azadirachta indica*, including 800 plants for administrative plantations (National Tree Planting Day). *Azadirachta indica* are sold for 200 Malian francs (MF), nongrafted *Mangifera indica* at 500 MF, and grafted *Mangifera indica* at 1,000 MF. Sylla learned grafting techniques from a Frenchman in Guinea forty years ago. He has tried to produce other species, such as *Gmelina* (production was stopped because this tree is less drought-resistant than *Azadirachta indica*) and *Leucaena*, presently being tested in his nursery.

In Karadie (Cercle de Banamba), villagers have, without any external advice, planted mango trees, nongrafted citrus, *Adansonia digitata, Khaya senegalensis, Parkia biglobosa,* and *Butyrospermum parkii*; they have experienced some difficulty with direct seeding of the latter. In Kolokani, a day laborer of the forest service privately produces grafted mango, orange, and guava trees. He has trained four other persons from his region in grafting techniques. In Didieni, no one is authorized to exploit *Borassus aethiopum* without permission from the village chief. Once his approval is given, authorization from the forest service in the form of a cutting permit is obtained as a formality. This is an interesting example of local control over the management of forest resources.

CONCLUSION

These examples show that peasants can and do take initiative in managing their environment through protection and rehabilitation. The exact figure is not known, but initial indications are that there may be quite a number of such peasants. The essential question is whether it is necessary to try to implement rural forestry projects (such as village plantations) when many peasants

are, on their own initiative and without any external help, carrying out indigenous silvicultural activities. It should certainly be possible to support and promote these efforts as an important component of rural forestry programs, especially by offering technical advice and basic material support.

Forestry development in rural areas is the starting point for any program of desertification control. Before rural forestry projects are launched, an assessment should be made of indigenous silviculture in the locality with a view to building on these efforts and improving the techniques employed.

NOTES

[1]For an introduction to the literature on "farmed parkland" in the West African Sahel, readers are referred to Paul Pelissier, *Les Paysans du Sénégal* (Saint Yrieix, France: Fabregue, 1966), and R. A. Pullan, "Farmed Parkland in West Africa," *Savanna* (Abu Zaria, Nigeria) 3(2) (1974):119-52.

[2]James T. Thomson and others, *Rapport de Mission Foresterie Rurale (1er Octobre 1983-31 Octobre 1983): Etude du Developpement Forestier en Milieu Rural* (Bamako, Mali: Direction Nationale des Eaux et Forêts, 1983).

THE GUESSELBODI EXPERIMENT: BUSHLAND MANAGEMENT IN NIGER

John G. Heermans
Forester, FLUP
Niger

Despite much investment in forestry in the Sahel after the drought of 1968-1974, results in combating the effects of desertification have been poor. Natural forest management has not been a significant part of this investment, but it is now considered essential to meaningful intervention. The Guesselbodi experiment in Niger is an attempt to manage 5,000 hectares of bushland with respect to local attitudes and traditions, while adhering to such sound principles as sustained yield, maintenance of biological diversity, and soil conservation. The Guesselbodi strategy is based on the concept of popular participation or management by villagers using the forest to generate the income required to assure continuity of the operation.

Since the 1968-1974 drought, approximately $160 million have been spent on forestry-related projects in the Sahel (NAS 1983). Few of these programs have dealt with the overwhelming effects of desertification: Soil erosion is steadily increasing; firewood, pasturage, and numerous forest products are becoming scarce; and overall biological diversity is being threatened as certain tree, plant, grass, and animal species have declined or totally disappeared in some regions.

It is axiomatic that natural forest and bushlands are essential to the survival of Sahelian inhabitants. The important role of soil, water, trees, plants, shrubs, grasses, and animals contained within the forests and bushland is well documented, and management of these resources was deemed a priority as early as 1965. Despite this realization, a substantial portion of the total investment in forestry-related activities has been and continues to be production oriented, that is, using rapidly growing species which take land away from peasants (with no compensation) while yields remain disappointingly low. Furthermore, cost overruns are frequent and often exorbitant. For example, according to World Bank forestry experts, the Niger Irrigated Eucalyptus Plantation cost more than $5,000 per hectare.

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Past efforts in natural forest management have entailed uprooting existing "useless brush" with bulldozers and replacing natural vegetation with species neither adapted to the local ecology nor preferred by the local inhabitants. An alternative is to manage existing native forests and bushlands in a manner consistent with basic, sound ecological practices. This approach considers the balance between roles of the forest or bushland both as an ongoing producer of firewood and as producer of food, fodder, and other products on which villagers depend for survival and economic welfare.

As a response to these issues, the Forestry Land Use and Planning Project in Niger, funded by USAID, attempts to test intermediate-scale interventions in natural resource management to serve as a model for national projects designed to arrest environmental degradation in the Sahel and to exploit rationally the forest resource base. There are 66 National Forests in Niger, most of them established during the colonial period, from the 1930s to the 1960s. The National Forest of Guesselbodi was chosen for demonstration because the forest service has been involved in ongoing research there, and the forest is conveniently located 25 kilometers east of Niamey. Work began in Guesselbodi in 1981, but a management plan was not implemented until September 1983. The intervening period was spent conducting studies and carrying out discussions with local villagers, which led to the creation of a natural resource management plan. This paper summarizes the results of the project and offers some cautions to be considered in managing Sahelian bushland.

BACKGROUND

Research as a Management Input

Research support is essential to the success of forest management in the Sahel. Past and current priorities have been established according to the type of activities being implemented, but much of the effort has involved developing rapidly growing, exotic species with little regard for existing resources. It became evident to the FLUP planners that development of a management plan would be hampered by a lack of information regarding the forest's ecology, and a 22-hectare parcel was set up in 1981 to provide the data required. Once the management plan was established, goals and research priorities became clearer, and the program was altered accordingly. Two major research foci emerged: soil restoration/conservation and factors related to the production, exploitation, and management of the local species that are preferred for use as firewood in Niamey.

Although there are already preliminary results from the soil improvement experiments, much of the work (for example, on indigenous species' growth rates) will not provide useful data for perhaps ten years. It was decided, however, that a management plan should be created despite the little useful knowledge regarding the forest's ecology. The rationale was that there exists a

wealth of information from local villagers and experienced forest service personnel which permits some qualified, educated decisions.

To repeat: Priorities should be reevaluated and established by planners. Researchers themselves often write their own programs without guidance from planners, who should be programming intervention priorities and directing researchers in order to obtain meaningful, practical information.

Interaction with the Local Population

The traditional role of the forester in the Sahel has been to enforce the Forestry Code, which is contradictory and repressive. Enforcement often accords with the local forester's interpretation of the code; as long as he is perceived by villagers as a paramilitary guard and not a benevolent extension agent, it will continue to be difficult to integrate villagers successfully into any management-related activity.

Discussions were carried out in 1981 with the affected villagers to explain the proposed intervention and to gather information about the following: (1) past and present uses of the forest; (2) changes in the forest over the past thirty years; (3) priorities and preferences for its ongoing use; and (4) local customs regarding present use. These discussions were vital in proposing strategies based on the concept of popular participation in sustained yield management (Thomson 1981) and also for developing the preliminary plan that was eventually implemented in 1983.

The initial contact with the villagers at Guesselbodi was the beginning of a continuing extension program. Successful forest management in the Sahel, as elsewhere in developing countries, depends on gaining the confidence of the local people and creating an avenue for frank, open dialogue. Only in this way will foresters gain insights into the complex social circumstances particular to each forest.

Vegetation and Soils Mapping

The forest was divided into ten parcels of approximately 500 hectares each, the number of parcels corresponding to the number of years the Combretum species would need to regenerate after a coppice cut. The unit size was deemed the largest the project could have dealt with in a year, given the lack of qualified personnel. The entire forest was stratified by major vegetation types using acetate overlays on a 90 x 90 cm enlargement (1:18,000 scale) from a 1979 aerial photo (Boudouresque and others 1983). The parceling also allowed concentration of effort on one section at a time and more detailed analysis of the environment in terms of soils, topography, and vegetation. Wildlife is of little consequence in the forest today, although villagers indicated that the forest had an abundant variety only 30 years ago.

After stratification, each type was ground-checked, and observations were recorded on field sheets. Vegetation was typed according to the Braun-Blanquet system; all plant species were recorded as to percentage of ground cover and classified according to height. Soil was described by its texture and depth; topography was observed, and the percentage of slope in each type also was noted. A legend was devised and transferred to an individual map of the first parcel to be worked in the rotation schedule.

Present Condition of the Forest

By comparing aerial photos from 1950 and 1979, it was determined that 40-60 percent of the total vegetative cover has disappeared in the last 30 years. Several important tree species, including *Parkia biglobosa* and *Prosopis africana*, were cut by the colonial army and sold or utilized (Thomson 1981, p. 5). There is much evidence of overgrazing, which has induced soil erosion. According to several scientists who have worked at Guesselbodi, the A horizon or upper layer of soil has been washed away by sheet and gully erosion; the exposed B horizon contains practically no organic matter and is crusted, which allows for little or no water penetration.[1]

In some areas of the forest, laterite (iron stone) is often exposed or found near the surface. Land that has degraded to these conditions is barren; even if protected from livestock, vegetation will not regenerate on these soils, as is the case in sandier soils found closer to the desert. The compacted condition that is aggravated by the constant pressure of animals reaches a point of no return, and a soil restoration program is necessary to initiate reversal. This process is ably summarized in a paper from the Malian-Dutch research project on Sahelian pastures and their utilization: "With decreasing soil cover and protection, and because of trampling, crust formation and deterioration of the local structure occur. Under such conditions water will soon be the main determining factor for growth, and even at the same concentrations of nitrogen and phosphorus these elements are less limiting" (Bremen and de Wit 1983).

MANAGEMENT PLAN

Goals

Guesselbodi has changed significantly in the last three decades because of the drought and increasing population pressure. Degradation continues at an alarming rate, and if nothing is done to manage the few but important resources left, it is not unlikely that the entire forest could turn into a barren wasteland within the next thirty years. The main goal of the approach adopted at Guesselbodi, therefore, is to stop the degradation and restore the forest to a balanced, stable condition, such that the vegetative resources exploited each year do not exceed annual growth. By doing this, a continual source of primary and secondary forest products would be provided to local users and to markets in Niamey.

Strategy

The basic strategy is to create a management system that exploits the forest in a cost-effective manner using the notion of popular participation (Thomson 1981). Thomson's efforts in that regard are based on a development principle found in all project design papers but rarely implemented. Simply stated, the notion is that villagers will effectively participate in development programs in which they have been included from the beginning and which they feel are in their best interests. Top-down approaches do not work because project design and implementation teams wrongly assume that they have insights into the complexities of local sociopolitical structures; such insights can only come from the people themselves. Proposed solutions cannot be offered as the "final word," and the stage for continuing dialogue must be set from the initial phase and carried into the implementation and evaluation stages.

Another consideration influencing the strategy at Guesselbodi stems from the fact that forest management is by definition an ongoing process which cannot be implemented at one time and then forgotten. Projects in developing countries that depend on uncertain inputs from donors or the national budget have no assurances of continuing over an extended period. A forest management system in the Sahel must strive toward autonomy from outside aid.

