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SOME NATURAL RESOURCE MANAGEMENT
ASPECTS OF COMMERCIAL CULTIVATION
OF HYBRID EUCALYPTUS IN
GUJARAT: INDIA

by

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SOME NATURAL RESOURCE MANAGEMENT ASPECTS OF COMMERCIAL
CULTIVATION OF HYBRID EUCALYPTUS IN GUJARAT: INDIA

Tirath R Gupta *

I. Introduction and Objectives

Since the large scale acquisition of forest lands belonging to the erstwhile princely states and those held by zamindars and jagirdars during the fifties, tree plantation on any major scale in India has been the responsibility of the State Governments. The Governments discharge this function through their respective Forest Departments. Realising the economic, social and ecological significance of the forests, the Government of India's Forest Policy Resolution of 1952 emphasised the need for increasing the area under this form of land use to one-third of the total geographical area of the country. A number of efforts have since been made to increase the area under forests. These attempts included planting of more trees along the national and state highways, canal banks and on waste lands etc. Attempts have also been made to increase the productivity of the existing forests.

In actuality, however, the area under forests in India has been declining rather than increasing. One study, for instance, indicated that between the years 1951-62 the growth rate of the area under forests in

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India was 0.6163 per cent and this was significant at one per cent level of probability (Gupta and Kaul, 1967). A more recent study has concluded that, in the State of Madhya Pradesh alone, some 3.3 million acres of forest land was lost during 1951-72 (Raynolds). This worked out to be 4.4 and 20 per cent of the currently reported area under forests for the country and the State, respectively.

The most important reason for this trend is to be found in the fact that both the annual crops and tree crops use more or less the same natural resources i.e., soil and water. They, thus, compete for land (Government of India, 1976, p.2). To start with, the competition became unfavourable for the forestry sector in India because of the phenomenal rise in population which generated the need for more food as well as increased employment opportunities. More importantly, however, the sad course of events with forestry activity in our country may be best summarised by (i) shortage of appropriate amount of investment resources, and (ii) a lack of conscious effort to generate productive employment. One result of this has been that, in the year 1971, the agriculture and ancillary sectors provided employment to over 70 per cent of the rural work force while forestry and logging accounted for only 0.2 per cent (Government of India, 1972, p.12). In the same year, gross returns per hectare of India's "productive" forests averaged at Rs 21.50 (Ibid). Contrary to this, the average gross returns per hectare of land under cultivation for the years 1968-69 to 1970-71, at current prices, have been estimated at Rs 1,173 (Gupta, 1978).

The situation can change for the better if the quantum of investment in forestry activity is appropriately enhanced. Attempts have been made in the recent past to attract institutional finance for the sector through the Forest Development Corporations. These Corporations have been formed in 16 out of the 22 States of the Indian Union. Appreciation of multiple objectives in forest management is also gaining ground. The process can be considerably accelerated if individual farm entrepreneurs are encouraged to use their managerial abilities and financial resources for the development of the sector. This may be particularly relevant for making appropriate use of the vast tracts of culturable waste lands under the ownership of Government Departments or other public agencies. While appropriate policy decisions in this regard will be required, the farm firms will also need to appreciate the value of diversifying their operations beyond the conventional short duration crops.

A basic objective of this paper is to show that given the needed capital investments and proper management, certain types of land and water resource combinations can generate much more income when placed under trees than under seasonal crops. This objective is sought to be achieved through the analysis of data from a privately owned and managed Hybrid Eucalyptus farm in Gujarat State. Results of the analysis may be expected to facilitate the needed policy decisions for appropriate management of an important segment of our natural resources.

II. The Data

Data on costs and returns of raising Hybrid Eucalyptus were collected from a farm located in Vatva village of Ahmedabad District. The village is situated about 10 kms South of Ahmedabad City and 3-4 kms off the main Ahmedabad-Surat National Highway. Total area of the farm is approximately 195 acres of which 160 acres is presently under Hybrid varieties of Eucalyptus. The entrepreneur first started with eucalyptus in the year 1971 and has gradually reached the current situation. Prior to this, the land was used for the cultivation of a variety of crops, eg., cotton, sugarcane, paddy, wheat, groundnut. These continue to be the main crops of the area. The soil on the farm is of sandy loam type and the water is brackish. Based on discussions with knowledgeable people and scrutiny of the relevant data, it was estimated that any combination of these crops, under the soil and water conditions of the area in general and the farm under review in particular, can provide a maximum net average income of Rs 500 per acre per year.

Eucalyptus can be raised upto 4 or 5 coppices. In the present analysis, however, only 3 coppice crops have been considered after the initial one. Since the farm firm has had 8 years of experience with eucalyptus, the costs of and returns from the main crop have been generalised on the basis of these experiences. The data used for the three coppice crops are partly based on actual experiences of the farmer and partly on his vision regarding the business. The data on costs and returns from the initial crop and the three coppice crops are summarised in Appendices 1 to 4. Some of the items appear to call for explanations which is attempted below.

Before turning to some specific items, however, two points may be noted. Firstly, a coppice crop matures faster than the initial one because of the powerful root stock left behind by the main crop. Thus, while the main crop is expected to mature in 5 years, the coppice ones use only 4 years each. There is a feeling that the market for the output of a coppice crop harvested at 5 years of age may be better. This aspect was not considered in this paper because marketing of the produce has not been a problem and the extra returns were expected to match the extra costs of entertaining the crop for an extra year. Secondly, the farmer has experimented a lot with what was a new crop for him and for the locality when he first started with it in 1971. The data presented here is based on what he considered to be the best practices.

