PROJECT ANALYSIS OF LARGE PLANTATION PROJECTS

by

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ABSTRACT

Development planning to meet the basic human needs for food, clothing, housing, health and education, has been adopted in most developing countries, and particularly in India. Forests and forestry can make an important contribution to meeting some of these needs, and India has placed emphasis on man-made forests in her development plans since these forests offer a number of advantages over natural forests. Man-made forests, however, require large investments which typically have long gestation periods. It is, therefore, necessary that plantation projects be adequately evaluated before investments are made in order to avoid misallocation of scarce resources.

In this study, the technique of cost-benefit analysis has been used to evaluate the financial and social profitability of a hypothetical Pinus radiata plantation project in the Australian Capital Territory (A.C.T.). The study is based on the following main assumptions:

1. That a forest estate of 14 000 ha would be developed over a 35 year period by establishing Pinus radiata plantations at an annual rate of 400 ha. This hypothetical project would have some similarities with existing plantations in the A.C.T.

2. Land for the project has been assigned an opportunity cost of $30 per ha.

3. The project period for each plantation block of 400 ha has been taken as 71 years (two rotations plus one year for advance action).

4. A single silvicultural regime which is similar to some of those used in A.C.T. forests has been assumed, ignoring differences in site characteristics between forest blocks. This regime assumes one pruning at age 10 and thinnings at ages 15,20,25 and 30 years.

5. Because of data and time constraints, this study considers only direct costs and benefits due to the project. External effects are, therefore, not explicitly considered. The analysis is based on money costs and prices obtaining in the beginning of 1979, except for small logs (7-14 cm diameter) where slightly higher real prices were assumed. The cost-price structure used in this study is assumed to hold during the project's life.

The financial analysis looks at the commercial profitability of the project from the point of view of the investing agency, with net present value (NPV) as the criterion of profitability. The analysis indicates that the project, which would produce mainly sawlogs, would not be commercially profitable, given the assumptions of the analysis. The project profitability is particularly sensitive to changes in discount rate and administration costs.

The social cost-benefit analysis considers the profitability of the project from the viewpoint of society. The result of this analysis indicates the project may be socially profitable in

contrast with the result of the financial analysis.

Finally, this study looks at the application of cost-benefit analysis to plantation forestry in the Indian situation and discusses the need to determine the true social value of labour and foreign exchange in a labour surplus economy beset with balance of payment difficulties. However, the basic framework used for the Australian analysis remains much the same for the Indian application.

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CHAPTER 1

INTRODUCTION

Forests and forestry can contribute significantly to the social and economic development of both the developed and less developed areas of the world. Forests produce the requisite raw materials for industries, contribute to a country's exports and create a large volume of employment in the primary, secondary and tertiary sectors. They also provide material for direct use by agriculturists, like fuelwood, small timber and grazing. The benefits from forests in the matter of soil and water conservation, recreation and wildlife have been well recognised. However, while many developed countries such as Australia are enjoying the fruits from the role forests play in their development, less developed countries such as India are yet to realise equivalent contributions from forests in their own development. To understand why this is so in the Indian context it is perhaps necessary to look more closely at the Indian situation and the development problems she is facing, the role that forests and forestry can specifically play in Indian development, the forest resources currently available for this purpose and the need for additional forest projects and their evaluation.

India is a poor country with a per capita income of only US$*150 (1977-78) and a large and rapidly growing population. Nearly two-

*In all other instances, $ in this study refers to the Australian dollar.

fifths of the population is below the poverty line.* Poverty is associated with conditions of considerable unemployment and underemployment in the traditional sectors of the economy (e.g. subsistence agriculture). Employment in India is structural in origin, patterns being determined by how available resources, particularly land and water, are owned and utilized. Land ownership is concentrated in the hands of a few with just 4% of holdings comprising 30.5% of the total area of agricultural operations (see Table 1.1). The main avenues for elimination of poverty under these

TABLE 1.1

CONCENTRATION OF LAND HOLDINGS IN INDIA

Total number of operational holdings = 70 million

Size of holding (ha)	No. of operational holdings as percentage of total operational holdings	Area operated as percentage of total area of operational holdings
below 1	51%	9%
up to 2**	70%	21%
2-4	15%	18.5%
4-10	11%	30%
10 and above	4%	30.5%

** Includes holdings below 1 ha.

Source : Natarajan, B. (1978).

* Defined in the Draft Sixth Plan Report (Natrajan, 1978), to mean a minimum expenditure of Rs61.8 and Rs71.3 per month (approximately Rs9 = $1) for rural and urban areas respectively at 1976-77 prices.

circumstances will necessarily be related to land and its proper utilization, together with improved water management and better utilization of the resources of the forests, fisheries and animal stocks. This can best be achieved through labour-intensive techniques in decentralized production units. India has implemented development planning to help alleviate the problems of poverty and the inequitable distribution of income and wealth. The problems of economic development in India are discussed below.

1.1 Problems of economic development in India

For almost three decades India has been following a policy of planned economic development. She has had five five-year plans and three one-year plans since 1951 and is now in the middle of the Sixth Five Year Plan. The major objectives of planning since 1951 have been to achieve a high rate of economic growth, national self-reliance in essential goods and services, full employment and the reduction of economic inequalities.

In the period 1951-77 the Indian economy recorded an average annual growth rate of 3.65% (Raj Krishna, 1980). However, the steadily rising population has reduced the growth of per capita income over the same period to less than 1.5% per year. The growth rate has not only been low in comparison with targeted growth rates indicated in the economic plans but also with rates achieved in most other countries.

