6-1-8

PN-AAQ-704
ISN 36026

REPLENISHING THE WORLD'S FORESTS:
TROPICAL REFORESTATION: AN ACHIEVABLE GOAL?

By JOHN S. SPEARS*

"Since there are countless ways to go wrong, but only a very few ways to do right, our best chance to deal successfully with our contemporary problems and those of the future is to learn from the success stories of our times." (René Dubos)

SUMMARY

The issue of tropical deforestation has received considerable publicity in recent forestry literature and in the international press, e.g. Myers. (1) U.S. 2000 Global Task Force. (2), National Geographic (3), etc., but little mention has been made of the extent to which reforestation might be able to compensate for such deforestation. This paper highlights past reforestation achievements and examines some of the main constraints. Twenty developing country reforestation 'success stories' are analysed and the reasons for their success briefly summarized. Ten of these relate to farm forestry in situations where fuelwood, fodder, building poles and other forest products are being grown for indigenous consumption; the other ten are examples of industrial plantation forestry.

The intention of the analysis is not to engender a spirit of complacency about the negative ecological and human impact of deforestation, which remain a matter of considerable concern to many developing country governments, but rather to restore a sense of balance to the tropical deforestation dialogue; to focus on reforestation problems which still have to be overcome and to examine the level of resource commitment needed to help developing countries to move more rapidly towards a goal of self-sufficiency in forest product needs.

The World Forest Area is Declining: True or False?

The publicity given to tropical deforestation has led to international concern that the world may be running out of wood. But certainly in the case of industrial wood, this is not so, nor need it be the case for fuelwood. To put that issue in perspective, a distinction has to be made between the situation in the temperate and tropical regions. Over half of the world's forest is located in the temperate region (see Annex 1). This includes the forests of North America, Europe, the USSR, China and Oceania. While these regions have large volumes of both hardwood and softwood, the softwoods are predominant. Analysis of FAO data on the forested area in the temperate regions between 1950–80 indicates that while the individual regions show fluctuations over the period, the aggregate picture is one of reasonable stability. Over the 30 year period analysed, the temperate forest area increased by about 2%, the largest increases occurring in Europe, China and Oceania. Growth in these areas offset declines in North America, while the total forest area in the USSR was reported to remain constant. It is the temperate region forests which have been the world's principal supplier of industrial wood providing about

*John Spears is Forestry Adviser to the World Bank based in Washington DC. This paper briefly summarizes the interim findings of a larger ongoing study which is being prepared for the next World Forestry Congress. It is not an official statement of World Bank policy.

75% of the world's industrial wood needs in 1980. North America and the USSR supply well over half of the world's total industrial wood.

By contrast, the forest area of the tropical regions is declining although at a slower rate than suggested by many observers. A comprehensive examination of the issue was carried out in 1980 in an FAO/UNDP study (Annex 4) which examined the extent and rate of tropical deforestation in 76 countries for 13 of which satellite imagery provided fairly accurate information. In this study, it was concluded that deforestation is occurring in the closed broadleaved forest at a rate of about 7 million ha or 0.6 per cent per year. The rate of deforestation is almost identical for Latin America, Africa and Asia. When other forest types in the tropics are included (that is open, savannah, bamboo and temperate forests, etc.), the total area being deforested annually is estimated to be 11 million ha. The principal cause of such deforestation is clearing of land for agricultural cropping. Importantly, this study indicates that the rate of decline in areas of undisturbed or virgin tropical rain forest is only 0.27% annually,[1] i.e., a far lower rate than implied in some of the recent literature. In short, as Sedjo and Clawson (Annex 5) have pointed out, current concern over the imminent loss of some of the world's more important plant genetic resources, may be exaggerated.

Despite this more reassuring assessment of the rate of deforestation, global statistics can be highly misleading. Thus, notwithstanding the fact that the forest area in the temperate region is increasing, Italy, UK and Japan are all substantial net importers of wood and are likely to remain so for many years to come. In the developing world, FAO studies of the current status of fuelwood supply and demand in developing countries identified 24 countries as containing substantial areas in which a state of "Acute Fuelwood Scarcity" exists.[2] On the other side of the coin, the forest resources in Zaire, Gabon and Surinam, for example, are so large relative to population density and wood demand, that the countries could remain self-sufficient in wood well into the next century even if nothing were invested in compensatory reforestation or forest management. Clearly, to obtain a more precise picture of the impact of tropical deforestation each individual country's resource situation has to be looked at separately and a relative wood supply and demand balance calculated both for non-industrial and industrial wood.

Reforestation "Success Stories"

A preliminary indication of the extent to which reforestation might be expected to compensate for tropical deforestation can be obtained by taking a look at those developing countries which are successfully tackling the deforestation issue via a vigorous program of reforestation and seeing what can be learned from those experiences. In this paper, 20 developing country reforestation 'success stories' have been analysed and the main reasons for their success identified. Major bottlenecks and constraints to further progress were also examined.

Ten of the examples related to farm forestry[3] in which the primary emphasis is on

[1] The FAO/UNDP study (4) suggests that at the current rate of destruction, the area of closed tropical rain forest will decline from about 1 billion ha to about 900 million ha by the year 2000.

[2] The FAO study suggests that the number of developing country people living in a state of 'acute' fuelwood scarcity, which was 100 million in 1980, will rise to 350 million by the year 2000 unless steps are taken to increase supplies and to reduce consumption.

[3] In this paper the term 'farm forestry' is used to cover what are variously referred to as 'Social', 'Community', 'Rural' and 'Agro-forestry' programs. The differences between them are mainly semantic. Their common factor is that they focus on reforestation of farmlands and wasteland situated outside government managed forest 'reserves'.

production of fuelwood, fodder, building poles or other minor forest products needed for indigenous consumption. They included China, Rwanda, Korea, Nigeria, Malawi, Haiti, Nepal, Niger, Pakistan and India (Gujarat, Uttar Pradesh and West Bengal States). Some of the examples given related to country wide reforestation programs (China and Korea). Others, such as Malawi, Haiti and Rwanda, are small scale experiences, the success of which point the way ahead for future planting on a larger scale.