The strategy at Guesselbodi is to create a cost-effective, sustained yield forest enterprise administered and managed by local users. Because of the relatively high price of firewood in Niamey ($15.00 per stacked cubic meter), the forest could not only meet the needs of the surrounding population but also provide continual employment. It is interesting to note that the immediate, significant benefit identified by the villagers is the employment of local people to carry out the labor as described in the work plan.

Work to Date on Parcel No. 1

Each of the ten parcels will be individually treated over a decade. During the first rotation of ten years the technical and administrative issues will be studied; as the system improves, the transfer of responsibility from the project to the villagers will take place.

A work plan for the first parcel was developed in 1983 after goals were determined. Techniques and strategies are based partially on results from other promising interventions being carried out in the Sahel. Some techniques being tested at Guesselbodi, however, should be considered as applied research in that they have never been tested; they are based on recommendations from foresters who have a wealth of practical knowledge and many years of field experience.

Each stratified zone of the parcel is being "treated" according to the conditions of topography, soils, and vegetation. The work begun in September 1983 continues to be supervised by two Peace Corps Volunteer foresters, supported by a Nigerian forest agent and a technical consultant based at project

headquarters in Niamey. The following describes specific efforts.

Extension Work. Our management and work plans were presented to the villages in November 1983 by two Djerma-speaking men who had been trained in an earlier study that was carried out at the project. They were guided and aided by a retired Nigerian forest agent with considerable extension background.

Colored posters were used to emphasize important aspects of the management plan, which was described as the posters were turned on a flip board and can be summarized as follows. (1) Thirty years ago the forest had an abundance of flora and fauna that does not exist today. (2) The disappearance of these resources has been accompanied by rampant soil erosion, which accounts for large areas of barren land. (3) The principal cause of this degradation is increased pressure by man and his herds of animals that have continued to overexploit the forest without a system of control. (4) We have come to help you restore the forest and to work with you in exploring different possibilities in regard to a management system that will assure you an increased and continuing supply of firewood, pasturage, and other useful forest products that you have recognized as important during earlier meetings with you. (5) The work plan that we will present you today is part of an overall management plan for the forest. It is a proposal based on information that you have related to us in previous meetings and also information we have gathered by visiting the forest. The success of the endeavor depends on you–we invite all of you to be frank with us and continue to provide us with information and ideas throughout the creation of this management system.

The remainder of the session was spent discussing different technical and administrative aspects of the work plan in regard to hiring, grazing, protection, the rotation system, erosion control, cutting, agroforestry, and the work calendar.

The extension program will continue, guided by specialists at FLUP. It will be the responsibility of this extension team to continue to provide necessary vital feedback and to participate in the gradual process of transferring responsibilities to a village forest cooperative.

Soil Conservation and Restoration Work. Because of the serious degradation due to soil erosion, we have had to invest in an intensive restoration program. Techniques vary with the nature of the soil and the topography of each site.

Contour Walls. Stone and earthen walls 20-30 cm. high were constructed on slopes greater than one percent. A simply constructed water level made with transparent garden hose was used to trace the contour lines. This system, which has been proven effective in Burkina Faso, is labor intensive and has worked to reverse the process of soil erosion. Villagers have begun to adopt the technique themselves (Hooper 1982). Trees will be planted from nursery stock or directly seeded behind the contour walls. The first heavy rains in 1984 demonstrated

the effectiveness of this method; finer soils, branches, and leaves began to fill in the stone walls, and water that normally would have run off was "harvested." The areas behind the walls remain moist longer and eventually will generate grasses, trees, and shrubs, which will protect the watershed and provide primary and secondary forest products.

Mulch. Small branches and twigs left from harvesting operations will be spread out evenly on the barren soils between the clumps of trees. Preliminary studies at the research plot have shown that mulch increases the moisture absorption capacity of the soil, thereby improving conditions for grasses, shrubs, forbs, and trees. More than 60 percent of our mulch-treated areas showed natural regeneration of ligneous species (Boudouresque and Chase 1984). Termites are an important factor, as they tend to colonize in the soil beneath the ligneous mulch. The colonies create numerous pores that "open" the soil and allow rainwater to penetrate the upper horizons. Leaves and sand are also trapped by the mulch, thereby increasing organic matter and favoring regeneration of natural growth.

The important role mulch plays in reversing degradation has far-reaching implications. If, in fact, trees will regenerate naturally by adding mulch that comes from exploiting trees, then we need only devise plans for rationally exploiting and protecting areas that have soil and vegetation characteristics similar to those found at Guesselbodi. Furthermore, forestry activities around urban centers, where the price of fuelwood is high, could combat the effects of degradation and become cost effective and profitable if sensible policies are devised and adhered to. Although these conclusions are still theoretical, the mulch trials have again demonstrated that many of the answers to the overwhelming environmental problems encountered in the Sahel are to be found within the existing social and natural surroundings; it is up to foresters to become acquainted with these surroundings and seek the answers.

Water Catchments. Several earthen water catchment techniques are being tried on the lower slopes. Both V-shaped and half-moon types have been constructed and seem to have held up well to the first rains of 1984. Areas directly behind and within the catchments can be planted before the normally recommended date for trees in the Sahel because the soil remains moist after the first rains.

Mechanized Erosion Control. Certain zones of the first parcel were opened along the contour to a depth of 30 cm. using a three-pronged ripper behind a D-6 bulldozer. Spaced 5 meters apart, these areas benefit from rainwater draining off the intervening nonripped surfaces. There are certainly precautions to be aware of when using mechanization, and the project will study the results as well as costs and make recommendations accordingly. Assuming the machinery is available, of course, by ripping strips as opposed to entire areas, the bulldozer can cover almost 8 hectares a day, which may be cost effective.

Controlled Harvesting. Studies on the cutting of live trees for firewood in the Sahel have been limited. This is partially due to the small importance placed on natural ligneous species and the fact that most forestry interventions to date have been production (plantation) oriented; questions related to exploitation of standing natural and plantation ligneous species have never been seriously addressed. Since existing laws prohibit cutting live trees for commercial purposes, there are large unmanaged stands of overly mature trees, and their annual growth or production is negligible. Ligneous species in the Sahel sprout readily if cut and grow rapidly: *Combretium nigricans* cut in June 1983 were remeasured at a height of more than 3 meters a year later.

Production data most often cited for ligneous species in the Sahel have also discouraged foresters from becoming more involved with natural forest management. One wonders how these figures have been determined because there is no statistically proven sampling methodology for the *Combretum* species. The resource inventory section at FLUP is presently working on a point sampling technique for this type of vegetation that will permit quantification of standing, merchantable firewood.

Areas to be cut at Guesselbodi were determined according to stand density, topography, and the site's susceptibility to erosion. *Combretum nigricans, Combretum micranthum,* and *Guiera senegalensis,* the three principal firewood species sold in Niamey, are being coppice cut, selected according to a minimum stem diameter of 6 cm., 4 cm., and 4 cm., respectively. Choices are marked with paint and cut on a contractual basis by teams of three men, who are assigned an area and harvest the equivalent of approximately 6 steres (1 stere = 1 cubic meter of stacked wood). Trees are cut between 10 and 25 cm. from the ground with bow saws and machetes. A market study is being conducted to determine the best method for sale of this wood, and discussions are under way with individual wood merchants as to the possibility of conducting a "timber sale."

Agroforestry. During the first interviews at Guesselbodi in 1981, villagers informed the management team that certain areas of the first parcel and adjacent to their fields were preferred zones for agriculture. After discussing the idea with forest service officials, it was decided to give approximately 30 hectares of this land to the villagers as long as they agreed to respect windbreak lines and protect the trees to be planted between the lines.

The zone was divided into 13 fields of approximately 2.5 hectares each. Forty villagers applied for farming rights; thirteen were randomly selected and signed agricultural contracts. Ten-meter wide windbreak lines spaced 90 meters apart were marked with colored ribbon, and the villagers cleared their fields between. Varieties of *Acacia* and *Prosopis* will be planted within the windbreaks and the fields, and some direct seeding and fertilizer trials conducted on the trees will be attempted in this zone.

By permitting cultivation within the forest, the management team was able to

demonstrate to villagers that their suggestions would be considered seriously and integrated into the operation as long as they aided in working toward the goals of the management plan. It is hoped that the agroforestry system being implemented will prove effective and be replicated by other villagers in their own fields outside the forest.

Plantations. Approximately 45,000 nursery-grown trees will be planted on the first parcel, within and between existing stands. Selection was based on preferences expressed by villagers and also on site characteristics (topography, soils, existing vegetation). Most species to be planted are presently growing naturally in the forest, but several exotics that have shown promise in the region will be tried. For example, *Prosopis juliflora* and *Acacia holocericia* will be used in the windbreaks and behind the contour walls. In the latter areas some direct seeding will be carried out, as well as in the barren zones between the denser *Combretum* stands. A commercial mulch (Terra Sorb) will be applied in these trials; it is highly absorptive and should improve germination rates by maintaining more moisture in the treated soil.

It is important to note that although the operation began using costly nursery stock, it is hoped that natural regeneration and direct seeding will prove viable.

Range Management. "The form of land tenure so common in undeveloped countries whereby the grazing lands are communal property cannot possibly work unless there is a reasonable balance between the carrying capacity and the number of stock actually present. Like so many traditional patterns of agriculture, the system was perfectly satisfactory in the context of a small constantly-moving population but is disastrous when continued today with much larger populations living permanently in the same areas and exerting constant heavy pressure on the land" (Hudson 1981).

A major cause of the serious soil erosion at Guesselbodi within the last thirty years is overgrazing. Barren areas will remain so unless systems are developed to control this pressure, which is increasing as villages grow in size and number. The present forest policy is that each parcel will be protected from all grazing animals for three years, whereas people will be allowed to cut hay and gather such products as gum, food, and medicines. The reentry of animals will be controlled by the carrying capacity of the parcel, to be determined by a team of specialists who will work in the forest over the next three years.

Herdsmen will be responsible for keeping animals off the parcel. A mounted forest guard will impound any that enter, and owners will pay a fine for each day the animals are kept in a holding pen; those not claimed within 15 days will be sold. All villagers have been informed of this policy and seem to have accepted the idea, although genuine acceptance and trust will not occur until herdsmen realize the benefits in terms of increased pasturage yields. All necessary measures will be taken to assure that traditional grazers of the forest be given priority access to the improved parcels at the end of the protection period.

CONCLUSION

Natural forest management in the Sahel is being redefined, and the new direction is encouraging. The forest is being regarded as a multipurpose provider that must be rationally and carefully managed to maximize the benefits and satisfy the needs of the forest exploiters, the herders, and the cultivators. In order to do this, foresters must study and become familiar with the complex environmental and social circumstances of each zone considered for management.

A major constraint to implementing management projects is the lack of qualified foresters. Such programs will demand a new breed of agents familiar with the ideas of sustained yield and popular participation. These concepts are still being formulated, but as new information and new directions become clearer they must be integrated into the education process at all levels.