The aim of self-reliance is the substitution of domestic production, where possible, for imports. This planning objective has been pursued with considerable success. Over the 23-year period

ending in 1978, imports in only six industrial sectors of the economy exceeded 25% of the total supply in the economy (Raj Krishna, 1980). Examples are oil and gas, organic heavy chemicals and some categories of machinery. This development is the outcome of a long-term policy to establish adequate indigenous capacity in all the basic sectors, particularly metals and machinery, heavy chemicals, energy and transport and communications. The policy has been criticized for its alleged neglect of rural development and its creation of a sheltered high-cost industrial sector. However, this policy has, on the whole, been beneficial (Raj Krishna, 1980). For one thing it has made many of the goods produced by India cheaper in the long run than their imported counterparts. Steel is an important example. The resulting relatively low price of many Indian engineering products (e.g. machinery, plant) has made it possible to export these products. Now engineering products form the single largest group of all Indian exports, surpassing the traditional farm products such as tea and textiles. The policy of import substitition has also helped generate the basic industrial capacities which are the prerequisites for growth in all other sectors.

One of the most disturbing aspects of economic development in India is that the numbers of unemployed keep rising, contrary to the third objective of planning. In 1978 the measure of unemployment was 16.85 million man-years for people between 15 and 59 years of age (Raj Krishna, 1980). In addition, a further five million or so young people reach working age each year. Unemployment and under-employment among the low income groups in Indian society are

rampant. Underemployment refers to employment in the traditional sectors (e.g. subsistence agriculture, cottage industries, etc.) where the social value of the marginal product of that employment is less than the wage rate the government usually pays for public sector employment (Dasgupta et al, 1972). This wage rate will generally be determined by the advanced, capitalistic sectors of the economy.

The ability of the modern industrial sector to absorb the unemployed is limited. Even after 25 years of planned growth, it hardly employs 10% of the work force, with a new job creation rate of only about 0.75 million per year (Raj Krishna, 1980). This, clearly, is inadequate considering the unemployment statistics. The planners, therefore, must find other avenues to tackle the problem of unemployment. At present, India's young are drifting into unemployment or are in underemployment situations. One interesting feature of the Indian economy, however, is that during the past seven decades, the share of agriculture and allied sectors (forestry, fisheries etc.) in the work force has been steady at 72-75%. However, underemployment is often found in these sectors, especially in subsistence agriculture. These sectors, perhaps, provide good bases for developing programs to provide for increased employment.

The progress towards achieving the fourth objective - equitable distribution of income and assets - has been extremely poor. In 1977-78, nearly half the population was below the poverty line (Table 1.2). Land holding in India is also concentrated as shown in Table 1.1. Also, the 1971 share of the poorest 10% of Indian households in the national assets was only 2% while the top 10% accounted for 51% (Raj Krishna, 1980).

TABLE 1.2

PERCENTAGE OF PEOPLE BELOW THE POVERTY LINE IN INDIA*

	1977-78	1982-83	1987-88
Rural	47.85	38.70	27.28
Urban	40.71	35.33	26.23
All India	46.33	37.95	27.04

*Estimates in the Draft Sixth Plan Report.

Source: Natarajan, B. (1978).

The current (sixth) plan, addresses itself particularly to the problems of unemployment and equity and has adopted three objectives for social justice. They are;

(i) to develop special measures for the promotion of employment and incomes in rural areas, particularly among landless labourers, tenants and marginal farmers; such measures to include public investment in labour-intensive rural works such as feeder roads, market facilities, tree plantations, clinics and water supplies; and to develop efficient cottage and small scale industries and provision of credit to purchase essential agricultural inputs such as fertilizer, seed and pesticides;

(ii) to implement land reforms for redistribution of land to the landless; and

(iii) the provision of basic minimum needs of food, housing, clothing, education, clean water and health care for the entire population, within a definite time frame.

A national science and technology plan has been drawn up to provide a framework of action for meeting the basic needs of the poor

people in villages and towns by mobilising local talent and resources. Thus, the emphasis of the Sixth Plan is on rural development.

1.2 Forestry in national development

Forestry has an important role to play in meeting the basic needs of the people for fuelwood and fodder, timber for house construction and raw materials for the production of paper, so important for education.

In rural India, where more than three-quarters of the total population resides, fuelwood accounts for 60% of the energy consumption (Singh, 1978). Wood is the preferred fuel because it can be used without complex equipment and can be acquired at little cost. Besides, there is often no alternative to wood fuel or other locally available organic fuel materials for the poor. Commercial fuels, even where available, require cash outlays on stoves which are generally beyond the ability of the poor to pay.

In many parts of the country, wood is also the principal structural material for shelter and house construction.

At the moment, sizeable quantities of pulp and paper are imported to meet the growing demands in education and commerce. This is shown in Table 1.3. Other forest products which India trades are saw- and veneer-logs, gums, resins, essential oils and leaves. Because of the high cost of these imports and the large population, per capita consumption of paper in India is low. This low per capita consumption is also reflected in the low levels in education, paper being so important in the educational process.