The remaining ten were industrial reforestation programs aimed at production of industrial roundwood for manufacture of pulp and paper, lumber or wood-based panels. The examples cited are Brazil, Chile, Kenya, Zambia, Swaziland, Philippines, Ivory Coast, Bangladesh, Burma and Portugal.

The conclusions drawn are derived partly from monitoring and evaluation studies of on-going reforestation programs being supported by the World Bank (in 16 out of 20 countries listed) and partly from studies carried out by individual Governments, by FAO and other agencies. Some of these experiences have been monitored over a period of 10-15 years, whereas other projects have only recently become operational. The conclusions drawn should, therefore, be treated as interim observations, subject to modification as further experience is gained.

Farm Forestry "Success Stories"

The factors which appear to have been responsible for the success of the farm forestry examples are:

Strong political commitment to reforestation and allocation of necessary human and financial resources to achieve large scale rural tree planting (China).

A tradition of communal self-help response to implementation of rural development projects across the board including forestry (Korea).

A shift in the emphasis of rural afforestation programs towards tree planting by individual farmers on their own homesteads (i.e., farm forestry) in addition to plantation forestry (India, Philippines).

Systematic use of sociological surveys carried out at the household and community level in order to determine people's likely response to tree planting, their attitudes towards selection of species and other critical issues at the outset of project development (Nepal). It is encouraging to note the increasing emphasis being given in such surveys to involvement of women in the decision making process.

The positive, and in many cases, spontaneous response of small farmers or communities to the commercial incentive of rising prices, particularly for fuelwood and poles, and the perception that farming fast growing, short rotation trees as a cash crop can be as profitable, as farming some of the traditional agricultural cash crops (Pakistan, India, Haiti).[4] The incentive of private ownership of trees seems to have been a decisive factor in the willingness of individual families in Sahelian zone countries such as Niger to protect planted trees from grazing animals.

Development of an adequate network of tree nurseries throughout the rural areas so that people do not have to walk far to secure a supply of trees for planting on the farm or in a village woodlot and a willingness of rural afforestation agencies to

[4] A recent household survey of some 2,700 rural households in Malawi, for example, indicated that 39% of the households sampled had voluntarily planted trees.

sub-contract nursery operations, to private farmers, schools or to non-governmental institutions interested in growing trees for sale (Gujarat, India).

Distribution, or sale of tree seeds to farmers for direct sowing (particularly for boundary planting) which can reduce establishment costs to a very low figure. This technique is being increasingly used in countries such as India, Malawi and Haiti. Similarly, low cost seedling nursery production techniques, such as the 'basket' system, result in seedling costs of something in the order of US$3 per thousand compared to more traditional methods of seedling production in, e.g., polythene pots which cost upwards of US$30 per thousand.

The demonstration impact of Government sponsored rural afforestation works such as the roadside and shelterbelt planting programs, e.g., in China and India which have had a positive influence on communities and farmers' receptivity to rural tree planting. The potential for using mass media for promoting tree planting is becoming more widely recognized. Top level political support for rural reforestation has had a positive impact on public attitudes to tree planting in several of the countries examined.[5]

The establishment of an effective low cost extension service for farm forestry which experience from several countries would suggest can most effectively be done by combining forestry with agricultural extension (China, Malawi) and by involving village people as extension agents (West Bengal, India).

Provision of credit, cash or other incentives which can ensure small farmers taking up tree crop farming the means of subsistence pending trees reaching harvest age (Philippines). Combining tree planting with planting of intercropped grass or fodder shrubs, provides a source of fodder for farmers' livestock and is likely to have significant impact on the farmer's willingness to plant trees.

The assurance of proven technical packages for rural afforestation including, wherever possible, a wide range of multipurpose, both indigenous as well as exotic, trees. Technical success stories are highly correlated with the existence of climatic and ecological conditions favorable to establishement of rainfed tree crops (Korea, Philippines) or to a degree of dependence on irrigated farming systems (Guuarat, India).

An overriding conclusion which can be drawn from a review of these farm forestry success stories is that the most rapid progress has been observed in those countries in which either there has been a very strongly developed tradition of community oriented involvement in rural development works across the board, or in situations where increasing scarcity of wood and rising prices have led to spontaneous tree planting by farmers or local communities, backed up by a government decision to shift the emphasis in development towards low cost tree seedling delivery mechanisms and to strengthening of forestry extension services.

A second noteworthy phenomenon is the improved perceptions by forestry agencies that traditional plantation forestry management systems which are mainly concerned with maximizing stem volume, are inappropriate for farm forestry, in which major emphasis needs to be placed on maximizing branch wood volume. Although few systematic studies have been carried out on this subject in developing country environments, those which have all indicate that sustainable branch wood volume is

[5] The personal interest in forestry of former President Park of Korea, First Lady Marcos in the Philippines and of Mrs. Indira Gandhi in India are good examples.

4

likely to be ten times or more that of stem volume. By adoption of pollarding or other systems of management which rely on periodic lopping of branches for wood or fodder, or by use of close espacement short rotation coppicing systems, much higher yields can be obtained than through conventional forest management systems, which depend on periodic clear felling of the whole tree and removal of the total stem and branch volume.

Fishwick has indicated how planting about 30 *Neem* trees on farms in Northern Nigeria which were allowed to reach a reasonable size (over 12 years) and then pollarded and periodically lopped for fuelwood, have adequately supplied an average rural family's domestic and fuelwood needs for the last 15 years. This is less than one tenth of the number of trees that would be needed from conventional fuelwood plantations being managed for maximization of stem volume. Similarly, Ghosh in India has demonstrated how in West Bengal an area of 20 × 20 m of closely spaced (1 × 0.5 m) biannually cropped *Leucaena* can supply a family's fuelwood and fodder needs.