II.1 Fixed Costs

Any business proceeds with some fixed investments in infrastructure and equipment. The farm under reference is served by a barbed wire fence, 2 tubewells, 3 wells, mixture of pucca and kuchha channels and pipelines for irrigation, and one tractor with trailer and other necessary equipment. The farmer also keeps an automobile which is mostly used for the business. At current prices, the entrepreneur estimated the total capital investments on the farm at Rs 400 thousand. Though nearly 35 acres of the farm land is put to various other uses, the whole of the capital investment was assumed to be fully utilised for the 160 acres under eucalyptus. It may also be noted that the capital items mentioned earlier have

varying lengths of productive life. This presented a problem in estimating the annual depreciation of the fixed investments. Following considerable thought and discussions, however, an average annual rate of depreciation of 7 per cent has been considered. The annual depreciation of Rs 28 thousand, thus, appears as the first cost item for each eucalyptus crop.

II.2 Variable Costs

Only a few items in this category appear to call for explanatory notes. Firstly, item 2.7 of Appendix 1 concerns transportation of ready stock of seedlings from the nurseries raised by the State Forest Department to the farm. The seedlings are supplied free of cost but they do cost the society an average of about Rs 50 per 1,000. In this case, the society has agreed to bear this cost in favour of an individual farmer. The costs of raising the nursery have, therefore, been omitted from the analysis of the enterprise. Account is also not taken of the costs for cleaning the land after the cotton crop in the first year. The logic is that the value of cotton stocks can pay for the labour required to take out the same.

Specific mention needs to be made of the irrigation costs. The first irrigation provided in the first year of the main crop is costed at Rs 35 per acre. This includes the labour used for making water channels. Since the water channels did not have to be made for subsequent irrigations, the cost of the three subsequent irrigations for eucalyptus and 12 irrigations for the cotton intercrop in the first year were estimated

at Rs 25 per irrigation per acre. More importantly, the costs per irrigation per acre have been estimated at Rs 30, 35 and 40 in the second, third and fourth years of the crop, respectively. The logic is that the land becomes more and more porous as the eucalyptus root stock goes down and the quantity of water required per unit of area is considerably enhanced. The cost per irrigation per acre is, however, expected to stabilise at Rs 40 and the same amount is charged thereafter in the fifth year of the main crop and the three coppice crops.

Intercultures (item 5.7 of Appendix 1 and items 2.5 in Appendices 2 to 4) may appear to be unnecessary to some people. This operation was, however, necessary to control evaporation losses. On the contrary, the costs of collecting, drying and storage of seed (items 5.11, 2.13, 2.11 and 2.11 in appendices 1 to 4, respectively) @ Rs 10 per acre may appear to be unusually low. But, only 10 kgs of selected seed per acre is collected and handled at an estimated cost of Re 1 per kg.

Cost items pertaining to harvesting the eucalyptus crop appear in section 6 of Appendix 1 and section 3 of each of the other appendices. To start with, labour is engaged on contract basis for felling and cutting @ Rs 65 per 100 trees. An average of 1,000 trees per acre were harvested and so the cost of Rs 650 per acre on this account. After this, the farmer used his own machinery (tractor and trolley) and hired labour to transport the harvested materials to a common point. The cost of Rs 350 per acre for this operation is based on the farmer's estimates. The last har-

vesting operation consists of grading the materials, debarking the poles and loading the trucks arranged by the buyer. Debarking was estimated to cost Rs 60 per 100 poles or Rs 600 per acre. Grading and truck loading each were estimated to cost Rs 10 per 100 trees felled or Rs 100 per acre. All these activities required close supervision and a cost of Rs 20 per 100 trees or Rs 200 per acre was, therefore, added. These estimates resulted in an overall harvesting cost of Rs 2,000 per acre.

It may be noted at this stage that all input costs were assumed to be constant throughout the period of the analysis. One logic for this was that a rise in input prices (fall ruled out) will also lead to a rise in output prices, at least, in the same proportion. More importantly, however, it was felt that the agricultural input prices have already gone beyond the limits of most members of the farming community. Given this and given the national policy of providing a somewhat preferential treatment for the agricultural sector, the input prices were not expected to rise to any substantial extent in the foreseeable future. Sensitivity analysis was, however, carried out to cover this assumption.

II.3 Returns

The farmer under reference has the practice of negotiating a price for the total output of a standing crop (except bark) over a certain area but he manages and pays for the operations of felling, cutting, debarking, and loading the trucks for the destinations decided upon by the buyer. The farmer has used this method of sale for the last four years

and has realised an average price of Rs 21,000 for the final output of an acre. This figure has been used for pricing the output from the three subsequent coppice crops as well. Prices were not expected to rise to any considerable extent because the eucalyptus wood/poles have yet to be widely accepted. Once again, any fall in prices or a glut in the market were ruled out considering the trend of rising prices and shortages of other timbers. Sensitivity analysis was, however, carried out to test the likely impact of this assumption on the enterprise.

A few more remarks appear to be in order before closing this section. Firstly, the yields from coppice crops may be 20-25 per cent higher than those from the main crop. But this aspect has not been considered in the analysis for want of actual data and also to cover any unforeseen business risks during the coppice years. Secondly, the amount of Rs 5,000 per acre as returns from thinning operations in the third year of each coppice (items 5.3 in Appendices 2 to 4) was arrived at by assuming an output of at least 500 good sized sticks per acre. This material was priced at Rs 10 per unit at the farm gate. Thirdly, the eucalyptus seed has been priced at only Rs 25 per kg which may appear abnormally low for a selected quality product. The farmer has no doubt been selling a portion of his produce at Rs 60 per kg but he also had to sell at much lower prices or to part with a portion free of cost. The average price realised by him was, therefore, estimated at Rs 25 per kg.