TABLE 1.3

INDIAN EXPORTS AND IMPORTS OF FOREST PRODUCTS

($,000)

Year	Total Forest Products Imports	Exports	Balance of Trade	Paper and Paper Boards Imports	Exports	Wood-based Panels Imports	Exports	Wood Pulp Imports
1968	38061	14503	-23558	23470	8019	36	641	13555
1969	48470	14939	-33531	31306	4759	26	1224	16575
1970	47302	14708	-32594	31331	4694	20	2259	15589
1971	57880	12474	-45406	44379	1500	238	1698	12721
1972	52992	12665	-40327	39575	1716	154	1673	12721F
1973	49715	33786	-15929	37199	4511	35	7008	11160
1974	82752	24760	-57992	70105	2589	70	10900	11257
1975	84042	22686	-61356	63385F	1478	33	5529	19534F
1976	74656	31622	-43034	67020	1509	53	10400	6657
1977	110821	28971	-81850	83692	3596	146	9296	25467
1978	110821	28971F	-81850	83692F	3596F	146	9296F	25467F

F = F.A.O. estimate.
Source: F.A.O. (1978). Yearbook of Forest Products.

1.3 Forest resources in India

In India, the forests are mainly state owned (more than 95%), however, the local inhabitants have been given collection rights in some forests for fuelwood, fruit, leaves, etc. In 1970, these forests provided less than 10% of the total fuelwood supply, or only 13 million m^3 out of a total consumption of 150 million m^3. The balance came from non-forest sources such as shelterbelts, woodlots and other trees on farm lands (Bannerjee, 1978; F.A.O., 1976). These non-forest sources of fuelwood are diminishing rapidly through heavy exploitation by a large and expanding population. In most parts of the country, heavy exploitation has pushed the forests far away from the centres of population. In view of the short distances over which fuelwood can be transported economically, the possibilities of supply from fuelwood rich areas to fuelwood poor areas are also limited. The inadequate supply of fuelwood has forced the people to use animal dung as fuel since other options such as coal, kerosene, liquified petroleum gas and electricity are not available to them. The need to use dung for fuel, and not as fertilizer, leads to the deterioration of soil structure and fertility, especially when the consumption of other types of fertilizer is already extremely low. In India, the annual burning of dung as fuel constitutes a loss equivalent to about 45 million tonnes of food grains valued at Rs36 000 million (Srivastava and Pant, 1979). In the same country, Singh (1978), estimating the comparative efficiency of different domestic fuels, found that fuelwood is almost the cheapest, and dung cakes the most expensive, form of energy.

Consequently, to avoid the use of dung for fuel the supplies of

fuelwood have to be augmented. In view of the foregoing discussion, an increasing proportion of the fuelwood requirement will have to be met from the forests proper, both natural and man-made.

The supply of industrial wood from India's forests has also been falling short of her domestic demand. In 1970, the domestic demand for industrial wood was about 15.9 million $m^3(r)$* as against the recorded production of 9 million $m^3(r)$ (Government of India, 1976). Thus, even for industrial wood, the non-forest sources of supply are important. The estimated demand for industrial wood in India is presented in Table 1.4.

TABLE 1.4

ESTIMATED DEMAND FOR INDUSTRIAL WOOD IN INDIA

(million $m^3(r)$)

	1980	1985	2000
Low income growth	25	30	47
High income growth	27	35	64

Source: Government of India (1976).

At present the annual increment from India's forests is estimated to be 33 million m^3 (Bannerjee, 1978). Allowing for some inaccessible areas where extraction is not economic, the total annual yield may barely be 30 million m^3. Assuming that two-thirds of the harvestable volume is in the form of fuelwood, the yield may be taken

*Cubic metres in the round

as 20 million m^3 of fuelwood and 10 million m^3(r) of industrial wood. Against this the demand for fuelwood is expected to rise to 184 million m^3 in 1980, 202 million m^3 in 1985 and 225 million m^3 by the year 2000 (Government of India, 1976).

Plantations of fast growing species near points of consumption appear to provide the best solution to the fuelwood/rural wood problem and India has begun such plantation projects, with programs for production and social forestry.

The major aims of production forestry (mainly plantations of eucalypts, pines, bamboo and indigenous hardwoods) are the provision of raw materials to industry, particularly the paper and building industries, and the provision of employment and support to the economy of backward areas. Social forestry programs are aimed at meeting the energy needs of the people by raising fuelwood and fodder plantations, the common species used being from the genera Eucalyptus, Casuarina and Acacia. The forest service also encourages people to plant trees on private lands by supplying seedlings and offering technical guidance.

1.4 Plantation forestry

In many developing countries, because of the urgent need to meet the fuelwood and timber requirements of the rural people and the long-fibre raw material requirements for paper manufacture, increasing emphasis is being placed on plantations of fast growing species to meet these requirements. In India, about 4.45 million hectares of plantations are expected to be established by 1980 (Government of India, 1974). Increasing emphasis is being placed on

plantations because of their capability for extremely high volume yields. For example, large-scale establishments of exotic species in New Zealand, South Africa and Chile have transformed an actual or potential wood deficit into a surplus due to the high yields of those forests. In addition, man-made forests have other substantial benefits. These benefits are discussed in the following sections (F.A.O., 1967).

1.4.1 Production benefits

There are several production benefits from plantation establishment.

(i) By correct choice of site and species, it is possible to create forests on sites which are both capable of producing satisfactory rates of growth and yet are readily accessible to main markets. Through wise use of exotic species, planting need not be confined to sites which previously carried natural forests - although an important consideration for fuelwood plantations - but may be extended to less fertile but more accessible and sometimes more cheaply plantable grasslands. In addition, use of more fertile sites for forest may be justified on economic grounds if suitable fast growing species can be grown efficiently using short rotations.

(ii) Suitable end products are obtainable through the correct choice of species.

(iii) The use of only a few species in even-aged stands leads to homogeneous trees both in size and wood properties. This results in easier handling, processing and marketing.