Farm forestry can be a relatively low cost operation (e.g. direct establishment and maintenance costs of about US$250 a hectare over one rotation), of which as much as 70% could be the value of the family's labor unit. To plant (say) 100 trees around the homestead or along a farm boundary is, at most, two to three days work. Such tree planting activity can, if necessary, be phased over the period of the rainy season, and thus need not necessarily conflict with agricultural labor requirements.

The relatively low cost of farm forestry planting is a significant factor in planning rural afforestation programs and can make a profound difference to investment requirements. Not only does the farm forestry approach make it possible to cover something in the order of five times (or more), the number of farm families for a given investment, but the end results are likely to be much more effective in terms of ensuring that the fuelwood, poles and fodder being grown are physically available on the farm homestead where they will be utilized, rather than having to be transported there from a fuelwood plantation situated some distance away.

In addition, farm forestry generally yields higher economic rates of return than traditional forest plantation investment. Studies of that issue carried out by the World Bank in countries such as India, Philippines, Kenya and others, indicate establishment including administrative and overhead) costs in the order of US$800–US$1.300/ha (1983) and economic rates of return in the range of 10 to 15%. By contrast, in most of the farm forestry projects financed by the Bank, total establishment costs range from US$200–US$500/ha (1983) with rates of return in the order of 25 to 30%. This is mainly a reflection of lower infrastructure and overhead costs.

Notwithstanding the bias in this paper towards low cost farm forestry; in the planning of rural afforestation programs, an appropriate balance is called for between on farm planting and plantation forestry which still has a vital role to play, particularly in providing a demonstration effect to encourage farmers and communities to take up forestry and a seed source for rural planting. Also, in some situations, to ensure the needs of urban populations for fuelwood and charcoal, Government plantations can provide a partial solution for meeting the fuelwood and building pole needs and providing employment for the landless.

Problem Areas in Farm Forestry

Ensuring adequate supplies of fuelwood building poles and fodder for the landless, who, in some developing countries, number more than 25% of the population, is probably the most difficult forest policy issue that most developing country governments face. Various approaches have been tried, such as Government sponsored establishment of roadside plantation or woodlots with preference in allocation of employment and output

to landless families. In West Bengal, India, small plots of Government owned wastelan are being allocated to landless families for tree planting.

The problem of creating viable employment for the landless is an issue which can onl be resolved by general economic growth, by movement of people out of the rural area into industrial employment, by resolution of inequities in land distribution, by growth o the service sector, by development of markets for processed primary products and b other development oriented interventions. Forestry's role in this area will remai marginal. Nevertheless, in absolute terms, the number of landless who could b absorbed into afforestation programs could, in some situations, be quite significant, fo example, if half of India's 20 million ha of degraded forest land were to be parcelled ou to say 5 million landless families for cash crop tree farming (2 ha per family), about 2 million people would benefit.

A second constraint is that of how to provide effective incentives for persuading smal farmers to take up tree planting in remote areas where they do not have access to cas markets for fuelwood, poles or other forest products, and where the main purpose o such tree planting is to create a supply of wood for domestic consumption, which in th case of fuelwood, for example, would substitute for the burning of animal dung or cro residues or save time spent on fuelwood collection. In such situations, there will be greater need for top level political support, promotional efforts and cash or othe incentives to induce farmer or community response.

The "commons" problem is a particularly difficult issue as it affects the willingness o rural communities to cooperate in the establishment of village woodlots, and to protec them from grazing animals (Noronha). So far, most attempts to transplant the successfu 'community' based Chinese and Korean woodlot models into other parts of th developing world have failed. As O'Keefe observes, the reality has to be faced that man developing countries are in the process of political transition which has see consolidation of capitalistic modes of production in the rural areas. In thi transformation, land has been privatised and 'community spirit' severely eroded Discussing the impact of such developments in a Kenya context, he comments:

> "It is impractical to suggest that energy (fuelwood planting) supply policies shoul seek to function through communally based organisations that have already bee destroyed."

World Bank studies of that issue indicate that uncertain land tenure situations hav certainly had an adverse impact on farmers' attitudes towards tree planting in severa countries, e.g. Pakistan (Haryana), India (Eastern Uttar Pradesh) and Tanzani (Tabora).

The intractible climatic and ecological conditions prevailing in many semi-arid zone in the developing world, such as in the Sahel region, make large scale tree plantin difficult, particularly where there is a need for introduction of mechanised deep rippin of lateritic soil pans so as to allow root penetration. The larger plantation area needed t produce significant quantities of wood in such arid zone environments can be a deterren to small farmer and community involvement in tree planting. In these arid zones, it i unrealistic to suggest that reforestation can make more than a limited contribution t future fuelwood needs. World Bank studies suggest that in the case of Niger, fo example, that contribution might be less that 35% of future rural energy needs.

Finally, there is the overriding issue of the need for sustained governmen commitment to rural forestry programs. Inadequate budgetary allocations for tre planting remain a major constraint to progress in most developing countries Considerable time may be needed to build up the necessary rural infrastructure needed to support expanded farm forestry programs and to train sufficient extension staff. I

may take anything from five to ten years to create the appropriate sociological and institutional framework before rural tree planting takes off on a large scale, although when it does, self-sufficiency in fuelwood may be achievable in a comparatively short time. (Korea).

(A) Industrial Reforestation Success Stories

The principal factors which seem to have been responsible for the success of the industrial plantation projects examined in this paper are:

Adequate investment in research into plantation establishment and management techniques before industrial planting on a large scale was commenced (Zambia, Bangladesh, Burma).

The favourable climatic and ecological conditions for plantation forestry (all examples quoted).