Planners and economists must begin to define priority areas. First consideration should be given to forests and bushlands with the most potential in renewable resources, proximity to markets, and concentration of population (Heermans and Daus 1984).

Forest management is far more complex than is suggested by the "definitive solutions" attempted in the past. Two years of study and analysis preceded implementation of the first work plan at Guesselbodi, and it is not unreasonable to estimate that a full rotation (ten years) should pass before a meaningful evaluation can be carried out. In other words, we are still beginners in regard to the complex environmental and social questions associated with natural forest management in the Sahel. We cannot rush into the endeavor, as was done in the past; the approach must be professional and careful, and priority should be given to practical research that will guide us.

The future of the Sahel lies within the people who live there. The Sahel is harsh; "definitive solutions" may not exist; but as the famous Hausa proverb says. "Mai hankuri shina dafua duwatsu," "One who has patience can cook rocks."

NOTE

[1] Through a Collaborative Research Support Program (CRSP) between Texas A & M and the Niger Research Soils Division, the project benefits from continued visits to Guesselbodi by the resident soil scientist, Dr. Robert Chase, his support team from Texas A & M, and Nigerian soil scientists from the lab in Niamey.

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SOIL AND WATER CONSERVATION AS A STARTING POINT FOR RURAL FORESTRY: THE OXFAM PROJECT IN OUAHIGOUYA, BURKINA FASO

Peter Wright
Project Leader, OXFAM
Burkina Faso

Edouard G. Bonkoungou
Director, IRBET
Burkina Faso

This paper is a case study of the agroforestry program also known as the Microcatchment Project, funded by OXFAM in the Yatenga region of Burkina Faso. The area has a history of overuse of land resources leading to a decrease in the arable surface and severe degradation of the environment. Past efforts to improve the farmers' situation have met largely with failure, while traditional methods of adapting were innovative but insufficient. The project, by relying on the farmers' participation to develop techniques of water conservation, has shown that land degradation can be reversed and food production increased by the farmers themselvers.

BACKGROUND

The Yatenga region (13° - $14^{o}15'$ north latitude, $1^{o}45'$ - 3° west longitude) is part of the Sudano-Sahelian zone on the southern edge of the Sahara. The regional capital, Ouahigouya, has a long-term average annual rainfall of 680mm. During the last decade the average has been exceeded only three times; less than 400mm. fell in both 1982 and 1983.

The Mossi farmers and Fulani herdsmen who live there are faced with a question that concerns their very existence: Can this land support them any longer? The question must be asked nearly daily in some families, and for a number the answer has been "negative." While many have already chosen to leave, those who stay find that they must take action if they are to survive in the Yatenga.

At the base of the problem is an agricultural system that failed to evolve with the increasing population. As described by Marchal (1979, p. 246), that system was originally a consumer of land, dependent on long fallow periods. Early in this century a disequilibrium appeared between the extension of continuous cropping and the soil potential. By 1935 all virgin land had been cleared around Ouahigouya. The fallow periods became progressively shorter and finally disappeared, without a transformation of the system toward one which returns to the land what is withdrawn from it.

With a population density of 75-100 per km^2 (ibid.), the land can no longer provide for those who till it. To make matters worse, the land itself is

disappearing, and around Ouahigouya the effects of erosion have become spectacular. The relief, forming long low slopes, is subjected at each rainstorm to sheet runoff, which has stripped the soils of the upper slopes and is eroding the mid-slopes, especially because they are cultivated continuously. Finally, the soils farther downslope are sealed by the sheet flow (ibid).

It is indeed the appearance of large sterile zones devoid of any vegetation and their encroachment on the cultivated fields that is the most visible aspect of land degradation. Estimated to cover nearly 11 percent of the central part of the Yatenga in 1973, the area of denuded, sterile land has been growing at an annual rate of 0.35 percent (Marchal 1983, p. 225). This represents a serious loss of productivity to the farmer and jeopardizes surrounding fields as well.

In the early 1960s a multimillion-dollar project was initiated with the goal of reducing runoff and erosion in the Yatenga. Known as the Groupement Europeen de Restauration des Sols (GERES), the project constructed earthen embankments, ditches, small dams, and rock barriers over 120,000 hectares of the Yatenga. Completed between 1962 and 1965, the effort was soon found to yield less than expected. The population did not use and maintain the system properly; it was rapidly dissected by multiple foot paths, which had not been taken into account, and by 1965 it was officially described as an "unfortunate experience."

Local farmers have attempted to remedy the situation by constructing barriers of rock or bundles of stalks and branches across waterways. The planting of perennial grasses similarly served this purpose. One technique of particular interest consisted of digging small basins into which sorghum, the principal cereal crop, was sown. When used on the sealed and crusted soils they provided excellent water capture. Placing organic matter in the holes early in the dry season drew termites, which perforated the soil beneath, providing rapid infiltration and root growth. The basins multiplied the water supply by catching runoff, thereby allowing successful plant establishment with as little as 7mm. of rainfall. But these efforts were not enough. The barriers were very short, and water tended to flow easily around the ends to produce another channel. The basins, while effective, were filled in with soil after heavy rains and were themselves subject to erosion. Something else was needed.

THE AGROFORESTRY PROJECT

In 1979 OXFAM,[1] a nongovernmental development agency, decided to try two new ideas with the goals of decreasing the environmental degradation while improving productivity. The first was to use the abundant runoff to advantage through water harvesting. The second was to enlist farmer participation in determining what techniques would be of most value.

The initial program consisted of meetings between project personnel and eight village "groupements" chosen for the interest they had shown previously

in tree planting. Such groups, known officially as pre-cooperatives, are often officially recognized and are the usual target for rural development activities. During the meetings, future trials and activities were discussed in which water harvesting might be used to reverse environmental degradation while increasing tree and/or food production. The farmers offered their most degraded pieces of land for experimentation during the first year. When later tested with a double ring infiltrometer, these soils typically showed infiltration rates of fifteen to sixty millimeters per hour, indicative of the compaction and surface sealing that had rendered them virtually useless.

The first technique tried was the "microcatchment" (Shanan and Tadmor 1979, p. 1), which consisted of a rectangular surface enclosed by a low earth wall. At the lowest point within it a shallow basin was dug to collect the runoff from the undisturbed surface. Each village, having constructed twenty or more microcatchments, planted various local tree species in the basins. Several, however, also planted upland rice after observing the abundant water supply created by the catchment. In others sorghum was accidentally introduced into the basins with manure.

The results of the first season were encouraging, while starting to show a change in orientation. Thomson (1980, p. 5) observed at harvest time that the accidentally introduced sorghum "had massive heads comparable to the best in adjacent fields." Meetings at the end of the first season confirmed that the farmers thought the project could place greater emphasis on developing the role of agricultural crops (Blade 1979).

PROJECT EVOLUTION

From the start the farmers were allowed to influence the activities they would undertake. The experimental nature was constantly emphasized, as was the importance of their observations. Individual members of the groups were encouraged to try out the ideas in their private fields as well as on the group sites.

By the end of the third season several important changes could be recognized. (1) The capture of runoff was of greater interest to the farmers for its potential to increase agricultural as opposed to tree production. (2) Group sites were being outnumbered by those of individuals trying techniques on their own fields as farmers saw real opportunities to increase their agricultural production. (3) Individual work in private fields was turning toward barriers of rocks or bundles of stalks or branches placed perpendicular to water flow. This showed that the farmers were starting to experiment with traditional techniques that had in fact been given little recognition by the project until then.

Two aspects of the project's initial orientation were retained by the farmers: working on degraded or abandoned fields and water harvesting, that is, the collection and use of runoff water.

STATE OF THE ART

After three years the microcatchment was abandoned by the farmers in favor of more labor-efficient traditional barriers placed perpendicular to water flow. To improve on these, however, it was necessary to lengthen them. This required following the contour lines of the terrain for maximum efficiency, both in terms of labor costs and water retention.

It was hoped that the project could train farmers to determine contour lines themselves; any other solution requiring outside assistance could probably not be utilized extensively by the farmers. The water tube level was introduced by the project as one of several possibilities and proved to be the best compromise in terms of ease of use, cost, and accuracy. Two or three days of training were sufficient to permit autonomous use by farmers, it was accurate enough for slopes as low as 0.5 percent, and it was affordable by a farmer.

After a year of working out the details of the tube level in the hands of farmers, two years were spent teaching the use of the tube level in an extension program. During that period more than 500 farmers from more than 100 villages learned how to determine contour lines with this device.

The short training course included visits to farmers already practicing various techniques of water and soil conservation. Forms of community organization that lend themselves to the construction of contour line barriers were also discussed. Proper organization was seen to be important if the skills were to be passed on to others. At the end of a training session the farmers were supplied with tube levels and invited to try their new skills on their own fields.

The most successful villages did as much as ten to twenty hectares of contour barriers in numerous fields in one season. The amount of activity in a village was highly related to the degree of degradation of the region and the availability of rock materials. In 1983 an estimated 150 hectares were treated by farmers working with the project.

A look at the techniques and applications that evolved from the earlier stages provides a view of the farmers' perception of their resources and how they manipulate them to their greatest benefit. Typically, farmers chose to construct low barriers ten to fifty centimeters high along the contour lines as they were determined by the tube level. The fields chosen varied in surface area from one-tenth to several hectares. Farmers elected to construct barriers on a field-by-field basis rather than on a larger unit such as a watershed, reflecting the importance of socioeconomic constraints over technical considerations.

An examination of more than 100 fields on which farmers have built contour barriers showed that a decided priority was given to a field exposed to significant runoff originating on it or upslope. Forty-six percent of fields surveyed were found to exploit runoff by barring small watercourses and diverting and spreading the water across the cultivated area with contour barriers. An important result of this is that heavily degraded areas, although previously considered to

have no agricultural value, were being given special attention with the new techniques because of their potential to produce runoff. Up to 25 percent of the fields surveyed were on degraded areas.

The extra supplies of water were especially important in drought years, when rainfall alone, even with 100 percent infiltration, would be insufficient for proper crop growth. Fields exploiting runoff were also found to have a special advantage early in the rainy season. Sowing not only was often more successful on the first try, but also and more important it took place up to one month earlier than on untreated fields.

Constructing barriers in such a way as to capture runoff from degraded zones also provided a measure of protection for the fields downslope. This buffer against sheet erosion also sealed the soil surface by decreasing the volume and velocity as well as the sediment load of the overland flow, thus helping to check the expansion of the degraded areas.

The barriers were invariably of the semipermeable type, that is, loose rock or bundled stalks or branches. The advantage of these materials as opposed to earthen embankments is that they allow water to enter and circulate through the field. This is an important feature when exploiting runoff, which cannot as easily be achieved with earth structures.

Spacing between barriers typically varied from ten to fifty meters. In choosing the interval the farmer makes an intuitive benefit-cost analysis, taking into consideration probable increases in production and available labor. Although the farmers gauge slope well enough to know at what spacing they may optimize the available water supply, when labor is scarce they are constrained to build fewer than the optimum number of barriers required for a given field. They then build a few widely spaced across the entire field rather than concentrating them more closely on one portion of it, thus reducing total erosion on the entire field rather than on just one area. During the following years farmers were observed to increase the number of barriers in their fields until the desired spacing was achieved.