(iv) Correct choice of sites and species permits higher growth rates than natural forests, particularly in the tropics, sub-tropics and

warm temperate zones with long growing seasons. High growth rates ensure rapid establishment and large volumes per unit area. Many tropical forests are often only capable of a mean annual increment of 2 m^3 per hectare per annum. On the other hand, mean annual increments of fast growing eucalypts, poplars and pines may typically be 10-25 m^3 per hectare per annum.

(v) Shorter rotations in plantations mean that expenditure on establishment, which is much higher than in natural regeneration, can be recovered in a short time. In fact, rates of return may be very attractive.

(vi) The production of large volumes per unit area in plantations means that, for a given yield, man-made forests need considerably less area than natural forests. In consequence, costs of management, protection, harvesting and transport per unit volume of wood extracted are reduced.

(vii) The simpler composition and structure of most plantations enables silvicultural treatments to be applied on a largely mechanical basis by semi-skilled staff, an important factor in developing countries where silvicultural expertise may be scarce.

1.4.2 Protection and amenity benefits

In general, man-made forests probably have no particular protection advantages over natural forests. In many cases, the even-aged mono-cultural forest, particularly if managed on a clear-cutting system, may be less efficient as a soil and water conserver and a balanced biological habitat for wildlife than a multi-species natural forest. However, where natural forest is incapable of

establishing itself, and the choice lies between man-made forests or none at all, the protective value of man-made forests may be high. Instances of this are the use of various species of pine to afforest sand dunes in western Denmark and elsewhere in north-western Europe, use of both pines and eucalypts to fix littoral dunes in Tunisia, shelter belts in many exposed areas throughout the world and the use of Alnus and other species for avalanche or torrent control in the high Alps. In such cases, the benefit through protection of valuable agricultural land, and even preservation of human life, may far outweigh any productive values.

1.5 Investment in man-made forests

Governments of developing countries are faced with making decisions on plantation investment for timber and wood products for use by their own communities and, in some instances, as a source of foreign exchange earnings or as a means of saving foreign exchange. In many countries major decisions have to be taken on the role of forestry in rural areas, decisions which are intricately linked with those for agriculture and which are of vital importance for environmental control.

Forestry projects have some particular features that distinguish them from most other public projects (F.A.O., 1979):

(i) Forests have a long production period or period from time of initial investment until time of return.

(ii) The tree is both the production unit and the product.

(iii) Trees have the characteristic of one-way flexibility in production. A tree can be left to grow, but once it is

harvested, the production unit is also destroyed and it can take a long time to build it back to a given level. Thus in forest management there is reasonable flexibility in deciding when to harvest but little flexibility in yield manipulation if total volume is to be maintained or increased.

(iv) Forests are biological production processes which tend to be characterized by a great deal of heterogeneity within any given system contrasting with production processes involving machinery and engineering control. Such forest and biological systems are characterized by great variation in output and by substantial uncertainty.

(v) Most forests have multiple uses, for example, timber production, wildlife protection, water-shed and soil protection, aesthetics and recreation. Thus the problems of joint products, conflicting objectives and trade-offs between different uses take on particular importance in forest project analyses.

1.6 Appraisal of plantation projects

The large investment in forest plantations, together with their previously discussed features, make it imperative that decisions on plantation projects be taken after adequate project planning, evaluation and analysis. The process of project planning involves the identification of various alternatives for achieving a given objective. Further consideration of these alternatives then follows

to narrow the choice to those which best seem to meet the development objective. Detailed designs for these chosen alternatives are then prepared. An appropriate economic approach for evaluation of the alternatives is cost-benefit analysis where acceptability is determined by the use of relevant criteria. Such criteria relate to how alternative projects affect society in terms of its objectives (F.A.O., 1979). One of the major objectives for public projects is to increase the aggregate of goods and services available to society from the use of a nation's scarce resources.

An analysis which looks at a project in terms of its contribution to the aggregate of goods and services available to society is called a social cost-benefit (SCB) analysis. A SCB analysis is, in a sense, merely an extension of the concept of financial analysis except that profitability is judged from the point of view of what is best for society from use of its limited resources rather than just market dollars. This is called social profitability to distinguish it from commercial profitability.

Both SCB analysis and financial analysis are similar in terms of general procedures. However, they differ in terms of what are included as costs and benefits and how costs and benefits are valued. In a financial analysis, benefits are defined in terms of actual monetary returns to a specific entity in society from whose point of view the analysis is being performed. In a SCB analysis, however, the concern is with what society gives up and what society gains from a project. Thus, costs in a SCB analysis are referred to as opportunity costs and project benefits are defined in terms of increases in goods and services available to society as a whole as a

consequence of the project (F.A.O., 1979).

The aim of this study is to present the methodology of cost-benefit analysis for appraising forestry plantation projects in India. However, practical data for the Indian situation are not readily available. It has, therefore, been decided to use Australian data as a starting point. This study uses data on forests of the Australian Capital Territory (A.C.T.) to develop a hypothetical plantation project. The project is based on the current plantation management practices of A.C.T. Forests, Department of the Capital Territory, hereafter referred to as A.C.T. Forests.

The study will first outline the use of cost-benefit analysis on this particular project. The technique of cost-benefit analysis will be described and then used to examine the efficiency of allocating resources to such a project. Both financial and social cost-benefit analyses will be carried out and the sensitivity of project profitability to changes in costs and returns will also be tested.