III. Analysis and the Results

Yearwise costs and returns for each rotation of eucalyptus crop were added up separately. The costs of and returns from the cotton intercrop in the first year of the business and the returns from the contractual sale of standing grasses were pooled with the data for the relevant eucalyptus crop. It may also be noted here that the intercrop was taken only in the first year of the main crop and the natural growth of grasses (worth harvesting) was considerably less during the coppice years. No intercrop was realised beyond the first year of the main crop. The farmer is currently experimenting with date-palm as an intercrop and this may be something for future analyses to consider.

Time discounting method has been used to translate the values of costs and returns in different years to a common period (base year). The costs and returns for each rotation i.e., the main crop and the three coppice crops were analysed separately. The logic is that the entrepreneur has the choice to discontinue eucalyptus cultivation after the first crop or at the beginning of any of the coppice crops. In other words, once the main crop is taken, the three coppice crops are independent activities in the sense that the entrepreneur may alter his crop mix at the beginning of the first, second or third coppice. The assumption, of course, is that eucalyptus will have to be planted afresh after the third coppice crop is harvested and that stage is not covered in this paper.

Tables 1 to 4 summarise the yearwise costs and returns for the main crop and the three coppice crops, respectively. The tables also pro-

Table 1

Costs of and Returns from Raising the Initial Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat : India

(Rupees)

Years	Current costs	Current Returns	Net Current Returns	Discount Factors		Present value of net returns discounted at	
				@ 11 per cent	@ 15 per cent	11 per cent	15 per cent
1	395,200	768,000	372,800	0.901	0.870	335,893	324,336
2	105,040	24,000	-81,040	0.812	0.756	-65,804	-61,266
3	109,040	24,000	-85,040	0.731	0.658	-62,164	-55,956
4	112,240	64,000	-48,240	0.659	0.572	-31,790	-27,593
5	376,240	3,392,000	3015,760	0.593	0.497	1,788,346	1,498,833
Total for the rotation						1,964,481	1,678,354
Average per year						392,896	335,671

Table 2

Costs of and Returns from Raising the First Coppice Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat: India

(Rupees)

Years	Current Costs	Current Returns	Net Current Returns	Discount Factors		Present Value of Net Returns discounted at	
				@ 11 per cent	@ 15 per cent	11 per cent	15 per cent
1	56,720	-	-56,720	0.901	0.870	-51,105	-49,346
2	138,160	48,000	-90,160	0.812	0.756	-73,210	-68,161
3	298,160	848,000	548,840	0.731	0.658	401,933	361,795
4	374,960	3,392,000	3017,040	0.659	0.572	1,988,229	1,725,747
Total for the rotation						2,265,847	1,970,035
Average per year						566,462	492,509

Table 3

Costs of and Returns from Raising the Second Coppice Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat : India

(Rupees)

Years	Current Costs	Current Returns	Net Current Returns	Discount Factors		Present value of net returns discounted at	
				@ 11 per cent	@ 15 per cent	11 per cent	15 per cent
1	110,640	-	-110,640	0.901	0.870	-99,687	-96,257
2	108,720	48,000	-60,720	0.812	0.756	-49,305	-45,904
3	268,720	848,000	579,280	0.731	0.658	423,454	381,166
4	373,200	3,392,000	3018,800	0.659	0.572	1,989,389	1,726,754
Total for the rotation						2,263,851	1,965,759
Average per year						565,963	491,440

Table 4

Costs of and Returns from Raising the Third Coppice Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat: India

(Rupees)

Years	Current Costs	Current Returns	Net Current Returns	Discount Factors		Present value of net Returns discounted at	
				@ 11 per cent	@ 15 per cent	11 per cent	15 per cent
1	110,640	---	-110,640	0.901	0.870	-99,687	-96,257
2	108,720	48,000	-60,720	0.812	0.756	-49,305	-45,904
3	264,800	848,000	583,200	0.731	0.658	426,319	383,746
4	368,160	3,392,000	3,023,840	0.659	0.572	1,992,711	1,729,636
Total for the rotation						2,270,038	1,971,221
Average per year						567,510	492,805

vide present values of net returns discounted at 11 and 15 per cent. The lower of the two discount rates would be relevant in case the farm entrepreneur borrowed from institutional sources. The higher rate (15 per cent), may be considered a risk free market rate of interest. More importantly, the analysis at multiple discount rates may also provide an insight into the likely impact of changes in the rates of interest payable by a farm entrepreneur.

III.1 Present Values of Net Returns Per Acre Per Year

Based on the data presented in tables 1-4, the present values of net returns per acre per year from the main crop and the three coppice crops of eucalyptus were calculated. These are presented in the form of table 5.

Table 5

Net Present Returns Per Year Per Acre from Raising the Initial Crop and Three Coppice Crops of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat : India

Crop	(Rupees)	
	Present Value of Net Returns Per Acre Per Year Discounted at	
	11 per cent	15 per cent
Initial Crop	2,456	2,098
Coppice I	3,540	3,078
Coppice II	3,537	3,072
Coppice III	3,547	3,080

Table 5 shows that the net annual returns per acre from the eucalyptus rotations, when discounted at 11 per cent, were nearly 5 to 7 times higher than those expected from seasonal crops on the particular farm or the locality. When the discount rate was raised to 15 per cent, the returns from eucalyptus were still 4 to 6 times higher than those expected from the short duration crops. It may also be noted that the net present returns per acre per year for the coppice crops worked out to be considerably higher than those from the main crop. This is so in spite of the fact that no intercrop was possible during the coppice years. There seem to be three reasons for this. Firstly, certain initial expenses eg., the land preparation, transportation of plants from the nursery, were incurred only for the main crop. Secondly, eucalyptus were available only in one year during the main crop but for two years each during each of the coppice crops. Thirdly, and more importantly, the coppice rotations matured in 4 years each while the main crop took 5 years. This had a considerable impact on the discounted values of the stream of net annual returns.