A measure of the success of the techniques in increasing food production while protecting the environment from further degradation is the popularity they have gained. More than 500 people have been trained, and the number grows every year. This is borne out by yield samples taken from 95 $100m^2$ plots in 1982 and 96 similar plots in 1983. In the first year, when rainfall was between 400 and 500 millimeters over much of the zone, the treated fields gave an average yield per hectare of 495 kilograms of dried grain (sorghum and/or millet), 10 percent greater than the control plots. In 1983, with rainfall as low as 350 millimeters in some zones, the treated fields gave an average yield of 430 kilograms per hectare, 48 percent greater than on the control plots.

Results on individual fields indicate that the collection of runoff indeed has a positive influence on yields, with well-watered and fertilized fields approaching

yields of one ton per hectare for sorghum. One degraded zone was treated and planted with rice and produced 1,200 kilograms per hectare of paddy rice (unhusked) under about 700 millimeters of rainfall in 1981. Indeed, during drought, water harvesting on the upper slopes may give better results than in the valleys where an effort has been made to improve soil fertility.

DISCUSSION AND CONCLUSIONS

Between 1979 and 1982 the agroforestry project undertook to develop techniques that increase agricultural production and lessen environmental degradation as a response to the worsening situation in the Yatenga region of Burkina Faso. With the participation of the farmers, various water conservation techniques were developed that are appropriate to the socioeconomic milieu. They can be practiced by most farmers with ordinary tools, excepting the tube level, which can be provided at minimal cost. Acquisition of skills is rapid; an entire village can be trained in two or three days. After one season most farmers can work independently of outside supervision.

The success of the project in motivating hundreds of farmers to undertake water conservation practices on their fields must be attributed to the immediate increase in yields and reduction of drought risk that the techniques provide. In addition, the techniques allow the restoration of severely degraded sites otherwise lost to production. They also can prevent the spread of land degradation, which is expanding at an alarming rate in the Yatenga.

The main difference between this and previous approaches, such as the GERES program, is in the treatment of runoff. Earlier efforts allowed for excess runoff to be channeled into waterways whereby it exits the cultivated area. In contrast, by using more appropriate construction materials, such as rock instead of earth, the farmer is able to capture and spread the water across his fields, improving soil moisture conditions and significantly lengthening the effective growing season.

If farmer participation was essential to developing the techniques, so also were some signs of success required to encourage that participation. These signs appeared in the form of increased cereal production and were apparent from the first season. This is in contrast to the results obtained with tree planting, which did not show immediate benefits and consequently received much less attention from the farmers.

The farmers of the Yatenga have shown they are capable of participating in scientific inquiry: testing hypotheses, analyzing results, and choosing alternatives. They demonstrated this ability first in developing the specific techniques appropriate to their use and again when choosing which fields to treat and when matching techniques to available resources in each situation.

The difficult question of maintaining and improving soil fertility in the Yatenga persists, however. While the construction of contour barriers permits

the application of fertilizers and organic matter on the treated field with much less danger of erosional losses, whether there is enough fertilizer and organic matter in the Yatenga to maintain soil fertility under permanent cropping conditions is debatable. In view of this, the project attempted to combine tree planting with water conservation techniques in order to supply organic matter, but the potential benefits to crops are longer in coming, and the frustrations of planting trees are many in a country where domestic animals are numerous and roam freely.

There are a few positive signs. Farmers can be observed gathering dead leaves to mulch their fields as a supplement to the manure that they recognize is insufficient in quantity. Some farmers are sufficiently motivated to plant trees along their contour barriers, and certainly the trend will continue. Not least, natural regeneration of trees and bushes has been observed along many of the older contour barriers.

With some guarded optimism one may hope the initial application of the techniques on the sites with good potential for exploiting runoff may eventually help pay for later treatment of other fields. If the first fields treated can give a farmer some food security, later efforts may be able to concentrate on the longer term problems of soil fertility: constructing soil conservation barriers and planting trees, for example.

It may eventually be decided to try to expand the experiences of the agroforestry project to another region. A word of caution is in order. The response in the Yatenga region was due to extreme circumstances affecting the survival of the population. Where circumstances are better, more diverse options are available. Investing in land protection may not seem like the best or only solution to the farmer. To be effective, any solution must be able to motivate the people to take the task into their own hands, requiring that the solution provide them with an immediate economic incentive to do so.

NOTE

[1]OXFAM, 274 Banbury Road, Oxford OX 2 7DZ, U.K. Known for its relief work, OXFAM also funds locally initiated development efforts in West Africa and elsewhere.

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LARGE PLANTATIONS OF RAPIDLY GROWING EXOTIC SPECIES: LESSONS FROM THE BANDIA, SENEGAL

Peter H. Freeman
USAID
Washington, D.C.

Tim Resch
USAID
Washington, D.C.

In the mid-1970s, large-scale plantations of rapidly growing trees for a variety of uses, major among them the provision of fuelwood (including charcoal) for the urban areas of the Sahel, were seen as one solution to easing the demands on land and forest resources exacerbated by the Sahelian drought of 1968 to 1974, the growing urban populations, and the rising cost of alternate fuels. The Senegal Fuelwood Production Project, sponsored by USAID, based in the Bandia forest near Dakar, was typical of this kind of intervention common to the Sahel in the late 1970s and early 1980s. This paper examines large-scale planting of exotic species as a forestry practice and discusses a 3,000 hectare (ha) plantation in the Bandia forest, similar to ones established at about the same time in Burkina Faso, the Gambia, Mali, Mauritania, and Niger. In general, the cost and difficulties of project implementation have been underestimated, and the tree growth and other benefits have been overestimated. These combined to result in programs that made less sense than anticipated on a technical, social, and financial scale.

BACKGROUND

USAID was first contacted in 1975 by the government of Senegal (GOS) to ascertain U.S. government interest in funding periurban reforestation. A project identification document (PID), USAID's initial authorizing document, was submitted in August 1976; when approved it triggered the next step in USAID's process, the development of a project review paper (PRP).

Parallel to this, a panel of experts (brought together in Dakar by a CILSS/UNSO/FAO Consultation on the Role of Forestry in a Rehabilitation Program for the Sahel in late April 1976) reviewed government proposals and consultant recommendations to identify a set of CILSS first-generation priority projects. SEN 302, a program to plant 3,200 ha of forest belts around urban centers in Dakar and Thies Department, was identified as a priority (CILSS 1976).

The CILSS/UNSO/FAO consultation recommended a number of large-scale block plantings of rapidly growing exotic species (primarily *Eucalyptus sp.*) in Burkina Faso, Mali, Mauritania, Niger, and Chad. These efforts often proposed

to plant contiguous blocks of trees, usually with the exclusive objective of producing fuelwood that most often was converted to charcoal, sometimes with the intention of producing poles as a secondary product. The plantations were generally intended for public lands over which governments in principle had control.

Several studies and field trips were subsequently requested by USAID/Senegal in a period when the agency was attempting to define more clearly its position on the general issue of land conservation and revegetation. Despite the wide variety of specialists and scope of work for these various studies, all concurred in supporting the fuelwood program by recommending that analysis be moved rapidly to the project paper stage (USAID 1979, p. 2). The plan also had strong government support and interest, being listed as part of both the Senegalese Fifth National Development Plan and the Regional Plan for Thies.

Tom Catterson, forestry advisor for USAID's Africa Bureau, in an unpublished discussion paper presented the advantages and disadvantages of block fuelwood plantations, information which is useful in understanding the rationale for this activity (Catterson 1984). Among the advantages he notes the fact that since tree plantations are a traditional professional skill for foresters, worldwide and Africa experience with the technique is significant. It is considered to be a tested one that need only be adapted to local conditions. Also, when tree plantations are established and grow, they are highly visible, create a sense of accomplishment, and demonstrate tangible action by governments. Because economic inputs can be quantified and yields projected, block plantations lend themselves to economic analysis, and the project can be seen as a discrete activity. This is attractive to national and international agencies, which must make comparisons with other investment opportunities. Economies of scale often may reduce costs, as does the simplified approach possible when a small number of species are planted. Catterson also suggests such indirect benefits as employment generation, contributions to environmental quality by increasing the density of vegetative cover, reduced pressure on other lands because of the higher productivity of the plantations, training values, and a demonstration that governments are acting to solve a pressing problem.

The major disadvantage, Catterson states, is the cost-benefit ratio, of which the Bandia is a good example. In too many cases the predicted benefits have been overestimated and expected costs underestimated. Land availability is another constraint, since areas with agricultural potential are generally used as such. Given increasing populations, it is unlikely they could be dedicated to fuelwood production. Marginal lands and nonagricultural soils tend to be unable to produce biomass volumes with a value greater than the cost of establishment and management. Alternate uses for indigenous vegetation often conflict with the imposition of a state-run plantation. Finally, the administrative and managerial complexity of mobilizing a large, well-trained force through a tightly

controlled biological calendar, with peak activity coinciding with maximum agricultural activity, has proven to be more difficult than perceived.

THE PROJECT PLAN

The Bandia National Forest, which covers 10,000 hectares, is 60 km from Dakar and 25 km from Thies, Senegal. It is characterized by large specimens of baobab (*Adansonia digitata*) associated with predominately *Acacia seyal.* Also frequent are *Ziziphus mauritiaca, Dichrostachys cinerea,* and *Combretum glutinosum.* The climatic type is considered Sudano-Sahelian, and the soils are calcareous. Established in 1933, the forest had been harvested since 1938 on approximately a 20-year rotation for charcoal and service wood. In addition, it served local food, fiber, and fuelwood needs. These uses and grazing, fire, and wood gathering had degraded and altered the vegetation.

The original project was a U.S. $3,133,000 grant over four years to the government of Senegal to replace part of this natural acacia forest with 3,000 ha of rapidly growing fuelwood species. The project was to be administered by a specially created unit within the Water and Forest Service, eventually called Project Autonome de la Forêt de Bandia (PARFOB).

The two major goals were to stabilize/increase the Dakar and Thies fuelwood supplies (charcoal and firewood) while stabilizing/decreasing their market prices and to halt/reverse environmental deterioration through easing cutting pressure on marginally productive and already deteriorating upland reserves. It was projected that at the end of the four years 3,000 ha of intensively managed forest plantations would be established (at a rate of 750 ha per year) and that an easily replicable fuelwood production system would have been developed. There were several technical features. (1) The species planted would be 80 percent *Eucalyptus camaldulensis*, with the remainder *Azadirachta indica* (neem), some indigenous acacias, and selected others. (2) A central nursery would have capacity of 700,000 seedlings per year. (3) Plantation yields should be 10m^3/ha/year, with the first harvest taking place in five years, thereafter at four-year intervals. Senegal's Centre National de Recherches Forestières (CNRF) experts at the time predicted yields for Eucalyptus of 10-15 m^3/ha/year, a first rotation at four years, and rotations thereafter every three years. (4) From 20-50 hectares of natural forest should be "saved" for every hectare established in the Bandia Forest. This assumption was based on a natural forest wood production rate of 0.3 to 1.5 m^3/ha/year at a twenty-year rotation.