Second, the application of cost-benefit analysis to a similar hypothetical plantation project in India will be discussed. The objectives of employment, self-reliance and equitable income distribution, noted in section 1.1 as important considerations in the Indian development plans, will be evaluated in the light of such a project. The application to the Indian situation will consider the necessary modifications to the procedures outlined for a developed country (Australia) so that the analysis conforms to those Indian objectives. Unfortunately, the paucity of the Indian data means this discussion will be mainly qualitative.

CHAPTER 2

THE APPROACH TO SOCIAL COST-BENEFIT ANALYSIS

Society desires to allocate its limited resources so that these resources make the maximum possible contribution in satisfying social wants for goods and services. Most private investment decision-makers, however, are not concerned with the wider social implications of investment but rather with the effect of investment on private profits and sales or on the producer status of the investing agency. In other words, they are concerned with the commercial rather than the social profitability of a project. However, to decide on the worthiness of a project involving public expenditure, it is necessary to weigh up the advantages and disadvantages of such a project in terms of social gains and losses. Therefore, a social cost-benefit analysis rather than a financial analysis is required since it looks at a project from society's viewpoint.

2.1 Limitations of commercial profitability for public projects

SCB analysis differs from financial analysis simply because the conditions for maximising social welfare through optimum production and distribution of goods and services are not found in an economy in practice. Lerner (1946) indicated the conditions for optimum resource allocation in an economy as;

(i) marginal social benefit (msb) should equal value of marginal product (vmp), ensuring optimum distribution of

goods and services;

(ii) value of marginal product (vmp) should equal marginal private revenue (mpr), the condition for selling the product under conditions of perfect competition;

(iii) marginal private revenue (mpr) should equal marginal private cost (mpc), the profit maximisation rule for the producer and the criterion for maximum efficiency in production;

(iv) marginal private cost (mpc) should equal value of marginal factor (vmf), the condition for perfect competition in buying the factors of production; and

(v) value of marginal factor (vmf) should equal marginal social cost (msc), this condition being met if there are no externalities, tax distortions or public goods.

These five conditions may be conveniently abbreviated as

$$msb = vmp = mpr = mpc = vmf = msc$$

Because these conditions are not met in practice, social and private benefits and costs differ. The important reasons for this divergence are summarised below. The discussion is drawn mainly from Dasgupta and Pearce (1978).

(i) Imperfect competition. Imperfect competition is almost always likely to exist in the marketplace, rather than perfect competition. In the product market, under imperfectly competitive conditions, the profit-maximising firm will equate marginal revenue (MR), not price, with marginal cost (MC) so that price will be above marginal cost as shown in Fig.2.1.

DD is the familiar downward sloping demand curve. Under imperfectly competitive conditions, the profit maximising price-

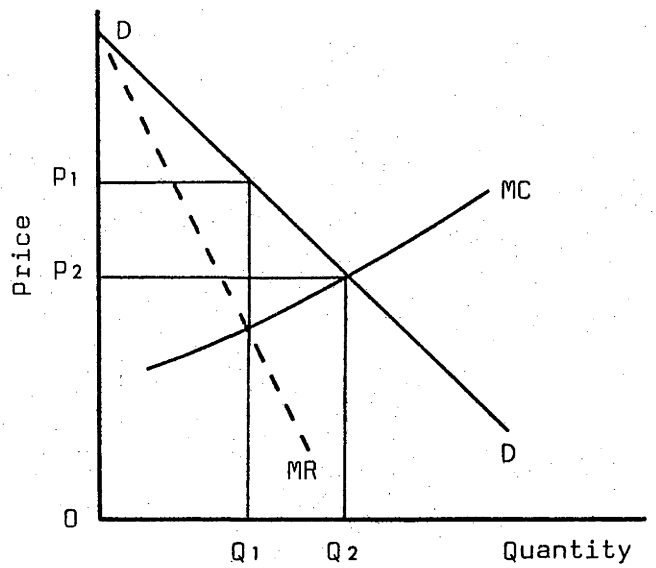

Fig. 2.1 Price under imperfect competition

quantity relationship P1-Q1 is determined by the intersection of MR and MC curves. Under conditions of perfect competition where MR is equated with price then the price-quantity relationship would be P2-Q2, determined by the intersection of the demand and supply (MC) curves. Clearly, under imperfect competition society pays a higher price since Pl is higher than P2, and less is produced, Q1 being less than Q2.

Similarly, in the resources market under conditions of imperfect competition, producers will buy resources to the point where factor prices equal the marginal revenue product which will be less than the value of the marginal product.

(ii) Externalities. Even in a perfectly competitive world

marginal costs will not reflect true social costs if external effects are present. An externality or external effect occurs whenever

(a) economic activity in the form of production or consumption affects production or utility levels of other producers or consumers (inter-dependence); and

(b) the effect is uncompensated.

Both these conditions must obtain for an externality to exist*. If inter-dependence exists, but the effect is compensated, then the externality is said to have been 'internalised'.

External effects** may be either benefits or costs. In the former case, condition (b) can be restated as saying that there is non-appropriation of benefits. In the latter case, the costs are uncompensated (Dasgupta and Pearce, 1978). Some common examples of external effects of forestry projects are given below.

A project may train a labour force in a region but the reward for that training may not be realised by the project alone for, after training, the workers are free to utilise their training on other projects. Similarly, a project for wood production may produce external benefits in the form of improvements in soil or watershed protection services from the forest land. It may also improve wildlife habitat and provide recreational opportunities. Alternatively, a forest project could have detrimental effects with regard to these protection and wildlife values therefore generating

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*Some authors regard the inter-dependence condition alone as sufficient for an externality to occur (Dasgupta and Pearce, 1978).