High standards of site preparation and plantation maintenance and management—particularly weeding (Portugal) and fire protection (Kenya and Zambia).

Achievement of significant productivity gains either through introduction of exotic species or by genetic improvement (Zambia, Brazil).*

The willingness of governments to allocate land title to individual tree farmers growing trees as cash crop and the incentive of private ownership (Philippines).

Introduction of very short rotation industrial species such as *Albizzia* and *Leucaena* which, in appropriate ecological conditions, can produce merchantable wood and a significant income for small farmers in five to seven years compared with more traditional industrial plantations rotations in the order of 25 to 30 years (Philippines).

Clear definition at the outset of a plantation program of the end use objectives and early commitment to construction of the necessary industrial plant to utilise project output (Swaziland, Kenya).

Sustained political commitment of the government of the countries concerned to carry through an industrial plantation program with the objective either of ensuring domestic self-sufficiency (Kenya, Zambia), or aimed at sustaining an export trade in forestry products (Ivory Coast, Burma, Portugal).

Perhaps the most noteworthy aspect of the industrial examples cited in this paper is the fact that some of the countries cited, such as Kenya, Zambia and Brazil, have been able to satisfy domestic industrial wood requirements from fast growing plantations in a relatively short time span. Industrial plantation programs in Chile, Kenya and Zambia, for example, took less than 20 years to produce enough wood fully to supply domestic requirements. Within the last 15 years, Brazil has planted enough trees to meet nearly 60% of its domestic requirements and within another 5 to 10 years, could be fully

* In Zambia, for example, where the exotic species *Pinus kesiya* was introduced some 20 years ago, yields of something in the order of 15 m^3 per ha per annum have been achieved which are ten times greater than those of the indigenous *Brachystaegia* woodlands which formerly provided most of Zambia's industrial wood requirements. In the area of genetic improvement, spectacular gains are being achieved in Brazil and Congo PR with vegetative propagation of *Eucalyptus*. Yields of something in the order of 30 to 40 m^3 per ha per annum have been obtained compared with 20 to 25 m^3 from unselected stands.

self-sufficient in all industrial wood needs from plantation forests situated close to th main urban and rural populations in the southern and eastern half of the country.

Of importance to the tropical deforestation dialogue is the fact that in countries suc as Brazil,[7] Chile and Kenya compensatory plantations have already contributed t taking pressure off the natural forest and opened up the possibility for the government concerned to set aside considerable areas of natural forest, either as nature reserve national parks or purely for water catchment protection. A considerable part of Kenya' forest estate, for example, has already been designated for such purposes.

Industrial Reforestation: Problem Areas

A commonly encountered constraint to acceleration of the current rate of industria reforestation in developing countries is land availability, particularly where there is hig population density and competition for land between agriculture and forestry (Kenya) and especially in those countries where a high proportion of the land suitable for forestr is under fragmented private ownership (Portugal and much of Latin America). Th successful attempts being made to tackle that problem in Portugal by the introduction o reforestation cost/revenue sharing contracts between local communities and th Government, are particularly noteworthy.

Given the fact that it takes 20 to 25 years in many countries to grow industrial tre crops to merchantable size, this long time period before any income is obtained can act a a disincentive to small farmers participating in industrial forestry. As a corrollary of this there is a need in some countries for more adequate incentive programs to induc farmers to take up reforestation and to stimulate interest in industrial forestry.[8]

Economies of scale in the pulp and paper industry dictate that a large area o plantations (100,000 ha or more) may be needed to sustain the wood requirement of mill of economic size. Because of the sensitivity of pulp mill rates of return to wood cost such plantations should, ideally, be established within a 100 km radius of a propose pulp mill for it to be economically viable and to ensure a reasonable stumpage return t the tree grower. Since the pulp and paper industry is highly site specific, particularly i relation to water requirements, locating an appropriate mill site, which coincidentally, i in the center of a potential planting area with low population sensity, may be difficult.

The risks of fungal or insect diseases which are associated with large scale plantatio monocultures, have created problems in some countries (e.g. *Dothistroma pinii* i Kenya and the ravages of the Pine Shoot moth in Philippines).

Despite misgivings that plantation monocultures may not be sustainable and tha exhaustion of soil fertility is an ecological risk, most studies indicate that the betwee rotation levels of fertilizer application needed to maintain soil fertility are significantl lower than those commonly applied to agricultural cropping. Fertilizer application ha become routine practice in many developing country reforestation programs.

[7] Brazil's 4 million ha of plantations already supply nearly 60% of the country's industrial woo needs — the 280 million ha of Amazon forest, less than 10%. Within a decade, Brazil will be able t supply all industrial wood demands from plantations and were it not for the threat of continue agricultural encroachment, it would be possible, in theory, to freeze the remaining Brazilia Amazon forest resource as a biotic preserve. Similarly, in a Latin American regional context industrial plantations covering one per cent of the total forest area already supply one third of th entire region's industrial wood needs.

[8] Such incentive programmes are a common feature of government forest policy in many wester European and are particularly well developed in the Scandinavian regions.

Finally, there is the same problem as that cited above for farm forestry, namely that of securing adequate government political commitment and the sustained budgetary support for carrying through industrial reforestation programs to maturity. In a global climate of scarce capital resources, forestry is nearly always competing with shorter term options such as food or cash crop production, education, health, transportation or other politically more attractive development projects.

Economic Rates of Return for Reforestation Investments

Notwithstanding conventional wisdom that economic rates of return from forestry plantations are low, the World Bank's experience suggests that this need not necessarily be a constraint to forestry investment. Annex 1 summarises investment costs and economic rates of return for some 35 afforestation or reforestation projects financed by the Bank over the period 1968–80 and covering an area of about 1 million ha. Investment costs ranged from US$250 per ha (Philippines) to US$6,000 per ha (Niger). The economic rates of return in all cases cited are higher than 10% and, in some cases, in the order of 25 to 30%.[9] The lowest investment costs and highest rates of return have been achieved in situations where small farmers were prepared to take up cash crop tree farming with fast growing, short rotation species.