A research component was designed into the project with the expectation that research information combined with improved management of procurement and operations could reduce costs substantially, perhaps as much as 40-60 percent. The second phase budget expected a 20 percent cut in costs due to the above. Specific research activities were to be worked out after the project team was assembled.

Specialized advanced training abroad for several Senegalese was added at the request of the government. Two were to receive training for an M.S. degree from a U.S. institution in forest management (silviculture, with an emphasis on reforestation, tree improvement, and nurseries), and one to receive an M.S. in forestry research. Two years' training at the National Forestry School in Morocco at the level of "Ingenieurs des techniques forestries" was to be given to two candidates, the first in nursery development and management and the second in silviculture and soils.

Village forestry and extension activities were to be actively promoted in collaboration with local extension agencies by using the annual surplus seedling production of about 150,000 for these activities.

A second phase of 3,000 additional hectares was anticipated, depending on the outcome of the first effort. Expatriate technical assistance, research, and training costs were not expected in the second phase. All procurement, operating, and manpower costs were reduced 20 percent to reflect anticipated reductions from the first four years. This planning indicates the pilot nature of the first phase and the expectation of some harvest from the smooth operation of the second phase.

PROJECT RESULTS: 1979-1983

The project overestimated most of the key technical features: rainfall, growth rates, project start-up time, and management capabilities of the government of Senegal and the USAID mission. The difficulty of clearing and loosening the ground prior to planting was underestimated, and the wheeled and crawler tractors ordered for the project were oversized. Some costs were underestimated, and some expenditures were ill-considered.

An annual rainfall of 500-600 mm was calculated to be possible over much of the project life; based on this, plantation yields were expected to exceed $10m^3$/ha/year (USAID 1979, p. 15). In fact, figures for the first three years were 320, 355, and 445 mm, or an annual average of 370 mm (Freeman and others 1983). Estimates in the project paper apparently were based on rainfall received at the coastal station of M'Bour, which averaged 739 mm from 1931 to 1960. During the evaluation in 1983, the same station was determined to have averaged 594 mm per year from 1960 to 1980 and 468 mm from 1976 to 1981. The CNRF raingage, seven miles south of the PARFOB raingage, and the Thies station averaged 429 mm and 492 mm, respectively, from 1976 to 1982. In those seven years of measurements, the CNRF rainfall has varied from 266 to 615 mm. This closer analysis of records confirms the well-known variability of precipitation in time and space in this zone of West Africa and that the project assumed unrealistically high levels. In addition, it appears that even 500-600 mm of rainfall in West Africa on soils without a high water table might mean that attaining 10 m^3/ha/year of wood volume production is optimistic.

Yield predictions were primarily based on preliminary results of species trials done by the CNRF in the Bandia Forest and elsewhere in Senegal. In 1981, two years after the project started, CNRF obtained additional data indicating lower yields. Cuttings of 1976 plantations of eucalyptus yielded 4.4 m^3/ha/year for the best provenance; second best was 3.0 m^3/ha/year; third best 1.7 m^3/ha/year. (These low results prompted an investigation of alternate sites farther south in 1982 by a soils assessment team and in 1983 by the evaluation team.) A comparison of mean heights at ages one, two, and three years of PARFOB trees and those of the CNRF provenance trials in the Bandia Forest showed PARFOB trees growing slower than the lowest yielding CNRF provenances. Although annual rainfall was different in the two periods, total accumulation was about the same.

Because of seed unavailability, the *Eucalyptus camaldulensis* with the best yields in the CNRF trails was not planted in the PARFOB plantations. The provenance planted by PARFOB was not tested in the early CNRF trials.

Comparison of research results and field achievements must take into account that the conditions of plantations and maintenance are generally better on experimental plots than is possible in large-scale efforts. Trees are planted more carefully, weeding is done better, and trees are protected more thoroughly. A comparison of CNRF and PARFOB accomplishments confirms this expectation of lower field results over research trials. Various small (one-hectare) CNRF research plots located inside the 25 ha compartments provide additional empirical confirmation of this tendency. Results are summarized in Table 1.

Table 1. HEIGHT AND MORTALITY OF PARFOB TREES AND CNRF TREES WITHIN PARFOB COMPARTMENTS

	Mean height (cm)		Mortality (%)	
Compartments	PARFOB	CNRF	PARFOB	CNRF
A3	221	331	10	8
A6	205	319	8	6
A5	191	310	22	26
B1	232	397	36	0
Species				
Eucalyptus	83	102	13	5
Proposis	72	96	8	0
Neem	-	-	37	26

Source: Freeman and others (1983).

The envisioned plantation density was 625 trees per hectare (4m x 4m spacing). Actual density because of wider spacing in 1980, 1981, and 1982 was found to be 550, 560, and 490 trees/ha, respectively. This also lowered yield per hectare.

Mortality of trees planted in some parts of the forest was higher than expected due mainly to the lateritic hardpan encountered one meter below the surface in the case of 1980 plantations and to inadequate weeding and drought for the later plantations. The higher mortality reduced the number of growing trees per hectare and thus potential yield. The 1981 plantings, having passed through one hot dry season, had a mortality of 15-25 percent. That of plantings in 1982, measured in early 1983 prior to the hot dry season, generally ranged between 5 percent and 32 percent, with the exception of those near the natural forest, where heavy loses of 75 percent were incurred due to grasshopper damage.

The project had proposed that in addition to *Eucalyptus camaldulensis*, 20 percent of the plantations would be in *Azadirachta indica* (neem), some indigenous acacias, and selected other species (USAID 1979, p. 8). *Prosopis Juliflora* (mesquite) was planted on the more severe sites in increasing quantities throughout the project life, representing 20 percent of the area planted in 1982 and 1983. Yields were not available from CNRF trials but were not expected to exceed 4 to 5 m^3/ha. Only small areas were planted in other species.

Direct costs of establishment for three plantation years were estimated at U.S. $808 per hectare (U.S. $1,253,295 for 1,550 ha.). Depreciation of equipment, buildings, and other installations was computed to be approximately U.S. $200/ha over ten years, which would bring costs to U.S. $1,008/ha. Indirect costs not attributed included expatriate technical assistance, research, and training.

The low growth rate of *Eucalyptus sp.* in this rainfall zone raises the question of its superiority to native species. The project design team used a production figure of natural forest yield at 0.3 to 1.5 m^3/ha/year. Differences were also expected in charcoal yield from these forests compared to the Bandia, in that the traditional charcoal conversion process often leaves large diameter logs (more than 10-15 cm in diameter) behind as waste, given that they are difficult to cut with traditional tools and, if not cut, do not carbonize completely. The project anticipated growing trees to optimum dimensions for charcoal conversion and providing training for improved practices.

A 1954 management plan for the Bandia, apparently not available to the project design team, showed a history of annual cuts of 4.5 tons of charcoal or 22 tons of wood per ha between 1944 and 1953. The plan envisioned, with management on an eighteen-year rotation, production of as much as 30 tons of wood per ha. This is the equivalent, at a wood density of 0.6, of between 0.6 and 1.0 m^3/ha/year (Bellouard 1954).

In 1982, a German forestry student undertook sample cuts of the natural *Acacia seyal* forest over a nine-hectare area in the Bandia Forest. Her data indicated a yearly production ranging from 0.8 to 3.2 m^3/ha/year, with a mean of 1.9 m^3/ha/year. The forest sampled had been exploited for charcoal six years earlier. The evaluation team in its revised economic analysis used the figure of 1.0 m^3/ha/year as the production of the natural forest and speculated this might be improved with management measures such as control of cattle and fire or selective thinning. Research in natural forest management as a viable alternative to plantations in this zone was a principal recommendation of the evaluation.

LESSONS LEARNED

First, the line between positive thinking and unrealistic optimism needs to be respected. Yet, it must not be forgotten that development is an experiment. Second, rainfed large-scale fuelwood plantations of *Eucalyptus sp.* below the 800 mm rainfall isohyet appear financially infeasible. Third, rainfall predictions, especially when extrapolated, should be carefully analyzed using statistically rigorous methods. Fourth, species, provenance, and even seed source selection can influence project success or failure.

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FORESTRY PLANNING: THE SENEGALESE EXPERIENCE

Chun K. Lai
USAID
Mali

Comprehensive and long-range planning efforts in the forestry sector have been conspicuously lacking in Sahelian countries until recently. At the regional level, the key proponent of such planning has been and remains the Comité Interétats de Lutte contre le Sécheresse dans le Sahel (CILSS). Although planning was articulated as one of the six subprograms in the revised CILSS forestry strategy (CILSS 1979), only 0.3 percent of the overall program funding was diverted for that purpose (CILSS 1980; Taylor and Soumaré 1983, p. 7).

Since 1980, significant progress has been made in developing forestry sector strategies and programs. A series of country-level "Bilan-Programme" was directed by CILSS and Club du Sahel, covering six Sahelian nations: Gambia, Niger, Burkina Faso, Mali, Cape Verde Islands, and Mauritania. Not included were Chad, embroiled in civil strife, and Senegal, already in the process of devising a forestry development plan. It is the latter which will be examined here.