** Also frequently referred to as indirect effects.

external costs. In many cases these external effects are unpriced and are, therefore, difficult to enter into the financial analysis of a project and in consequence are often ignored. In any SCB analysis where society's welfare is the concern, both external benefits and external costs have to be considered. In any case of an external benefit, where the provider is not compensated, less than the socially optimum amount of the generating activity will result from private decisions. Conversely, whenever an external cost exists, an individual decision maker will choose to undertake more than the socially optimum amount of that activity generating the external cost. A major problem in resource and environmental policy is to develop property rights, laws or institutions to prevent such misallocation of resources, from society's view.

The externalities described above can be either technological or pecuniary. A technological externality occurs when the project in question alters the physical production possibilities of affected producers or the utility function of affected consumers. A pecuniary externality, on the other hand, relates to a change in the output or utility of a third party due to a change in demand. Increased production of sugarbeet, for example, will result in higher demand and hence higher profits for suppliers of agricultural machinery, seed suppliers and beet processors. Thus, pecuniary effects show up in changed prices and profits, but do not alter the technological possibilities of production (Dasgupta and Pearce, 1978). A SCB analysis is only concerned with technological externalities as they reflect real gains or losses. Pecuniary effects, on the other hand, reflect only transfers from one section

of the community to another, via changes in prices of products or factors. Therefore, these distributional items should be ignored in a SCB analysis as we are concerned with the value of the increment of output arising from a given investment and not with the increment in value of existing assets (Prest and Turvey, 1965).

Externalities arise because of the absence of, or failure to properly define and enforce property rights in certain areas of economic activity. Thus the absence of property rights to rivers and air space often leads to (over) pollution of them (unless use is strictly regulated) because no individual has the responsibility or incentive to manage and conserve the common property. In other cases where rights are well-defined, the law may not be enforced.

(iii) Public goods. Dasgupta and Pearce (1978) define a public good as having the following characteristics;

(a) non-exclusiveness; and

(b) non-rivalry in consumption.

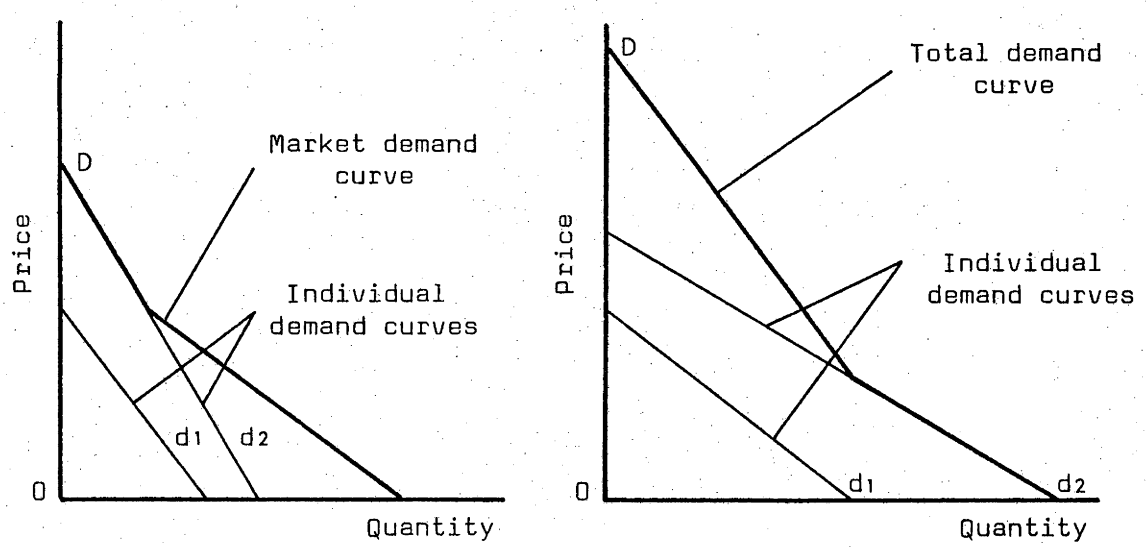
The first characteristic implies that if a good is provided to one person it is provided to others simply because the others cannot be excluded from also consuming it. The non-rivalry characteristic implies that consumption of the good by any one economic agent does not reduce the amount available for consumption by others in the community, unlike a private good. A private good, the normal type of good discussed in economic literature, is rival in consumption and excludable.

The converse of a public good is a public 'bad', e.g. air pollution. Public bads affect many users but here the element of

non-exclusiveness is less pronounced (Dasgupta and Pearce, 1978). It is possible to devise a system whereby those who are willing to pay for airfilters and smog masks can reduce the nuisance to themselves (Dasgupta and Pearce, 1978).

Public goods provide a particular kind of beneficial externality. The scenic beauty of a forest landscape or environmental protection are two examples of public goods provided by a forestry project.

From the definition of a public good it follows that the marginal cost of supplying the public good to an extra person is zero. The market demand curve for a public good is obtained by vertically summing the individual demand curves rather than horizontally summing them as in the normal private goods case, for a public good is consumed in equal amounts by each person as shown in Fig.2.2.



(a) Demand curve for private good

(b) Demand curve for public good

Fig. 2.2

The public goods case, where the areas under the individual demand curves are being summed, involves the summation of consumer surpluses, a concept which is discussed under (iv) below.