III.2 Present Values of Net Returns Per Annum Per Rupee of Investments

Given his owned entrepreneurial capabilities and natural resources, eg., land and water, a farmer has to decide on the extent of capital investments to be made in the business. While, certain minimum equipment is necessary, there is a wide choice available beyond this minimum. Looking at this issue, it is but natural for a rational entrepreneur to look

at the returns per rupee of fixed investments and compare the same with the opportunity cost of capital. This exercise was done for the farm under review. As stated earlier, the capital investments on the farm were estimated at Rs 400 thousand. The results are summarised in the form of Table 6.

Table 6

Present Values of Net Returns Per Annum Per Rupee of Capital Investments in Raising Eucalyptus on 160 Acres of Irrigated Land in Gujarat : India

Crop	(Rupees)	
	Present Value of Net Returns Per Year Per Rupee of Capital Investments Discounted at	
	11 per cent	15 per cent
Initial Crop	0.982	0.839
Coppice I	1.416	1.231
Coppice II	1.415	1.229
Coppice III	1.419	1.232

The table is self-explanatory. Needless to say that not many business investments and no fixed deposits can possibly yield those high returns.

Yet another angle to look at the choices available to an individual entrepreneur is to consider the owned land also as a capital resource. The logic is that he may look at the market value of his land and debate for himself whether selling the land in question and investing the money thus received will give him higher or lower returns than expected from the current use of the land. In other words, he may look at the opportunity cost of the sale proceeds of the land and compare the same with the returns from cultivation.

The going land price in the vicinity of the farm under review was estimated at about Rs 6,000 per acre. The market value of the 160 acres under eucalyptus, thus, worked out at Rs 960 thousand. The farmer has also invested Rs 400 thousand in other capital assets. He may, therefore, consider his total investment in the business to be Rs 1,360 thousand. An exercise was carried out to find out the returns per rupee of this investment. The results are presented in table 7.

Table 7

Present Values of Net Returns Per Year Per Rupee of Investments in Land and other Fixed Assets for Raising 160 Acres of Eucalyptus in Gujarat : India

(Rupees)

Crop	Present Values of Net Returns Per Year Per Rupee of Investments Discounted at	
	11 per cent	15 per cent
Initial Crop	0.289	0.247
Coppice I	0.417	0.362
Coppice II	0.416	0.361
Coppice III	0.417	0.365

If the farmer was to put his money in fixed deposits with a bank (safest investment next to retaining the possession of the land), he could expect a return of 9 per cent per annum. Against this, as table 7 indicates the returns from the business varied between 29 and 42 per cent per annum, when the discount rate used was 11 per cent and 25 to 36 per cent when the discount rate was 15 per cent.

It is important to add at this stage that the results presented in Table 7 do not represent the view point of the society as a whole. Firstly, the land has no cost for the society. Secondly, and more importantly, certain resources may be transferred between individuals and their use(s) may be altered. The uses of all the resources cannot, however, be altered beyond a certain point even if the resources are capable of sustaining the alternative uses. In other words, while an individual owner of a natural land resource may be free to dispense with it, the society does not have that freedom.

It may, thus be concluded that, for a farmer with very limited formal education, the appropriate considerations are to maximise the (i) returns per unit of the given land resource, and (ii) returns from capital investments in the form of machinery, equipment and other infrastructure.

III.3 Sensitivity Analysis

The net present values of annual returns per acre from the initial crops and the three subsequent coppice crops of eucalyptus were presented in Table 5. Since the analysis assumed constant prices of inputs and outputs, it was considered necessary to study the impact of variations in these prices on net annual returns per acre. Sensitivity analysis was, therefore, done and the results are summarised in Table 8.

Table 8

Changes in the Present Values of Net Returns Per Acre Per Year From Raising Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat (India) with Variations in Returns and Cost Streams

(Rupees)

Crop	Normal Returns and Costs	Returns Increased by 10 per cent, Costs Normal	Returns Normal, Costs Increased by 10 per cent	Returns Normal, Costs Increased by 20 per cent	Returns Increased by 10 per cent & Costs by 20 per cent
(1)	(2)	(3)	(4)	(5)	(6)
Main Crop	2,455	2,804 (14.22)	2,354 (-4.11)	2,251 (-8.31)	2,602 (5.99)
Coppice I	3,540	3,993 (12.80)	3,443 (-2.74)	3,345 (-5.51)	3,895 (10.03)
Coppice II	3,537	3,989 (12.81)	3,439 (-2.77)	3,340 (-5.57)	3,891 (10.01)
Coppice III	3,547	3,999 (12.74)	3,449 (-2.76)	3,352 (-5.50)	3,901 (9.98)

Note: Figures in parentheses indicate percentage change over the normal returns and costs, i.e., column (2).

The table is self-explanatory. A perusal of the data leads to the conclusion that the relative profitability of eucalyptus is not adversely affected to an appreciable extent even if costs were to rise by 10 or 20 per cent while the returns were constant. This implies that even if the assumption of constancy of input and output prices does not uphold over time, the entrepreneur's expected returns from eucalyptus will be 4-6 times higher than those from the seasonal crops which his land and water resources can support. Moreover, while the quality of soil and water may improve with eucalyptus cultivation, there is a high probability of their deterioration with continued use for the annual crops.

III.4 Internal Financial Rate of Return

The internal rate of return is commonly defined as the rate of discount which equalises the present values of benefits and costs. In other words, the internal rate of return is that rate of discount which makes the present value of the entire stream of benefits and costs equal to zero. This is considered to be the most comprehensive test of the profitability of an investment because the difference between the internal rate of return and the rate of interest (opportunity cost of capital) can provide a measure of net returns on the capital investments. Considering the investments on the farm under review to be Rs 400 thousand, the internal rates of return worked out to be 162.93, 212.97, 212.78 and 214.36 per cent for the Initial and the three Coppice crops, respectively.