Sufficiently high financial rates of return to induce private sector investment in industrial plantation forestry have been clearly demonstrated in countries such as Philippines, Kenya, Chile and Brazil. In the case of industrial energy plantations, satisfactory financial rates of return have been demonstrated for charcoal plantations, for example, in Brazil, and for fuelwood plantations to supply urban markets in Malawi and many other countries. Prospects for industrial scale energy plantations for dendrothermal power generation in some countries seem promising and studies are under way of the potential for replacing oil with whole wood, charcoal or compressed wood briquettes or pellets.

Developing Countries' Reforestation Programs: Current Status

Currently the world's plantation area is about 100 million ha, of which about 30 million ha are located in China and 13 million ha in the rest of the developing world.

The area of fuelwood plantations in the developing countries, excluding China, in 1980, was about 4 million ha and this is currently being added to at the rate of about 500,000 ha a year[10] which will increase the total area by a further 10 million ha by the year 2000. This compares with a 1980 World Bank study estimate of an additional 50 million ha needed by that year to ensure a reasonable degree of self-sufficiency in fuelwood.[11] In other words, the current rate of reforestation needs to be increased about five-fold. While at first sight this sounds a formidable target, the achievements of China and Korea and the encouraging progress being made in India and several other countries, suggest that a significant increase in the current rate of planting could be achieved, particularly if the emphasis can be shifted towards low-cost farm forestry.

In the case of industrial plantations, the current area of plantations in the developing

[9] These are economic rates of return which are based on evaluation of the economic benefits of reforestation programs to the national economy of the country concerned.

[10] This is based on Government estimates of the area being reforested annually and may be an underestimate because in some countries it does not take into account spontaneous tree planting by individual farmers, the area of which is difficult to quantify.

[11] Over and above that part of demand which can be met from more intensive management of natural forests and also deducting savings in consumption via conservation and wood substitution.

9

countries is about 9 million ha which is being added to at about the rate of 470,000 ha a year. Allowing for currently planned increases, this will reach about 21 million ha by the year 2000. Sedjo and Clawson (5) have pointed out the great potential of plantation forestry to contribute to society's industrial wood needs, calculating that in theory all of the world's industrial wood needs in the year 2000 could be supplied from about 140 million ha of well managed plantations, i.e., only 5% of the world forest lands. As already noted, some countries, e.g. Kenya, Brazil, Zambia, Chile and Malawi have already demonstrated that domestic industrial wood needs can be satisfied within a relatively short period from a comparatively small area of industrial plantations, and there is good reason to expect that many others will follow suit during the coming decades.

For example, Annex 3 summarises the actual progress being achieved in 38 farm forestry and industrial reforestation projects spread over 27 developing countries. Actual planting has exceeded 80 per cent of target in 33 cases (86 per cent). Only two projects record planting achievements below 50% of the projected target. Reported survival rates exceeded 80% in 35 out of the 38 projects being monitored. These projects which cover about 25% of the area of all ongoing developing country reforestation programs (excluding China), provide a hopeful indication that, given adequate budgetary support, the necessary degree of political commitment and in the case of social forestry, a shift towards lower cost reforestation methods, then certainly many developing countries should be able to respond to this challenge and move towards a goal of self-sufficiency. The chances of achieving this will be greatly improved if, in addition to reforestation efforts, simultaneous emphasis is given to upgrading the productivity of remaining natural forest stands; secondly, to adoption of conservation oriented technology such as more efficient wood burning stoves; and, thirdly, to energy policies which temporarily take the pressure off scarce wood resources (e.g. subsidised kerosene or bottled gas in urban townships such as Lagos in Nigeria).

Investment Requirements: The Role of the Donor Community

While the main thrust of future reforestation efforts must come from the grass roots level within the developing countries themselves, external aid can play a significant role. The current level of external aid funding for reforestation in developing countries as a whole, is some US$200 million a year, of which the World Bank contributes about 60%. The support for forestry by other development banks, UNDP and bilateral donors, has been steadily increasing. Taking into account absorptive capacity constraints at the country level and the time needed to create the necessary rural infrastructure and to secure local community and farm support, external aid to forestry could probably be doubled over the next five years and increased in the medium term (say) five-fold. In mobilizing external aid funding, a particular important issue will be the willingness of donors to fund a high proportion of local currency costs. (In most industrial reforestation programs, the foreign exchange component is quite small (25%) and in farm forestry, less than 10%.)

That external aid can be a significant factor in assisting developing countries to achieve an increase in the rate of reforestation, seems a reasonable assumption. Post hoc analysis of the impact of forestry loans (including recipient country's own perception of the positive and negative aspects of development bank involvement), suggest that even in developed countries like Finland, the World Bank's support has made it possible significantly to step up the rate of reforestation compared with past achievements, also to secure more sustained local funding.

A positive response to reforestation needs by the development banks is highly dependent on a sustained technical assistance input for institution building which has

been traditionally provided by UNDP and bilateral donors. These have made a major contribution to developing the human and institutional infrastructure needed to support larger scale reforestation programs. These two aspects of donor aid, i.e., investment and technical assistance are entirely complementary and both will need to be sustained and increased if the targets outlined in this paper are to be achieved. Co-financing of forestry development programs between development banks and technical assistance agencies has been successfully achieved in several developing countries and is a formula which could be more vigorously pursued.