The characteristics of joint usage and non-exclusiveness may cause consumers to understate their preferences for a public good. For if a good is supplied to one individual, it must be supplied to all so that any one individual can understate the benefit to him of securing the good. Therefore, an observation of total willingness to pay for a public good would understate the true total willingness to pay. Alternatively, knowing that the cost of provision of the public good must be shared by all, individuals with intense personal interest in that good (e.g. landscape or defence) might grossly overstate the perceived benefits. In consequence the social benefits of public goods are difficult to assess by reference to revealed preferences expressed in terms of monetary bids (Dasgupta and Pearce, 1978). In such cases, political mechanisms (e.g. referendums) provide a potential means for expression of these 'non-market' preferences.

(iv) Consumers' surplus. The market value of a good produced by a project gives a floor value for the expected satisfaction from its consumption. A consumer may, in fact, expect and enjoy a higher level of satisfaction than that indicated by the market value. Therefore, to determine the total satisfaction from a project, it is necessary to determine the excess that consumers would be willing to pay for its output above what they would actually have to pay. This excess is called the consumers' surplus.

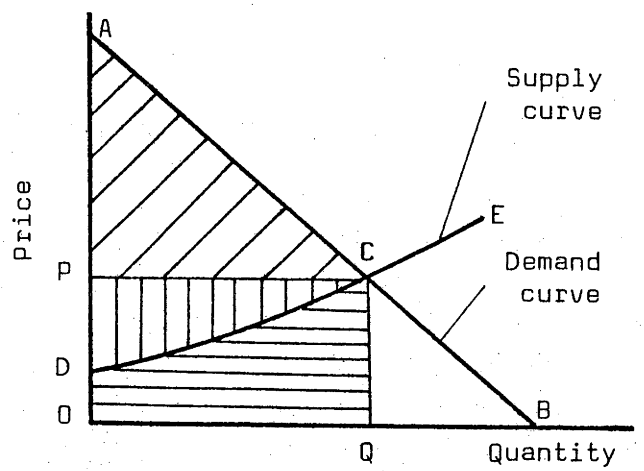


Fig. 2.3 Consumers' surplus

In Fig.2.3 line AB is the downward sloping demand curve and represents the quantity of project output consumers are ready to consume at a given price. If the market price is OP, they will buy OQ units of it and pay out an amount PCQO. However, some consumers would have paid more than OP for the product; their preferences are recorded on the demand curve above the ruling price, OP. This is the consumers' surplus and is represented by the area ACP in Fig 2.3. Therefore, in any market situation

total consumers' willingness to pay	=	consumers' expenditures	+	consumers' surplus

The total revenue received by sellers in a given market must equal the total consumers' expenditure. The actual cost to the sellers is the aggregate of the marginal variable costs indicated by the supply curve, or area ODCQ (Sinden and Worrell, 1979). Because the producers would be willing to sell their product at these marginal costs, if necessary, the total revenue (PCQO) they obtain includes a producers' surplus, the area PCD. Thus, consumers' total willingness to pay indicates the total benefits and producers' total

costs indicate the cost of producing these benefits (Sinden and Worrell, 1979). The total net benefit is therefore shown by area ACD in Fig.2.3.

In any market situation

net social benefit = consumers' surplus + producers' surplus

Commercial profitability considers only the actual revenues and costs. Consequently it takes no account of consumers' surplus. It is, however, a relevant consideration for a SCB analysis of public projects.

(v) Income distribution. In the classical theory of perfect competition and private enterprise, the questions of what and how much to produce in an economy are determined by consumers' sovereignty, that is, resources are allocated in accordance with consumer preference - what the consumer is prepared to pay. This, however, does not fully reflect the intensity of preference because the amount of money a person is willing to offer in a market depends on his level of income. A rich man may offer a good deal of money for trivia while a poor man may find it difficult to spend even very small amounts of money on essentials (Dasgupta et al, 1972). In other words, the price offered in the market does not allow for differences in the marginal utility of income : $1 to a poor man may yield more utility than $1 to a rich man. Therefore, market price cannot be taken as a guide to social welfare, for it includes the influence of income distribution on prices offered (Dasgupta et al, 1972).

(vi) Taxation. In practice market prices may contain elements of

indirect taxes, or alternatively, subsidies. Where the product is highly taxed, the use of unadjusted market prices will exaggerate the maximum benefits, while the benefits of a subsidized product would be undervalued (Dasgupta and Pearce, 1978). To correct for these distortions, all outputs should be valued net of indirect taxes and subsidies.

(vii) Increasing returns. The existence of increasing returns to scale mean that marginal cost will be below average cost. In the case of a public enterprise monopoly, the use of marginal cost pricing to value output will involve it in a financial loss. But the losses have to be financed and the methods of financing will themselves have welfare effects (Dasgupta and Pearce, 1978). In addition, industries with increasing returns (scale economies) have a tendency to become monopolies so that problems mentioned in (i) above become relevant.

(viii) Rates of discount. The necessary condition for the adoption of a project is that the discounted (or present value of) benefits should exceed discounted costs.* Given the cost and benefit (private or social) streams of a project, the size of the present value depends on the rates of discount. The social rates of discount may differ from the commercial rates of interest for several reasons. These reasons are examined in detail in section 2.3.

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*For superiority of the present value rule and elaboration of other measures of profitability, see Section 2.2.4.