IV. Policy Implications

The foregoing analysis seems to have proved that the net returns to enterprise from raising eucalyptus have been significantly higher than the expected returns from the seasonal crop activities. An added intangible return to the farm firm was that the day to day management problems were far less time-consuming than they would be with the short duration crops. In other words, the leisure time available to the management was considerably enhanced. This, of course, does not mean that the tree crops can be recommended for all or a majority of the farmers under similar situations. The wider issue of social benefits and costs of a private activity must also be considered.

On the benefit side, perhaps, the most important consideration is the improvement in the water absorption capacity so as to improve the quantity and quality of sub-soil water. While this aspect was not specifically considered in the analysis (done primarily from the point of view of the enterprise), it may be mentioned that, in the year 1976, water accumulated from 12" of rainfall in one night was absorbed within one hour on the farm under review and there was no outflow. On the contrary, the water on a neighbouring farm stood for 3-4 days after the rain.

Another intangible benefit is that the eucalyptus wood is extremely hard and does not require seasoning before use. Its price, on an average, is only 20-25 per cent of teak and 40-50 per cent of sal wood. It can, thus, provide a considerably cheaper construction material for the average and below average income families. Even the furnitures made out of eucalyptus timber have been found to be extremely light, durable, and cheaper. This implies that large scale cultivation of eucalyptus may hold the possibility of improving the quality of living for a large section of our population.

On the cost side, it is feared that a eucalyptus crop consumes a lot more water than the seasonal ones. As a result, water table in a particular area may fall. This fear is born out of the fact that the three roots may go 20-25 feet deep. Contrary to this, it has already been mentioned that the water recharge capacity of the soil is considerably improved as a result of the crop itself. It may, thus, be subsumed that,

given normal rains, eucalyptus plantations will replenish at least as much water as they consume. Eucalyptus, of course, does not provide some of the other social benefits of trees, eg., fodders, fuels, and leaves (which increase humus in the soil) in as high quantities as some of the other commercial tree species.

It may seem from this discussion that on certain types of soils even the overall societal benefits from eucalyptus cultivation may be higher than the costs. While prime agricultural land cannot be readily shifted from food and fibre crops to tree crops, this conclusion has immediate implications for culturable wastes in the State.

In Gujarat State, forests cover 8.44 per cent of the total reporting area (Government of Gujarat, 1975, p.83). But only 50 per cent of the area classified as forests supports commercial operations. This area is located to the South of the Narmada River. The State forests, on an average, generate only 150 thousand M^3 of timber and 300 thousand metric tonnes of fuelwood annually as against the requirements of 300 thousand M^3 of timber and 3,300 thousand metric tonnes of fuelwood (Jhala, 1978). Any effort to bridge this gap between requirements and production is sure to be judged as economically and socially desirable.

The State is well ahead of the rest of the country in respect of Social and Extension forestry activities. The extension wing of the State Forest Department has 3 Conservators and 15 Deputy Conservators along with the necessary supporting staff and equipment. During the years 1970-77,

4,276 kms of road and canal banks out of a total length of nearly 17,000 kms were covered with trees (Jhala, 1978). The progress of such works can be much faster if the responsibility is shared with other private and public organisations and individuals. Sharing this activity may appear all the more relevant once the importance of time element is realised. Needless to say that, to enable the people to feel its impact, the total programme of social forestry must be executed within a time frame limited to foreseeable future.

Commercial tree farming has already gained some ground in Gujarat. A number of farmers seem to have been induced into the activity by the experiences of Shri Kalidas Bhai Patel. In the year 1977, the number of such farmers was estimated at 86 covering an area of 752 hectares or nearly 1,860 acres. During the current year, 300 more farmers were expected to join this category (Jhala, 1978). Further, the World Bank is reported to have approved an ambitious scheme of social forestry worth Rs 450 million for Gujarat. The scheme envisages to allocate 2.5 hectares of land to individual families for planting and guarding trees. A sum of Rs 200 per month is proposed to be paid to each such family to help it carry out the operations. The families will also have rights over grasses and other minor forest products on this land. Moreover, they may receive a share in the returns when the trees planted on the allocated lands mature (Times of India, Ahmedabad, July 20, 1978). This means that the State administration is prone to involving individuals for furthering the cause of forestry. This, however, need not be limited to small scale family operations.

Action on the part of the individual entrepreneurs/farm firms may prove to be valuable for covering culturable wastes in the State. Data available for the year 1969-70 show that such lands were spread over an area of 552,000 hectares or nearly 3 per cent of the total reporting area of the State and their distribution varied from approximately 1 per cent in Junagarh and Kheda districts to 4.6 per cent in Bharuch district (Government of Gujarat, 1975, p.83). Placing these lands under trees can raise the forest area in the State by nearly 35 per cent or from 8.44 per cent to 11.43 per cent of its reporting area.

The success story of the farm firm reviewed here may induce enough other firms to come forward if they are invited to participate in the task of greening this land. While working out the detailed terms for facilitating the farm firms' participation in the task, it may be worthwhile to consider long term leases of the culturable waste lands. Further, it may be binding on the lease holders to cover the land within a certain number of years. The landowner (State in most cases) may be entitled to a certain share in the net returns on maturity of the crop. In the interest of practicability and social justice, it may be necessary to restrict the leases to practising farmers. All such lands will, of course, not support eucalyptus. The State Forest Department may have to shoulder the responsibility of identifying appropriate tree species for specific areas and advise the farm firms accordingly.