Ecological and Environmental Considerations

The observation was made at the outset of the paper that it was not the intention to engender a spirit of complacency about the tropical deforestation issue. The negative ecological and environmental impact of deforestation remain a matter of very real concern to many countries, particularly the need to preserve genetic resources, to slow down the rate of agricultural encroachment into tropical rain forests, to protect the habitat of forest dwelling people, to preserve wildlife resources, and in upland areas, to protect those catchment area forests which play a major role in regulating downstream water flow. While the overall situation, especially in relation to preservation of genetic resources, may be less alarming than suggested by some observers, the fact remains that with increasing population pressure in the developing countries, the remaining tropical rain forests are certain to come under threat and substantial areas could disappear in the longer term if remedial action is not taken.

Probably the most critical issue is that of how to provide the 200 million people already living in or adjacent to the tropical rain forest with a viable alternative to forest settlement. The best hope in this area lies in improving the productivity of agriculture in areas outside the tropical rain forests such as the 'Cerrado' of Brazil[12] and 'alang-alang' grasslands of Indonesia. Perhaps one of the more encouraging indicators of the potential in this area is the fact that over the last decade 40% of developing countries incremental food production has come from increasing per hectare yields on existing agricultural lands by use of improved seed varieties and judicious use of irrigation water and fertilizers.

In relation to preservation of what remains of the tropical forest eco-system, a major issue of concern to forest policy planners is whether the 20 countries which contain the bulk of the world's remaining economically accessible tropical timber resources will have the political will to resist economic pressure to mine those resources as a source of easily earned foreign exchange. As the examples cited in this paper demonstrate, the opportunity exists for all of those countries to more than compensate for the potential wood production of the tropical rain forest by establishment of forest plantations of either industrial, utility or high value species. The attention being given to this type of plantation forestry in countries such as Brazil, Ivory Coast, Burma and others, suggest that the Governments concerned are already highly aware of the importance of this issue. Given adequate investment in compensatory plantations, the prospect of preserving a substantial part of the rain forest, either as national parks or biotic reserves would be reasonably good, provided that at the same time effective policies could be devised for avoiding further agricultural encroachment. To help preserve what remains of the tropical rain forest and to ensure future self-sufficiency in wood requirements, the developing countries will need all the external aid assistance and moral support they can get from the richer nations of the North.

[12] Savannah forest lands which, in general, overlie better soils for agricultural development than the acid latosols of the tropical rain forest.

REFERENCES

MYERS, N. (1980) "Conversion of Tropical Moist Forests". Prepared for the Committee on Research Priorities on Tropical Biology of the National Research Council. National Academy of Sciences, Washington DC, USA.

"The Global 2000 Report to the President of the United States of America": U.S Government Printing Office.

WHITE, P. T. (1983) "Nature's Dwindling Treasures: Rain Forests". *National Geographical Magazine*, Vol. 163, No. 1, January 1983, p. 3.

LANLEY, J. P. and CLEMENT, J. (1979) "Present and Future Natural Forest and Plantation Areas in the Tropics". *Unasylva*, Vol. 31, 1979. No. 123, pp. 12–20.

SEDJO, R. and CLAWSON, M. (1983) "Global Forests". Resources for the Future Washington DC.

FISHWICK, R. E. "Neem Plantations in N. Niger" (1965) and Personal Communication (1983) World Bank, Washington DC.

GHOSH, Dr. R. C. Personal Communication (1983) Dehra Dun, India.

NORONHA, R. "Why is it difficult to grow Fuelwood?" *Unasylva*, Vol. 33, No. 131.

O'KEEFE, P. (1981) Background papers prepared by Beijer Institute for the UN Renewable Energy Conference, Nairobi, 1981.

Annex 1 World Forested Area by Region
Annex 2 Reforestation Projects Financed by the World Bank 1968–80
Annex 3 World Bank funded Social and Industrial Afforestation Projects Afforestation Performance compared with Appraisal Targets
Annex 4 Developing Countries Fuelwood Supply/Demand Situation
Annex 5 Developing Countries — Industrial Roundwood Supply/Demand Situation

ANNEX 1

WORLD FORESTED AREA BY REGION (1973)

	Forest Land	*Closed Forest*	*Open Wood-land*	*Total Land Area*	*Closed Forest* (% of land area)	*Total Forest* (% of land area)
	(millions of hectares)				(%)	
North America	630	470	(176)	1,841	25	34
Central America	65	60	(2)	272	22	24
South America	730	530	(150)	1,760	30	41
Africa	800	190	(570)	2,970	6	27
Europe	170	140	29	474	30	36
U.S.S.R.	915	785	115	2,144	35	43
Asia	530	400	(60)	2,700	15	20
Pacific area	190	80	105	842	10	23
World	4,130	2,655	(1,200)	13,003	20	31

Source: *The Global 2000 Report to the President, Technical Report Volume Two*. p. 118
Data on North American forests represent a mid-1970s estimate. Data on U.S.S.R. forests are a 1973 survey by the Soviet government (see Reference 3). Other data are from Persson (1974); they represent an early-1970s estimate. Forest land is not always the sum of closed forest plus open woodland, as it includes scrub and brushland areas which are neither forest nor open woodland, and because it includes deforested areas where forest regeneration is not taking place. In computation of total land area, Antarctic, Greenland, and Svalbard are not included, 19% of arctic regions are included.