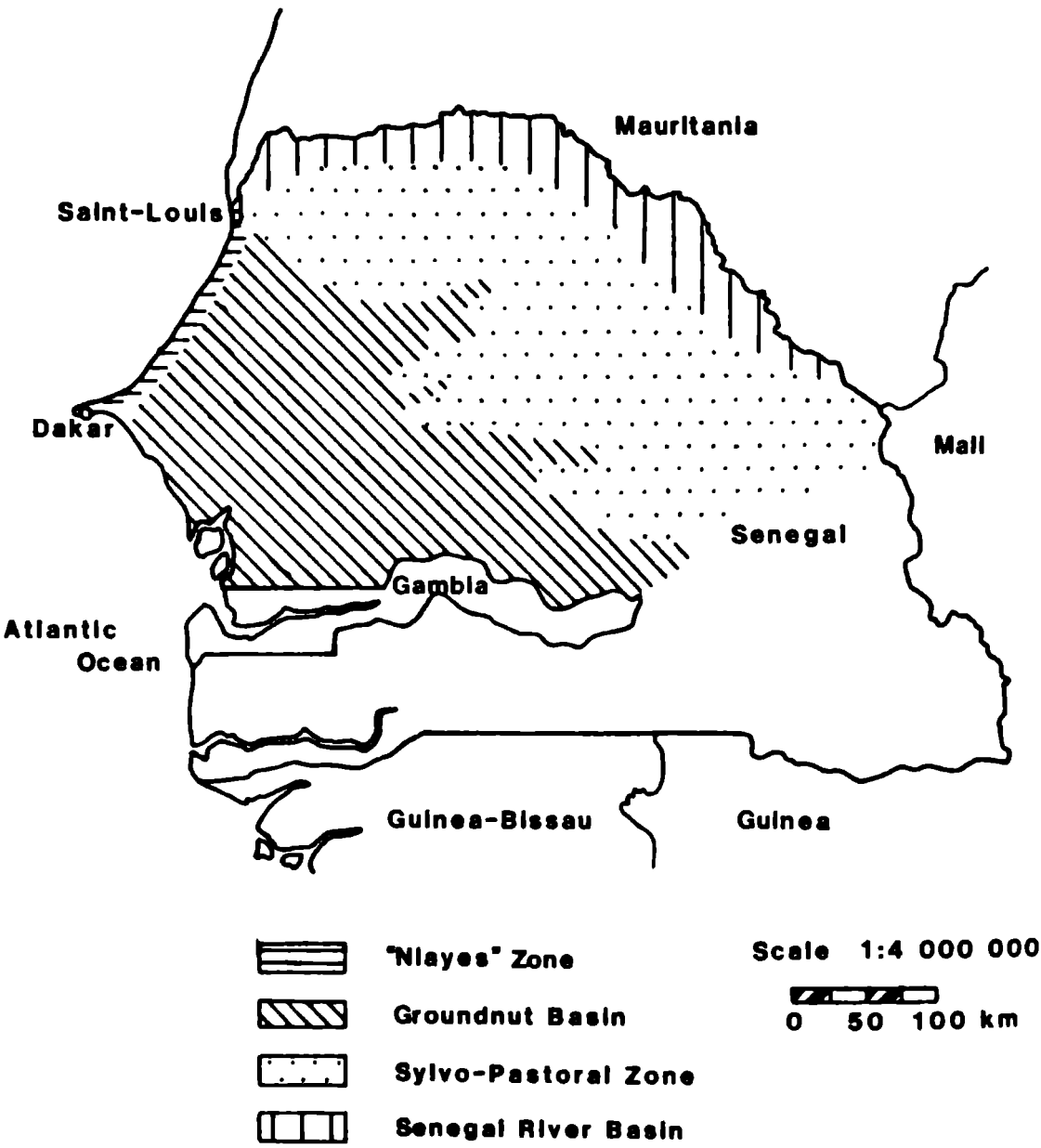
HISTORICAL PERSPECTIVE OF REFORESTATION EFFORTS IN SENEGAL

The Senegalese have a relatively long history of involvement in reforestation. Filao (*Casuarina equisetifolia*) planting trials were initiated in 1908, leading eventually to operational programs of dune stabilization starting in 1947. Teak (*Tectona grandis*) was introduced to southern Senegal in 1936 and *Gmelina arborea* shortly thereafter (République du Sénégal 1983). The introduction of neem (*Azadirachta indica*) occurred in 1944 (Giffard 1974), and it remains the most ubiquitous exotic tree species in the Sahelian landscape.

Cashews (*Anacardium occidentale*) and neems were planted extensively along roads and in villages during the 1950s and 1960s. There were also large-scale campaigns to promote the kad tree (*Acacia albida*), either by interplanting or protecting natural regeneration in fields.

In the 1970s and early 1980s, the emphasis was on fuelwood plantations of rapidly growing exotics; *Eucalyptus camaldulensis* was especially touted. More recently, the evolution has been toward "social forestry" initiatives that integrate local participation with appropriate technical packages, which often include indigenous tree species. The major reforestation zones are depicted in Figure 1. (For a comprehensive review of reforestation in Senegal, past and present, see Lai 1984).

Figure 1. Major reforestation zones in Senegal



Given this history, it is not surprising that, among Sahelian nations, Senegal took the lead in the formulation of a long-term forestry plan.

MASTER PLAN FOR FORESTRY DEVELOPMENT

The Plan Directeur de Développement Forestier (hereafter, the master plan) documents the planning process and the proposed strategy and programs. Two organizations were responsible for developing the master plan: the Centre Technique Forestier Tropical (CTFT) and SCET International, a private French consulting firm. They, in turn, secured the services of the Société Nouvelle des Etudes de Développement en Afrique (SONED), particularly for socioeconomic studies. Personnel from the Service des Eaux et Forêt (Senegalese Forest Service) were involved throughout the process, which began in 1980 and concluded in 1982.

The planning work involved three phases: diagnostic, long-term strategy, and programmatic strategy.

The diagnostic phase lasted five months and included the inventory and analysis of forest resources, with supply and demand projects up to 2016, the end of the planning horizon. LANDSAT imagery was used to distinguish ten vegetation types, ranging from shrub steppe to closed forest. The pertinent data and analyses were consolidated in the "resumé and synthèse" volume (CTFT/SCET 1981a).

The formulation of long-term strategy evolved over four months and embodied goals and guidelines for the development of policies and programs. Broadly stated, the goals are (CTFT/SCET 1981b): (1) conserve the forest resource potential; (2) satisfy priority needs for forest products; (3) improve rural living conditions by supplying energy and supporting food production; (4) integrate trees into rural activities; and (5) reduce dependence on foreign markets by developing domestic forest products and promoting exports.

In the third phase, which lasted three months, objectives and project proposals were developed for the short and medium term (1982-1997). The "summary note" (CTFT/SCET 1982), available in English and French, puts forth strategy and "standard" projects necessary to attain the long-term goals. There are also separate volumes on reafforestation, industrial forest projects, natural forest management, inland fisheries, and "cynegetics" (wildlife).

IMPLICATIONS FOR FUTURE ACTION

Fuelwood Trends

Master plan projections of wood supply and demand for 2000 and 2016 are presented in Table 1. On an aggregate basis, fuelwood deficits are not expected to occur until after the turn of the century, but regional disparities in production and consumption already exist. More than half the avilable fuelwood is

Table 1. PROJECTED SUPPLIES AND DEMANDS OF WOOD IN 2000 AND 2016, IN THOUSANDS OF M^3

Year	End Use	Supply: Natural Forests	Supply: Plantations	Total demand	National surplus or deficit
2000	Fuel wood	6,300	236	6,500	+ 26
	Construction Wood	1,100	33	950	+183
	Timber	25	4	160	- 131
	Pulp	0	0	300*	- 300
2016	Fuel wood	5,300	506	8,140	- 2 , 334
	Construction Wood	900	71	1,100	+ 80
	Timber	25	20	250	- 205
	Pulp	0	0	540*	- 540

Source: Adapted from CTFT/SCET 1981a, p. 131.

*Roundwood equivalent of imported pulp.

located in the extensive savanna formations of the remote eastern region (Lai 1984, p. 15).

One critical point illustrated by these projections is that even with an accelerating rate of plantation establishment and a declining rate of per capita fuelwood consumption (see below) factored in, plantations will only meet 4 percent of the total fuelwood demand in 2000 and 6 percent in 2016. A shrinking base of natural forests, due to deforestation and degradation, will be relied on as the primary source of wood.

Natural Forest Management

The importance of natural forest management should be self-evident. This is well recognized in the master plan "diagnostic" (CTFT/SCET 1981a, p. 89): "D'une façon générale, la Recherche montre que *l'amenagement des formations forestières naturelles, quand elle est possible, est de loin préférable aux coûteux reboisements*" (emphasis in original). Unfortunately, this priority is not fully reflected in the programmatic strategy (see below).

In a CILSS simulation model, using a Visicale computer program, improving the yield of natural forests by one percent per year would increase future wood supplies much more than planting trees on 10,000 hectares annually (CILSS 1983, p. 20).

Rural Forestry

The total area of forest reserves (forêts classées) deemed suitable for plantations is 231,750 hectares, mostly located in the remote eastern regions. Given these limited state-managed sites, more than half the future plantings are projected to occur in the private rural sector. This raises the issue of land availability (largely unaddressed in the master plan), which is a major constraint in such congested areas as the Groundnut Basin. For example, in the Diourbel region, fallowing practices have been virtually abandoned, and arable land has been reduced to 0.75 hectare per person due to intense population pressure (NAS 1980; Freeman 1982). As a result, land ceded for village woodlot establishment is usually on marginal sites such as "bas-fonds," small depressions that are seasonally inundated and have very compact clay soils (Lai 1983).

Furthermore, motivating the rural populace to undertake forestry initiatives—incentive systems, equity in distribution of benefits, land and tree tenureship—is inadequately dealt with in the master plan.

Improved Utilization and Reduced Consumption

Fuelwood, in the form of firewood or charcoal, accounts for 60 percent of all energy consumed in Senegal (CILSS 1978). In the rural sector, firewood is virtually the sole energy source, representing 96 percent of the total (CTFT/

SCET 1981a, p. 53). The energy efficiencies of charcoal (3.3-6.6 percent) and firewood (5-10 percent) are extremely low due to traditional conversion and cooking methods that result in high energy losses (CTFT/SCET 1981a, p. 55).

The master plan projected that per capita fuelwood consumption would decrease by the following magnitudes (in m^3/inhabitant/year):

Year	Rural	Urban
1980	0.85	0.65
2000	0.75	0.60
2016	0.65	0.55

This decline would be attributable to several factors (CTFT/SCET 1981a, pp. 57-58): improved methods of charcoal-making, such as the Casamance kiln; more efficient cookstoves, such as those tested in the "Ban ak suuf" program, resulting in 40-50 percent fuelwood savings; and greater use of alternative energy sources: butane gas, agro-industrial residues (such as groundnut shells), peat, solar, and wind. The effects of increasing fuelwood prices and the longer distances traveled to gather wood should also be considered.

It is interesting to note that, in the CILSS model, reducing per capita consumption by one percent per year had a much greater positive effect on projected fuelwood deficits than did any other single parameter (CILSS 1983, p. 20).

Institutional Reform

The Senegalese forestry code is emblematic of the colonial legacy that pervades Sahelian forestry; a code that is designed to promote conservation by freezing demand through the creation of extensive forest reserves and "protected" species legislation (Thomson 1981) but that is ineffective.

The lack of definitive tree ownership rights has been a major drawback in rural forestry initiatives. This deficiency is pointed out in the master plan (CTFT/SCET 1981a, p. 108): "Les communautés et les individus ne voyant pas exactement à qui reviendront les bénéfices, manquent de motivation. Il conviendrait donc de préciser clairement et au profit de qui seront récoltés les produits." Revising the forestry code to facilitate "privatization" (Thomson 1983) of tree ownership would act as a positive incentive to protect trees—planted or natural—whether the action is done collectively or individually.

A complimentary step would be gradually to decentralize forest use regulation and enforcement to local communities. Already, many villagers have expressed their desire to be allowed to organize at the local level a form of "forest police" to address illegal wood land exploitation (PRECOBA 1982).

DISCUSSION

The Diagnostic-Programmatic Chasm

Contained in the master plan "diagnostic" are many implications for "the road ahead." The importance of developing strategies to manage the natural forest system, to integrate forestry into rural development, and to improve utilization and reduce consumption of fuelwood is recognized. The corollary that appropriate research, training, and institutional reform must support these strategies is espoused. Somewhat lacking are the specific options and prescriptions for shifting to the new orientations, but one would expect these to emerge through experience and comparative analysis.