V. Summary

The paper has presented the results of financial analysis of a 160 acres eucalyptus farm in Ahmedabad District. The soil on the farm is sandy loam type and the water is brackish. The fixed capital investments in the business were estimated at Rs 400 thousand.

The analysis supported the conclusions that, in certain situations, (i) individual farm entrepreneur may expect significantly higher returns by practising tree-culture than crop-culture, and (ii) forestry activity with fixed investments averaging Rs 2,500 or more per acre may prove to be much more economical than with lesser or no investments. Based on these conclusions, the need for involving farm firms in the task of bringing culturable waste lands under trees has been stressed.

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Appendix 1

Costs of and Returns from Raising the Main Hybrid Eucalyptus Crop and Cotton as an Intercrop on 160 Acres of Irrigated Land in Gujarat: India

(Rupees)

Sl No.	Description	Years				
		First	Second	Third	Fourth	Fifth
(1)	(2)	(3)	(4)	(5)	(6)	(7)

A : COSTS

1	Depreciation on the fixed investment of approximately Rs 400 thousand @ 7 per cent per annum	28,000	28,000	28,000	28,000	28,000
2	<u>Planting</u>					
2.1	Labour for making approximately 1450 pits per acre of 0.5 metre ³ @ Rs 100 per acre (Spacing 10'x3' lines East West)	16,000	-	-	-	-
2.2	Benzene Hydro Chloride(BHC): 25 kg per acre priced at Rs 20	3,200	-	-	-	-
2.3	Muriate of Potash (MOP): 50 kg per acre priced at Rs 35	5,600	-	-	-	-
2.4	Di-Ammonium Phosphate(DAP): 50 kg per acre priced at Rs 110	17,600	-	-	-	-
2.5	Two Truck loads of Farm Yard Manure (FYM) per acre priced at Rs 300	48,000	-	-	-	-
2.6	Labour for mixing items 2.2 to 2.5 and refilling the pits: 8 mandays per acre priced at Rs 44	7,040	-	-	-	-

Appendix 1 contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2.7	Transportation of 240 thousand naked plants from the Forest Department Nursery to the site (Assumed average lead 75 kms)	2,400	-	-	-	-
2.8	Plantation at site: 4 mandays per acre priced at Rs 22	3,520	-	-	-	-
3	<u>Post Planting Care</u>					
3.1	First irrigation @ Rs 35 per acre including (a) 2 mandays for making channels, (b) attendant labour 1 manday, and (c) operating cost of tubewell and equipment	5,600	-	-	-	-
3.2	Three irrigations @ Rs 25 per irrigation per acre including (a) 1 manday of attendant labour, and (b) operating cost of tubewell & equipment	12,000	-	-	-	-
3.3	Urea: 100 kgs per acre priced at Rs 166	26,560	-	-	-	-
3.4	Aldrex: priced at Rs 30 per acre	4,800	-	-	-	-
3.5	Labour for applying items 3.3 and 3.4: 4 mandays per acre priced at Rs 22	3,520	-	-	-	-
4	<u>Inter-crop: Cotton</u>					
4.1	Land preparation: Rs 25 per acre	4,000	-	-	-	-
4.2	Seed: Rs 50 per acre	8,000	-	-	-	-
4.3	DAP: 50 kg per acre priced at Rs.110	17,600	-	-	-	-
4.4	Ammonium Sulphate: 100 kg per acre priced at Rs 104	16,640	-	-	-	-
4.5	MOP: 50 kg per acre priced at Rs 35	5,600	-	-	-	-
4.6	Labour for applying items 4.3 to 4.5 in two instalments: 8 mandays per acre priced at Rs 44	7,040	-	-	-	-
4.7	Insecticides: priced at Rs 420 per acre	67,200	-	-	-	-
4.8	Labour & Equipment for application of Insecticides: Rs 3 per acre	480	-	-	-	-

Appendix 1 contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.9	Twelve irrigations @ Rs 25 per irrigation per acre	48,000	-	-	-	-
4.10	Contract labour for cotton picking and cart loading @ Rs 15 per quintal (expected yield 12 quintals per acre)	28,800	-	-	-	-
4.11	Transportation of cotton to market: Rs 30 per 50 quintals or Rs 20 per acre	3,200	-	-	-	-
5	<u>Continued care of Eucalyptus after Harvesting Cotton</u>					
5.1	Urea: 100 kgs per acre priced at Rs 166	-	26,560	26,560	26,560	-
5.2	Labour for applying item 5.1 in 2 instalments: 2 mandays per instalment priced at Rs 11	-	3,520	3,520	3,520	-
5.3	Zn SO ₄ : 5 kgs per acre priced at Rs 12.50	-	2,000	2,000	2,000	2,000
5.4	Fe SO ₄ : 25 kgs in years 2 to 4 and 50 kg in year 5 priced at Rs 76 per quintal	-	3,040	3,040	3,040	6,080
5.5	Labour for application of items 5.3 and 5.4: 2 mandays priced at Rs 11	-	1,760	1,760	1,760	1,760
5.6	One weeding: 2 mandays per acre priced at Rs 11	-	1,760	1,760	1,760	-
5.7	Three intercultures: Rs 15 per acre per operation	-	7,200	7,200	7,200	7,200
5.8	Five irrigations: Rs 30 per acre per irrigation	-	24,000	-	-	-
5.9	Five irrigations: Rs 35 per acre per irrigation	-	-	28,000	-	-
5.10	Five irrigations: during the fourth and one irrigation during the fifth year: Rs 40 per acre per irrigation	-	-	-	32,000	6,400
5.11	Collection, drying & storage of Eucalyptus seeds: Rs 10 per acre for approximately 10 kgs per acre	-	-	-	1,600	-