TALL FORESTRY LIBRARY

12

ANNEX 2

TABLE 1

RETORESTATION PRODUCTS FINANCED BY THE WORLD BANK 1968-80
RANGE OF INVESTMENT COSTS AND ECONOMIC RATES OF RETURN

	Year of Loan or Credit	Loan Amount US$ Million	Reforestation Area ha	Main Species	Principal End Products		Rotation (years) Eucalyptus	Pulpwood	Sawlogs	Approximate Investment Cost per ha* US$	Economic Rate of Return
Zambia	1968	5.3	8,000	*P. kesiya*	Sawlogs	Pulpwood		15	25	1300	13
Kenya	1970	2.6	25,000	*Cup. lusitanica P. patula*	Sawlogs	Pulpwood		15	25	500	12
Philippines	1974	2.0	10,000	*Albizzia falcata*	Pulpwood			7		200	25
Madagascar	1975	13.5	35,000	*P. kesiya P. elliottii*	Pulpwood			15		385	13
Kenya II	1975	20.0	46,000	*Cup. lusitanica P. patula*	Sawlogs	Pulpwood Sawlogs	10	15	25	1195	20
India, Madhya Pradesh	1976	3.0	3,000	*P. caribaea P. elliottii*	Pulpwood			15	25	1000	20
Tanzania	1976	5.0	16,000	*P. patula P. elliottii*	Pulpwood			15		500	13
Zambia II	1977	17.0	17,500	*P. kesiya Eu. spp*	Sawlogs	Pulpwood		15	25	1200	14
Kenya*	1977	4.4	120,000	*Robinia, Alnus, Leucaena spp*	Fuelwood		5			250	18
Pakistan Hazara	1978	1.7	2,000	*P. roxburghii*	Pulpwood			15	30	400	11
Niger	1978	4.5	400	*Eu. camaldulensis*	Fuelwood		5			6000	11
Turkey	1978	86.2	152,000	*P. brutia, P. nigra, P. pinaster*	Sawlogs Fuelwood	Pulpwood		30	60	300	12
Philippines II	1978	8.0	20,000	*Leucaena glauca, Albizzia spp*	Fuelwood			7		300	22
Brazil, Minas Gerais*	1978	16.0	40,000	*Eu. saligna*	Pulpwood	Fuelwood	12	12		350	18
Burundi	1979	3.6	8,500	*Eu. saligna P. patula*	Fuelwood		10			360	17
Liberia	1979	7.0	1,000	*P. caribaea P. caribaea*	Pulpwood			15		3500	10
Nigeria	1979	31.0	25,000	*Gmelina arborea*	Pulpwood	Fuelwood	15	15		8000	13
Mali	1979	5.0	3,600	*Gmelina and Eu. spp*	Fuelwood		12			1900	11
India, Uttar Pradesh	1979	23.0	52,000	*Eu. Acacia, Dalbergia Magnolia, Madhuca, Morus spp*	Fuelwood	Fodder Poles	5			554	13
Greece	1979	25.0	16,000	*P. nigra, P. radiata, P. pinaster*	Sawlogs	Pulpwood		20	30	1250	21
Jamaica	1979	12.0	10,000	*P. caribaea*	Sawlogs				25	1500	10
Ivory Coast	1979	18.0	20,000	*Terminalia superba and Lophira alata Triplochiton scleroxylon*	Sawlogs	Pulper Logs			25	2000	11
Burma II	1980	15.0	11,000	*Tectona grandis*	Sawlogs	Pulper Logs			60	250	20
Upper Volta	1980	14.3	3,500	*Eu. spp Gmelina*	Fuelwood	Sawlogs	7		25	2000	16
India, Gujarat	1980	17.0	30,000	*Albizzia, Acacia, Bambusa Casuarina Pterospermum, Morus spp*	Fuelwood	Fodder Poles	5			720	17
Malawi	1980	13.6	20,000	*Gmelina Eu. spp*	Fuelwood		8			500	14
Nepal	1980	17.8	11,000	*Alnus, Prunus, Betula, Pinus spp*	Fuelwood	Fodder Poles	10			500	16
Portugal	1980	50.0	150,000	*Eu. spp and P. pinaster*	Pulpwood			15		1000	19
Rwanda	1981	21.0	8,000	*Eu. spp P. patula*	Fuelwood	Sawlogs	10		25	1000	12
Bangladesh	1981	11.0	40,000	*Mangium spp*	Fuelwood	Pulpwood Sawlogs	10	10	20	600	18
Thailand, Northern Agriculture*	1981	2.2	11,000	*Eu. spp Pinus spp*	Fuelwood	Poles	10			227	13
Philippines, Watershed*	1981	45.0	32,000	*Pinus, Leucaena spp*	Pulpwood	Fuelwood		12	20	2300	18
		368.0	1,154,500								

Best Available Document

ANNEX 3

WORLD BANK FUNDED SOCIAL AND INDUSTRIAL AFFORESTATION PROJECTS AFFORESTATION PERFORMANCE COMPARED WITH APPRAISAL TARGETS

Country	Rate of Annual Planting at Outset of Project (ha)	Target Rate of Planting at Project Completion (ha)[1]	Factor by which it was Planned to Increase Rate of Planting over the Project Period[1]	Actual Achievement as a Percentage of Original Target %	Remarks and Problem Areas
(A) Social[2] Forestry Projects					
Korea	50,000	77,000	1.5	112	
Philippines I	800	3,400	4.25	107	
Philippines II	3,400	28,000	8.2	55*	Financial constraints among smallholders, loan size, weakness of extension.
Niger I	Minimal	700	—	100	
Niger II	750	1,730	2.3	80*	Over-optimistic assessment of rate of seedling acceptance.
Burundi	1,500	5,250	3.5	120	
Mali	450	706	1.7	95	
India, Uttar Pradesh	5,040 (plus 20 million seedlings)	12,920 (plus 20 million seedlings)	2.5 1.0	105 160	Less than 50% survived in rainfed areas.
India, Gujarat	14,760 (plus 5 million seedlings)	23,830 (plus 5 million seedlings)	1.6 1.0	110 202	
India, West Bengal	2,600 (plus 5 million seedlings)	15,765 (plus 16 million seedlings)	6.0 3.2	108 150	
India, Haryana, etc.	4,600	20,500	4.4	110*	
Upper Volta	200 (plus 50,000 seedlings)	600 (plus 50,000 seedlings)	3.0 1.0	95 110	
Malawi	2,580 (plus 8.8 million seedlings)	3,000 (plus 8.8 million seedlings)	1.1 1.0	100 20	— Lack of farmer demand; weakness of extension and promotional activities.
Nepal	250 (plus 43,000 seedlings)	5,000 (plus 240,000 seedlings)	20.0 6.7	200 900	— 70-80% survived.
Rwanda	250	2,000	8.0	125	—
Bangladesh	4,000	8,000	2.0	110	—
Senegal	609	1,600	2.6	115	—
Haiti	403	2,000	5.0	80	—
TOTALS	88,780* plus (19 million seedlings)	182,845 (30 million seedlings)	2.0 1.6		