One major flaw of the master plan, however, is that the insightful analyses, evaluation, and recommendations found in the"diagnostic" are not adequately reflected in the programmatic strategy. Instead, this is heavily biased in favor of short-term, externally funded plantation projects. As an example, proposals relating to natural forests *and* existing plantations represent only 19 percent of total program funding for 1981-1985 as opposed to 72 percent for projects to establish new plantations. For the 1993-1997 planning horizon, the figures are 7 percent and 91 percent for natural forest and plantation projects, respectively (based on projections from CTFT/SCET 1982, p. 31).

This unfortunate chasm between "diagnostic" and programmatic philosophies is at the heart of the statement made by Taylor and Soumaré (1983, p. 22): "As a result of 'development-through-projects,' short-term advantages in efficiency have been gained at the expense of long-term program viability."

Absorptive Capacity

The central role of "absorptive capacity" in Sahelian development efforts is becoming increasingly clear (see Berg 1983). Taylor and Soumaré (1983, p. 19) referred to absorptive capacity and recurrent costs as "the twin issues of pace and sustainability."

The master plan projections for increasing rates of plantation establishment—up to 28,740 hectares per year by 2001—appear unrealistic in light of the financial, personnel, and land availability constraints. Tables 2 and 3 demonstrate some of the funding and staffing shortfalls that are anticipated if the proposed program were to be carried out. To achieve them, massive infusions of donor financial assistance would be required. Likewise, huge investments of foreign capital would be needed to expand and upgrade the training infrastructure. Even if this external funding could be mobilized, such an accelerated planting program defies a rational pace and sustainability. Excessive dependence on foreign capital would also undercut a goal intrinsic to any development strategy, regardless of the sector: a move toward greater self-reliance.

Table 2. COMPARISON OF PROJECTED AND REQUIRED FUNDING IN THE FORESTRY SECTOR, 1981-1997

National development plan	Period covered (July 1-June 30)	Total investment (millions FCFA)	Projected forestry funding (millions FCFA)	Projected forestry funding (as % of total investment)	Required funding to meet master plan objectives (millions FCFA)
Sixth	1981-85	463,847	10,665	2.3	10,258
Seventh	1985-89	512,100	13,310	2.6	18,374
Eighth	1989-93	565,300	16,960	3.0	37,151
Ninth	1993-97	624,100	21,849	3,5	62,981

Source: Adapted from CTFT/SCET 1982, pp. 18, 32.

Table 3. MASTER PLAN PROJECTIONS FOR FORESTRY PERSONNEL, 1980-1990

Personnel Category	Staff in Service	Staff in Training	Total Available by 1985	Projected Staffing Needs 1980-1985	Projected Staffing Needs 1985-1990
IEF	11	30	41	40	50
ITEF	93	33	126	131	226
ATEF	293	39	332	880	1550
Total	397	102	499	1051	1826

Source: Adapted from CTFT/SCET 1982, p. 49.
Note: IEF = Ingénieurs des Eaux et Forêt (professional level); ITEF = Ingenieurs des Techniques des Eaux et Forêt (subprofessional); and ATEF = Agents Techniques des Eaux et Forêt (technical).

Data Gaps

A massive undertaking in the master plan process was the compilation, analysis, and synthesis of available information. Unfortunately, reliable baseline data are lacking in many areas, for example, growth and yield of natural forests. As such, the confidence levels of some assumptions and projections must necessarily reflect these data gaps.

Largely because of their degraded and often understocked state, growth rates of natural forests in the Sudano-Sahelian zone are generally low. The master plan estimated a growth rate of 0.10 to 1.00 m^3/ha/year for forests in the zone (CTFT/SCET 1981a, p. 44). This corresponds relatively well with the 0.16 to

1.20 m^3/ha/year estimate put forth by Clement (1982). However, preliminary results from sampling data in a nine-hectare block in the Bandia Forest indicated production rates ranging from 0.8 to 3.2 m^3/ha/year (Freeman and others 1983, p. 101).

For fuelwood plantations, *Eucalyptus sp.* is assumed to produce 5 m^3/ha/year over a seven-year rotation; slower growing species such as neems and acacias are expected to have a growth rate of 3 m^3/ha/year and a rotation age of 15 years (CTFT/SCET 1981a, p. 129). These production rates and cutting cycles have yet to be validated in the field.

In demand projections, the assumption of decreasing per capita fuelwood consumption (see above) seems sound, but the *rate* of this decline was, admittedly, arbitrarily set. In addition, expected rates of population growth and urbanization are not explicit in the master plan. In 1978, the urban population growth rate was 4.1 percent (7 percent in Dakar) as opposed to one percent in the rural sector (ETI 1982).

The master plan was quantitatively weak in presenting an economic justification for its proposed strategy and program. This may be attributable to the paucity of sound economic data on development and investment in the forestry sector.

Participatory and Integrative Planning

One possible criticism of the master plan is that it was not a participatory or integrative process. There was insignificant input from donor organizations, parapublic rural development agencies (such as SODEVA and SODESP), representatives of the rural population, and user groups (for example, charcoal cooperatives). Their participation would have added more depth to the planning process and contributed to a more comprehensive evaluation of forest resources and usage.

The second aspect found lacking was the degree of cross-sectoral integration. In particular, the interdependence of the forestry and agricultural sectors merited greater examination during the planning process. The need to strengthen and develop the forestry-agriculture interface is increasingly apparent (Taylor and Soumaré 1983, p. 26) and must logically start during the planning stages.

Monitoring, Evaluation, and Revision

Despite the critical tone of this paper, the mere existence of the master plan for forestry development is commendable. Once again, Senegal was in the forefront among Sahelian nations in breaking new and important ground. Despite the flaws to which one may point, the underlying process—the inventory, analysis, and evaluation that provided the basis for strategy and program formulation—was a sound and replicable one.

Perhaps one of the most important functions of the master plan would be to serve as a model of forestry sector planning, but effective forms of monitoring, evaluation, and revision need to be built in. This is essential so that as data gaps are plugged through research and operational experience, as general assumptions become more finely honed, as new supply and demand trends emerge, corresponding adjustments may be applied to the planning model.

Thus, the master plan should not be viewed as something carved in stone but rather as a preliminary version, part of a dynamic process, that will be refined as the knowledge base in the forestry sector is improved and enlarged in scope as pansectoral interactions are examined.

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THE DINDERESSO FORESTRY SCHOOL: CASE STUDY OF EXTENSION FORESTRY TRAINING IN BURKINA FASO

Robert T. Winterbottom
World Resources Institute
Washington, D.C.

Peter E. Linehan
Forestry Instructor
Burkina Faso

This paper discusses the evolution of the training program at the National Forestry School of Burkina Faso and the development of a new curriculum with increased emphasis on practical training in extension forestry techniques. In retrospect, the experience gained at Dinderesso over these four years and that from other comparable forestry schools in the Sahel clearly justify a significant effort to uprade and reorient the training of forest service field agents, in order better to prepare them to meet the challenges of environmental conservation and natural resource management in the Sahel.

THE CHANGING ROLE OF THE FORESTER

Sufficient numbers of well-trained foresters are the essential backbone of any forest service. Although adequate funding and efficient administration of programs are also necessary, the successful implementation of forestry activities is ultimately dependent on the skills, competence, and motivation of the people in the field. This is particularly true when the programs of the forest service are rapidly expanding in size and scope. Today, the forester's job encompasses a wide range of new tasks and activities, such as extension forestry in rural areas, agroforestry and reforestation, establishment and exploitation of fuelwood plantations, and the more intensive management of the national forests (forêts classées). The demands made on personnel now go much beyond law enforcement and issuance of cutting permits.

Historically, reforestation and forest management activities were small scale and confined to a few locations. In the four decades prior to 1972, fewer than 1,000 hectares of plantations had been established in the entire country. In addition, small amounts of three or four species of exotic trees were routinely distributed and planted in Arbor Day ceremonies, but the 3.5 million ha of reserves and classified forests benefited from no significant management other than sporadic surveillance. This situation persisted until the mid-1970s, when considerable assistance from international donors began to be mobilized to

promote development of the forestry sector. In the past ten years, another 10,000 ha have been planted, and perhaps another 10,000 ha will be established by the end of the decade.

Recent studies by the World Bank, however, suggest that 15,000 ha per year need to be planted in Burkina Faso for the next 20 years if a balance is to be restored between wood production and consumption. In a similar type of analysis, the CILSS concluded that 150,000 to 300,000 ha per year need to be reforested in the Sahel between now and 2000. Obviously, if deforestation and desertification are to be controlled, foresters must become more efficient tree planters.

Other surveys have estimated that, for a variety of reasons mostly nontechnical in nature, only one out of five seedlings planted in the Sahel survives to maturity. In this regard, foresters need to be trained to do much more than plant trees if they are to succeed in meeting today's forestry challenges. They must first be dedicated to satisfying the basic needs of the local population and sensitive to socioeconomic, cultural, political, and other constraints that may impede their participation in forestry activities. They must also be able to communicate with and motivate the people likely to benefit from forestry and be familiar with a variety of techniques to integrate forestry into the rural development context. If land, labor, and other scarce resources are to be made available for forestry, they must ensure that it complements and sustains agricultural production and does not compete with it.

These tasks require considerable skills in survey techniques and project development, extension, land use planning, agroforestry, soil and water conservation, and range management. At the same time, the Sahelian forester must have a practical understanding of other basic skills: land surveying, mapping, identification of flora and fauna, inventory techniques, nursery and plantation establishment, fire control, harvesting and utilization, as well as plantation and natural forest management. Traditionally, the Service des Eaux et Forêts in the Sahel has also had responsibilities for parkland and wildlife management as well as fisheries and fish culture, and these programs are expected to expand. With the need better to satisfy the burgeoning demands of growing populations, deal with increased land pressures and overexploitation of renewable resources, and control desertification, the forester's job is rapidly growing in complexity and importance.

PERSONNEL REQUIREMENTS AND TRAINING INSTITUTIONS

Faced with this challenge, the human resources and forestry training institutions of Burkina Faso appeared very meager indeed until a few years ago. As recently as 1978, the Forest Service included only eleven foresters with B.S. or M.S. degrees, 15 mid-level forest technicians, and approximately 174 field

agents at the junior (préposé) and senior (agent technique) level. A forestry manpower and training study completed by the CILSS and FAO in 1977 projected the personnel requirements for the service to 1990. After estimating staffing needs for administrative, project-related, and general forestry activities, the CILSS/ FAO study concluded that Burkina Faso would need 400 field agents, 32 technicians, and 32 university-trained foresters by 1980.

A more recent survey by the Ministry of Environment and Tourism estimated that 659 field agents, 166 technicians, and 140 foresters need to be trained between 1984 and 1994 to meet adequately projected staffing requirements. In the case of field agents, this will entail graduating an average of 65 per year.

Until the mid-1970s, most of the upper level foresters were trained in Europe, as no institution existed in Burkina Faso. Consequently, their programs included little practical training of relevance to conditions in the Sahel. With donor assistance, a university-level program in forestry was launched in Ouagadougou, and by 1980 several classes of five to ten foresters had been graduated.