Appendix 1 contd.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
6	<u>Harvesting Main Eucalyptus Crop</u>					
6.1	Contract labour for tree felling & cuttings Rs 650 per acre	-	-	-	-	104,000
6.2	Transportation of the harvested materials to a common point Rs 350 per acre	-	-	-	-	56,000
6.3	Grading, debarking, truck loading and supervision Rs 1,000 per acre	-	-	-	-	160,000
7	<u>Miscellaneous</u>					
7.1	Watch and ward: Rs 30 per acre per year	4,800	4,800	4,800	4,800	4,800
7.2	Gap filling and other sundry expenses @ Rs 15 per acre	-	2,400	2,400	-	-
Total costs		395,200	105,040	109,040	112,240	376,240
<u>B : RETURNS</u>						
8	<u>Sale of Outputs</u>					
8.1	Cotton: expected yield 12 quintals per acre and expected price Rs 400 per quintal	768,000	-	-	-	-
8.2	Right to harvest grasses: Rs 150 per acre	-	24,000	24,000	24,000	-
8.3	Eucalyptus seed: only selected quality: 10 kgs per acre priced at Rs 25 per kg	-	-	-	40,000	-
8.4	Contractual sale of the total yield of the main eucalyptus crop (except bark): Rs 21,000 per acre	-	-	-	-	3,360,000
8.5	Eucalyptus bark: Rs 200 per acre	-	-	-	-	32,000
Total Returns		768,000	24,000	24,000	64,000	3,392,000

Appendix 2

Costs of and Returns from Raising the First Coppice Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat : India

(Rupees)

Sl No.	Description	Years			
		First	Second	Third	Fourth
(1)	(2)	(3)	(4)	(5)	(6)

A : COSTS

1	Depreciation on the fixed investment of approximately Rs 400 thousand @ 7 per cent per annum	28,000	28,000	28,000	28,000
2	<u>Care of Eucalyptus for Coppicing</u>				
2.1	One irrigation each in the 1st & 4th years and 5 irrigations each in the 2nd and 3rd years @ Rs 40 per acre per irrigation	6,400	32,000	32,000	6,400
2.2	Zn SO ₄ : 5 kgs per acre priced at Rs 12.50	2,000	2,000	2,000	2,000
2.3	Fe SO ₄ : 25 kgs per acre in the 1st and 4th years and 20 kgs per acre in the 2nd and 3rd years priced at Rs 76 per quintal	3,040	2,400	2,400	3,040
2.4	Labour for application of items 2.2 and 2.3: 2 mandays priced at Rs 11	1,760	1,760	1,760	1,760
2.5	Three intercultures: Rs 15 per acre per operation	7,200	7,200	7,200	7,200
2.6	Labour for pruning: 4 mandays per acre priced at Rs 22	3,520	-	-	-
2.7	Urea: 200 kgs per acre in the 2nd and 3rd year priced at Rs 166 per quintal	-	53,120	53,120	-
2.8	Labour for application of item 2.7: 4 mandays per acre priced at Rs 22	-	3,520	3,520	-

Appendix 2 contd.

(1)	(2)	(3)	(4)	(5)	(6)
2.9	One weeding: 2 mandays per acre priced at Rs 11	-	1,760	1,760	1,760
2.10	Labour for thinning: Rs 325 per acre-	-	-	52,000	-
2.11	Transporting the materials from thinning operation to a common point: Rs 175 per acre	-	-	28,000	-
2.12	Labour and supervision for grading, debarking and truck loading: Rs 500 per acre	-	-	80,000	-
2.13	Collection, drying and storage of Eucalyptus seeds: Rs 10 per acre	-	1,600	1,600	-
3	<u>Harvesting First Coppice Crop of Eucalyptus</u>				
3.1	Contract labour for tree felling and cutting: Rs 650 per acre	-	-	-	104,000
3.2	Transporting harvested materials to one common point: Rs 350 per acre	-	-	-	56,000
3.3	Labour and supervision for grading, debarking and truck loading: Rs 1,000 per acre	-	-	-	160,000
4	<u>Miscellaneous</u>				
4.1	Watch and Ward @ Rs 30 per acre per year	4,800	4,800	4,800	4,800
----- Total costs -----		56,720	138,160	298,160	374,960
<u>B : RETURNS</u>					
5	<u>Sale of outputs</u>				
5.1	Eucalyptus seed: only selected quality: 10 kgs per acre priced at Rs 25 per kg	-	40,000	40,000	-
5.2	Right to harvest grasses: Rs 50 per acre	-	8,000	8,000	-
5.3	Output from thinning: Rs 5,000 per acre	-	-	800,000	-
5.4	Contractual sale of total yield from 1st coppice crop of eucalyptus (except bark): Rs 21,000 per acre	-	-	-	3,360,000
5.5	Eucalyptus bark: Rs 200 per acre	-	-	-	32,000
----- Total Returns -----		-	48,000	848,000	3,392,000

Appendix 3

Costs of and Returns from Raising the Second Coppice Crop of Hybrid Eucalyptus on 160 Acres of Irrigated Land in Gujarat: India

(Rupees)