ANNEX 3

Country	Rate of Annual Planting at Outset of Project (ha)	Target Rate of Planting at Project Completion (ha)[1]	Factor by which it was Planned to Increase Rate of Planting over the Project Period[1]	Actual Achievement as a Percentage of Original Target %	Remarks and Problem Areas
(B) Industrial Plantation Projects					
Zambia I	1,195	1,500	1.2	110	—
Zambia II	1,500	1,700	1.3	115	—
Kenya I	4,800	5,000	1.1	95	—
Kenya II	7,400	7,700	1.1	60	Land availability; technical failure of Pine; erratic rainfall; management problems; over-optimistic appraisal targets.
Finland	63,000	126,000	2.0	169	More farmers carried out spontaneous planting using their own funds than had been anticipated.
Madagascar I	4,000	7,000	1.78	110	—
Madagascar II	6,500	6,500	1.0	80	40% of area affected by yellowing and fertilizer deficiency.
Tanzania I	1,500	4,500	3.0	120*	—
Tanzania II	2,000	2,000	1.0	100	Market constraints.
Turkey	56,000	82,000	1.5	111*	—
Liberia	200	450	2.3	63*	Machinery operations, marketing and management problems.
Nigeria	2,000	6,000	3.0	89	Counterpart funding and land clearing problems.
Greece	2,000	4,600	2.3	32*	Bureaucratic delays in securing equipment and land acquisition.
Jamaica	310	330	10.6	52	—
Pakistan	60	1,000	1.0	100	Pilot program.
Ivory Coast	4,000	4,000	1.0	90	—
Burma I	680	2,816	4.1	100	—
Portugal	24,000	33,000	1.34	—	—
Morocco	1,000	7,500	7.5	87*	—
Cameroon	1,000	2,500	2.5	90*	—
TOTALS	168,650	288,096	1.7		

* Projects with an asterisk have only recently become operational.

ANNEX 4

DEVELOPING COUNTRIES FUELWOOD SUPPLY/DEMAND SITUATION

	Africa	*Asia/Middle East and Mediterranean Region*	*Latin America*
Countries in which the natural forest area is large enough relative to population density and fuelwood demand to ensure self sufficiency to beyond 2000 without the need for major investment in fuelwood reforestation.	Cameroon CAR Congo PR Equatorial Guinea Gabon Guinea Bissau Liberia	New Caledonia Malaysia Papua New Guinea Solomon Islands Fiji	French Guiana Guyana Honduras Nicaragua Surinam Trinidad/Tobago
Countries in which reforestation has already ensured self sufficiency in fuelwood through to the year 2000.		Korea	
Countries in which a satisfactory fuelwood situation prevails.	Algeria Ghana Ivory Coast Mauriti Morocco Mozambique Togo Tunisia Zaire	Bhutan Burma Cambodia Kampuchea Laos Portugal Sri Lanka Vanuatu	Argentina Dominican Republic Paraguay Venezuela
Countries in which a medium fuelwood deficit situation prevails.	Angola Comoros Benin Gambia Madagascar Malawi Sierra Leone Swaziland Zambia Zimbabwe	India Indonesia Pakistan Philippines Thailand Turkey Vietnam	Bolivia Brazil Chile Colombia Cuba Ecuador El Salvador Guatamala Uruguay Jamaica Mexico Panama
Countries in which a state of acute fuelwood deficit prevails	Ethiopia Lesotho Kenya Mali Niger Rwanda Somalia Sudan Botswana Burundi Chad Djibouti Mauritania Nigeria Senegal Tanzania Uganda Upper Volta	Afghanistan Bangladesh Nepal Yemen AR Yemen PDR	Haiti Peru

16

ANNEX 5

DEVELOPING COUNTRIES INDUSTRIAL ROUNDWOOD SUPPLY/DEMAND SITUATION

	Africa	*Asia/Middle East and Mediterranean Region*	*Latin America*
Countries in which the remaining area of natural forest could sustain domestic requirements to the year 2000 without the need for major investment in industrial plantations.	Cameroon CAR Congo PR French Guinea Equatorial Guinea Gabon Guinea Bissau Ivory Coast Liberia Zaire	Bhutan Burma Cambodia Kampuchea Laos Malaysia New Caledonia Papua New Guinea Solomon Island	Bolivia Costa Rica French Guyana Honduras Nicaragua Paraguay Surinam Venezuela
Countries in which a sufficient area of industrial plantations has already been established to sustain domestic requirements to year 2000 (3).	Angola Kenya Malawi Mauritius Mozambique Swaziland Zambia Zimbabwe	Fiji Portugal Turkey	Chile
Countries in which a medium deficit situation exists.	Algeria Benin Botswana Burundi Comoros Ethiopia Gambia Ghana Lesotho Morocco Nigeria Rwanda Sierra Leone Sudan Tanzania Togo Tunisia Uganda	Afghanistan Bangladesh China Korea India Indonesia Nepal Pakistan Philippines Sri Lanka Thailand Vanuatu Vietnam	Argentina Brazil Colombia Cuba Dominican Republic El Salvador Equador Guatemala Haiti Jamaica Mexico Peru Panama Trinidad/ Tobago Uruguay
Countries in which self-sufficiency in industrial wood will be constrained by arid climatic and ecological conditions which are unsuitable for rainfed industrial afforestation.	Chad Djibouti Mauritania Mali Niger Senegal Somalia Upper Volta	Yemen AR Yemen PDR	

17