Middle level technicians (controleurs) have been well trained according to a classical curriculum at the Banco Forestry School in Ivory Coast, but because of the limited capacity of the school and preference given to Ivory Coast nationals, Burkina Faso has not been able to place more than two students every one or two years at this institution. An attempt to develop an in-country program for technicians at the Centre Agricole Polyvalent de Matourkou (CAP/M) was made in the late 1970s but faltered because of staffing shortages and organizational problems.

Although the number of field agents in the Forest Service in 1978 (174 agents) seems large, it was far from the quantity needed to staff all posts throughout the country. Even if one assumes that no more than 10 percent of these agents were assigned to administrative tasks in district and regional offices, each of the remaining agents would be responsible for an area of nearly 2,000 km^2 (175,160 ha./agent).

Training for field agents has historically been provided at the National Forestry School at Dinderesso (18 kms. from Bobo-Dioulasso). It operated much as a forestry camp in the early years and provided only rudimentary training to forest guards. Around 1953, a mud-brick dormitory and classroom were build (by the students), and regular recruitment began among candidates with a primary school certificate (sixth grade level education). They received eight to ten months of elementary instruction in classical forestry subjects before graduating as "préposés des Eaux et Forêts" (*préposé* meaning "the representative of the law" or the "government servant or overseer"). Training essentially prepared them for their primary mission of surveillance of the classified forests and reserves and enforcement of the laws protecting the country's flora and fauna. Most silviculture and nursery training was in the production and planting of

rapidly growing exotics (neem, gmelina, teak, and cassia).

Until the mid-1970s, classes were limited to ten students per year. As the Forest Service evolved, the school's output was increased to twenty students per year, to compensate for attrition from retirement, transfers, and other causes, and to provide more agents for the projects that were funded in the aftermath of the Sahel drought (1969-1974).

PROJECT DEVELOPMENT AND ACTIVITIES

Recently, a USDA technical assistance team worked for three years with teachers at Dinderesso under the USAID-funded Forestry Education and Development project. The intent was to improve or develop the following areas: field trips, practical training, new courses, curriculum changes, approval of a new statute, and establishment of a new school advisory board.

Field trips throughout the country to visit various forestry projects, game parks, and different ecological zones have helped give the students a more realistic understanding of what would otherwise be sterile classroom descriptions. For example, seeing animals in game parks and observing the problem of poaching first hand immensely improves the wildlife course. Soil conservation is made more dramatic by seeing the seriousness of erosion in the Sahelian region and working with villagers on various antierosion techniques. The idea of using extension as opposed to repressive techniques in dealing with people is much more valid when it comes from a working forester, who can show the plantations he helped establish with villagers. In fact, members of the teaching staff who initially discounted extension training were finally converted to its importance during field trips. The amount of time spent outside the classroom doing field work and hands-on training has increased since the beginning of the project. The eventual goal is to have at least 50 percent "practical work" for most courses.

New courses were established by the USDA teachers. The extension techniques course teaches students how to speak and work with villagers using a series of presentations developed by CESAO and GRAAP [Editors note: Centre d'Etudes Economiques et Sociales de l'Afrique de l'ouest and Groupe de Recherche et d'Appui pour l'Autopromotion Paysanne, both based in Bobo-Dioulasso.] Basic interview and survey skills to discover villager needs and attitudes are also taught. A new soil science and conservation course stresses basic ways to analyze a soil's usefulness and shows practical methods of soil conservation and erosion control with simple tools. A course in mensuration teaches elementary techniques in measuring primary forest products, standing trees, and simple forest inventory field work. A short course in aerial photo interpretation and in the use of contour maps has also been introduced.

Military training has traditionally taken up one day per week at Dinderesso and has always been considered a key course in the Forest Service. Efforts to

have it downgraded or eliminated have not been successful. Soon, however, this training will take place in a one-month block before regular technical training starts. This will allow the staff to concentrate full time on forestry courses without losing one day a week.

Since its inception in 1953, the Dinderesso Forestry School has never had a statute to legitimize its functions. One was drafted by the teaching staff, and a slightly altered version was signed by the president in June 1984. It created a Conseil de Perfectionnement (school advisory board) made up of the secretary general and technical directors of the Ministry of Environment and Tourism (MET) as well as representatives from the school. Their job is to oversee the training program and to make decisions as to the direction the school will take.

The statute also mandates a "training-by-objectives" approach in developing a program at Dinderesso. Objectives for a revised training program put together by USDA consultants Fred Weber and Jean Barry were discussed by the conseil at its first meeting in July 1984. Although it approved the basic orientation of the proposal, it reapportioned the time alloted for each course. The staff at Dinderesso is now revising old courses and developing others to fit the newly adopted training objectives. The conseil will review progress periodically. It is hoped a strong Conseil de Perfectionnement will have a positive effect on training at Dinderesso by helping to make sure the school's ouput is high in quality and responsive to present and future needs of the Forest Service.

LESSONS FROM THE DINDERESSO EXPERIENCE

The following are some points that the authors believe to be important for the success of similar endeavors elsewhere.

First, any organization contemplating establishing or revitalizing such a training facility must realize that institutional development is a long-term process. Five years is too short a time to expect realistically to establish a dynamic, relatively sustainable institution. Especially if considerable commodity procurement and construction are involved, the first several years will be taken up managing administrative matters and supervising contracts. Eight to ten years, or even more, of technical assistance is likely to be necessary to provide for both infrastructure improvements and institutionalization of training programs.

Second, long-term participant training is useful to improve the educational level of national staff in their technical field. It can also entice better teachers, if the beneficiaries of this training agree to return to the school afterward (a signed contract specifying the number of years of teaching required after training would be necessary). However, there is also a need for short-term teacher training programs to upgrade skills. People who have had a purely technical education probably have had little experience as teachers, and they often tend to rely on traditional lecture techniques.

Special teacher training seminars could help adjust for the use of technical tools and audio-visual materials in an imaginative manner. Designing relevant educational field work and classroom exercises requires special skills. Although the technical assistance team is there to do these things, it is worthwhile to bring in outside people for added emphasis. Teacher training could be done in a way to enhance the status of teachers and help them be more comfortable doing field work exercises.

Third, although it is important to have a comprehensive training program that is well thought out on paper, this alone cannot guarantee the program will survive the end of externally funded assistance. It is the people involved who determine the vitality of any program. During the life of a project, every effort must be made to seek out good people and work hard to get them interested in extension forestry and training. Having them assigned to the school is paramount. Even though an improved infrastructure will tend to draw people, it is important to work against the school becoming staffed with bureaucratic dead wood. To this end, it is vital to maintain open collaborative relationships with government authorities and decision makers.

It must also be recognized that the resulting training program will be a mixture of ideas and very much a compromise. New teaching techniques and courses will be tempered by local social and political realities. In French West Africa this means that as much as it is agreed that the forest service should become extension oriented, this will not be achieved by eliminating entirely its paramilitary character. Dinderesso can help create a new type of forester, who feels at home and can work in a rural setting, but he will still wear fatigues and will still keep a gun.

Fourth, the problem of recurrent costs constantly haunts development efforts. This is especially true for forestry schools, since Sahelian governments cannot support them at levels comparable to similar establishments in developed countries. They lack the means and also have other priorities. Each purchase of new equipment or vehicles, construction of every new building, must be preceded by the question: Can the local government support this?

A striking example at Dinderesso was the installation of small air conditioners in one room of each staff housing unit. Even though the total electric bill for the use of the fans, lights, and electrical installations for the entire Dinderesso School is less than what is often paid for a single expatriate home, the local government recently decided it was excessive and more than the budget could support. The government instructed the school's director to disconnect most of the air conditioners.

There are ways, however, for a field agent forestry school to supplement income and at the same time provide educational opportunities for its students. A vegetable garden and orchard can provide not only food but also the chance to practice skills students will need to work as forestry extension agents. In

the same vein, but depending on the locale, a small-scale fish raising or bee-keeping operation could be established. A student-run nursery providing reforestation and fruit tree species could be both profitable and instructive.

If the school is located near a national forest, arrangements could be made for part of the forest to be placed under the school's management. Developing a management plan and carrying out silvicultural operations would add a very practical aspect to traditional courses. Sales of posts, poles, firewood, and charcoal could augment income and teach students about forest product marketing. This idea has already been tried at the Forestry Agent School in Ziguinchor, Senegal, and seems to be working well.

Finally, tight management over project resources and commodities from the beginning will help establish a tradition that it is hoped will remain and lessen the burden of recurrent costs.

Fifth, for a forestry school to become truly extension oriented, there needs to be a program of practical training. In the Sahel, the shortage of forest service personnel and the overwhelming need for extension work give forestry schools an opportunity to assist villages directly in the area surrounding the school. In this way class lessons can be applied in the field. Yet, there must be an ongoing coordination of effort so that the program develops over time and does not merely use the villagers as passive actors in a training exercise.

Sixth, there is a tendency for field agent level forestry schools to become isolated from new developments in the discipline. Close contacts between school staff and other forestry projects, research organizations, and the parent ministry should be promoted. In this way the teaching staff can renew its knowledge and update courses. Teachers also can be encouraged to conduct appropriate research projects themselves, which could be incorporated into field work exercises.

The Institut Superieur Polytechnique of the University of Ouagadougou plans to conduct a two-month training camp each year for its students at Dinderesso. It is hoped that this interaction between the faculty and students of both schools will help stimulate new ideas and better teaching on both sides.

The forest management component of the Forestry Education and Development project is developing an applied research program in the Dinderesso Forest. It is planned for the students and teachers to become regularly involved in these activities and eventually in the implementation of the forest management plan.

Seventh, there need to be changes in civil service procedures for the recruitment of forestry students in Sahelian countries. In some circumstances, admissions tests might be administered at more than one center in order to give more opportunity to candidates from rural areas. Burkina Faso has, in fact, recently added a second center at Bobo-Dioulasso. It is hoped that this trend will continue, so that other regional capitals will also give civil service tests.

In the past, once a student was admitted to the school, he was fairly well

assured of completing the program and getting a job. To improve the quality of training, schools must become more rigorous in evaluating their students. New entrants could be screened in a three- or four-week "*stage de motivation,*" whereby those who had passed the entrance exam would work in the forest under the supervision of the teaching staff. At the end of the program, students who find they do not like forestry could leave without losing face, and unsuitable candidates could be dropped before a great deal had been invested in their training. This idea has been tried in Senegal, but difficulties in paying candidates (the government did not recognize the procedure officially) and resistance from local staff make it uncertain whether this weeding out process will continue.

Finally, traditional teaching methods rely heavily on dictation of class materials to students from a "*cahier de roulement.*" This system, aside from being prone to copying errors, tends to reduce teaching to a bare minimum of getting through lesson notes. Any project assistance should envision developing a series of text/workbooks that can be produced and distributed to students. These can be used with a variety of classroom exercises to provide the students, as efficiently as possible, with the basic theoretical material they need. Such books can help complement the field work program by serving as introductions and summaries of procedures. They should not be developed as self-teaching guides, but should serve as a tool for *active* teaching.