Sl No.	Description	Years			
		First	Second	Third	Fourth
(1)	(2)	(3)	(4)	(5)	(6)
<u>A : COSTS</u>					
1	Depreciation on the fixed investment of approximately Rs 400 thousand @ 7 per cent per annum	28,000	28,000	28,000	28,000
2	<u>Care of Eucalyptus for Second Coppicing</u>				
2.1	Urea: 100 kgs per acre priced at Rs 166 per quintal	26,560	26,560	26,560	-
2.2	Zn SO ₄ : 25 kgs per acre priced at Rs 12.50	2,000	2,000	2,000	2,000
2.3	Fe SO ₄ : 25 kgs per acre priced at Rs 19	3,040	3,040	3,040	3,040
2.4	Labour for application of items 2.1 to 2.3: 4 mandays priced at Rs 22 during the 1st three years and 2 mandays priced at Rs 11 during the 4th year	3,520	3,520	3,520	1,760
2.5	Three Intercultures: Rs 15 per acre per operation	7,200	7,200	7,200	7,200
2.6	Five irrigations per year during the 1st three years & 1 irrigation during the 4th year: Rs 40 per acre per irrigation	32,000	32,000	32,000	6,400
2.7	Labour for pruning : 4 mandays per acre priced at Rs 22	3,520	-	-	-
2.8	Labour for thinning: Rs 325 per acre	-	-	52,000	-
2.9	Transporting the materials from thinning to one point: Rs 175 per acre	-	-	80,000	-

Appendix 3 contd.

(1)	(2)	(3)	(4)	(5)	(6)
2.10	Labour and supervision for grading, debarking and truck loading: Rs 500 per acre	-	-	80,000	-
2.11	Collection, drying and storage of eucalyptus seeds: Rs 10 per acre	-	1,600	1,600	-
3	<u>Harvesting of Second Coppice Crop</u>				
3.1	Contract labour for tree felling and cutting: Rs 650 per acre	-	-	-	104,000
3.2	Transporting harvested materials to one common point: Rs 350 per acre	-	-	-	56,000
3.3	Labour and supervision for grading, debarking, and truck loading: Rs 1,000 per acre	-	-	-	160,000
4	<u>Miscellaneous</u>				
4.1	Watch and Ward & Rs 30 per acre per year	4,800	4,800	4,800	4,800
Total Costs		110,640	108,720	268,720	373,200

B : RETURNS

5	<u>Sale of Outputs</u>				
5.1	Eucalyptus seed: only selected quality: 10 kgs per acre priced at Rs 25 per kg	-	40,000	40,000	-
5.2	Right to harvest grasses: Rs 50 per acre	-	8,000	8,000	-
5.3	Output from thinning: Rs 5,000 per acre	-	-	800,000	-
5.4	Contractual sale of total yield from second coppice crop of eucalyptus (except bark): Rs 21,000 per acre	-	-	-	3,360,000
5.5	Eucalyptus bark: Rs 200 per acre	-	-	-	32,000
Total Returns		-	48,000	848,000	3,392,000

Appendix 4

Costs of and Returns from Raising the Third Coppice Crop of Hybrid
Eucalyptus on 160 Acres of Irrigated Land in Gujarat: India
(Rupees)

Sl No.	Description	Years			
		First	Second	Third	Fourth
(1)	(2)	(3)	(4)	(5)	(6)
<u>A : COSTS</u>					
1	Depreciation on the fixed investment of approximately Rs 400 thousand @ 7 per cent per annum	28,000	28,000	28,000	28,000
2	<u>Care of Eucalyptus for Third Coppicing</u>				
2.1	Urea: 100 kgs per acre priced at Rs 166 per quintal	26,560	26,560	26,560	-
2.2	Zn SO ₄ : 5 kgs per acre priced at Rs 12.50	2,000	2,000	2,000	-
2.3	Fe SO ₄ : 25 kgs per acre priced at Rs 19	3,040	3,040	-	-
2.4	Labour for application of items 2.1 & 2.3: 4 mandays priced at Rs 22 in the first 2 years, 3 & 2 mandays priced at Rs 16.50 and Rs 11 in the third and fourth years, respectively	3,520	3,520	2,640	1,760
2.5	Three intercultures: Rs 15 per acre per operation	7,200	7,200	7,200	7,200
2.6	Five irrigations per year during the 1st three years and 1 irrigation in the 4th year: Rs 40 per irrigation per acre	32,000	32,000	32,000	6,400
2.7	Labour for pruning: 4 mandays per acre priced at Rs 22	3,520	-	-	-
2.8	Labour for thinning: Rs 325 per acre	-	-	52,000	-
2.9	Transporting the materials from thinning to one point: Rs 175 per acre	-	-	28,000	-

Appendix 4 contd.

(1)	(2)	(3)	(4)	(5)	(6)
2.10	Labour & supervision for grading, debarking and truck loading, Rs 500 per acre	-	-	80,000	-
2.11	Collection, drying & storage of Eucalyptus seeds: Rs 10 per acre	-	1,600	1,600	-
3	<u>Harvesting of Third Coppice Crop</u>				
3.1	Contract labour for tree felling and cutting: Rs 650 per acre	-	-	-	104,000
3.2	Transporting harvested materials to one common point: Rs 350 per acre	-	-	-	56,000
3.3	Labour and supervision for grading, debarking and truck loading: Rs 1,000 per acre	-	-	-	160,000
4	<u>Miscellaneous</u>				
4.1	Watch and ward @ Rs 30 per acre per year	4,800	4,800	4,800	4,800
Total Costs		110,640	108,720	2 64,800	368,160
<u>B : RETURNS</u>					
5	<u>Sale of Outputs</u>				
5.1	Eucalyptus seed: only selected quality: 10 kgs per acre priced at Rs 25 per kg	-	40,000	40,000	-
5.2	Right to harvest grasses: Rs 50 per acre	-	8,000	8,000	-
5.3	Output from thinning: Rs 5,000 per acre	-	-	800,000	-
5.4	Contractual sale of total yield from third coppice crop of Eucalyptus (except bark): Rs 21,000 per acre	-	-	-	3,360,000
5.5	Eucalyptus bark: Rs 200 per acre	-	-	-	32,000
Total Returns		-	48,000	848,000	3,392,000