2.1.1 Role of social cost-benefit analysis

In the preceding section, the important reasons for the divergence between private and social benefits and costs were discussed. Under these circumstances, SCB analysis is appropriate for the evaluation of public projects, the acceptability of a project being determined by the use of relevant criteria. SCB analysis is more necessary the greater the extent to which project expenditures differ from social costs, and project benefits from social benefits (Little and Mirrlees, 1974). The essence of SCB analysis is that it does not accept that actual receipts adequately measure social benefits, and actual expenditures social costs. But, rather, it does accept that actual receipts and expenditures can be suitably adjusted so that the difference between them will reflect the true social gain (Little and Mirrlees, 1974). The prices used for making such adjustments are called shadow prices (See section 2.4).

A SCB analysis generally proceeds on the implicit assumption that the existing distribution of income is correct from society's point of view. Increasingly this assumption is being questioned and where equitable income distribution is an objective of a public project, a further adjustment has to be made to actual receipts and expenditures. This is taken up in some detail in Chapter 7 in the context of the Indian situation.

A discussion of the measures of profitability commonly used in project evaluation to determine the worthiness of a project follows.

2.2 Measures of profitability

Cost-benefit analysis proceeds on the explicit assumption that a project is deemed socially worthwhile if the social benefits generated exceed the social costs. Several measures of profitability (or selection criteria) are used by project evaluators for determining the worthiness of a project. A discussion of these measures to help choose an appropriate selection criterion for this study is given below. The discussion is largely drawn from Dasgupta and Pearce (1978).

2.2.1 Net present value

The net present value (NPV) of a project is the difference between the discounted value of the stream of benefits and the discounted value of the stream of costs due to the project. The basic formula is

$$NPV = GPV(B) - GPV(K)$$

where GPV(B) = gross present value of benefits, and

GPV(K) = gross present value of costs.

For a project yielding a stream of benefits $B_1, B_2, \ldots, B_n$ and a stream of costs $K_1, K_2, \ldots, K_n$

$$GPV(B) = \sum \frac{B_t}{(1+i)^t} \qquad t = 1,2,\ldots,n; \text{ and}$$

$$GPV(K) = \sum \frac{K_t}{(1+i)^t} \qquad t = 1,2,\ldots,n$$

where i = rate of discount

n = life of the project

t = time period.

Formulated in this way, the worth of a project is expressed as a unique, absolute magnitude, with costs and benefits measured in the same units. The selection criterion is to accept the project if its NPV is positive, or, if there are alternative projects to choose from, then to choose that with the greatest positive NPV.

Usually, constraints exist on the resources available for investment in the public sector. When it is necessary to rank projects in order of preference to select the optimal combination of projects such that the total combined cost exhausts a budget, then valuing by NPV is not necessarily the best criterion. In such cases, the NPV criterion has to be modified to a benefit-cost ratio (BCR) and projects are then ranked by this ratio.

2.2.2 Benefit-cost ratio (BCR)

BCR is the ratio of the gross present value of benefits to the gross present value of costs, i.e. $\frac{GPV(B)}{GPV(K)}$. This ratio has sometimes been employed as a selection criterion in project evaluation. The general rule is

(i) Accept a project if $\frac{GPV(B)}{GPV(K)} > 1$.

(ii) In the face of capital rationing, rank by the ratio in the descending order of value until the capital budget is exhausted.

(iii) In choosing between mutually exclusive projects, select the project with the highest ratio.

The BCR criterion is sensitive to the classification of a project effect as a cost rather than a benefit, and vice versa. Thus all costs can be treated as negative benefits and all benefits as negative costs. In the case of the NPV criterion, the result is unaffected however the division is made. However, the benefit-cost ratio criterion will be affected by this division since it will affect the magnitudes of the numerator and the denominator. Also, the BCR criterion is inappropriate when applied to mutually exclusive projects. For example, the NPV of project A may be more than that of project B yet B may have a higher BCR. In general, the BCR criterion is not appropriate outside the rationing context discussed under 2.2.1.

2.2.3 Internal rate of return (IRR)

The present value and the BCR criteria require the use of some predetermined or guiding rate of interest to discount future benefits and costs. An alternate criterion is to calculate the interest rate which would give the project an NPV of zero and then to compare this solution rate with a predetermined rate of interest. In other words, the benefit and cost streams are presented in equation form as

$$\sum \frac{B_t}{(1+i)^t} = \sum \frac{K_t}{(1+i)^t} \qquad t = 1,2,\ldots,n \qquad (2.1)$$

where i = rate of interest which solves the equation and is the IRR

n = life of project

t = time period.

Once i is determined, the criterion for accepting or ranking projects is according to the magnitudes of their IRRs, providing they are in excess of the guiding discount (interest) rate. As with the NPV criterion, it still remains essential to choose an acceptable discount rate.

2.2.4 Present value versus internal rate of return

Many authors (for example Baumol, 1965; Turvey, 1963; Henderson, 1965; Mishan, 1976; Dasgupta and Pearce, 1978; Gittinger, 1972) have commented on the relative merits of these two criteria. The consensus appears to favour the adoption of the present value criterion, at least for public investment decisions. Some reasons given by Dasgupta and Pearce (1978) for dissatisfaction with IRR are;

(i) Sensitivity to economic life of projects. Where projects with different economic lives are being compared, the IRR approach may inflate the desirability of a short life project, the IRR being a function of both the time periods involved (t) and the size of the capital outlay (K) as shown in Section 2.2.3. The NPV, on the other hand, is not affected by the absolute magnitudes of the outlay.

(ii) Sensitivity to time phasing of benefits. Frequently projects have long gestation periods (e.g. plantations, dams etc.). The IRR will tend to be lower on such projects when compared to projects with a fairly even distribution of benefits over time, even though the NPV of the former may be larger.

(iii) Mutual exclusion. The IRR criterion is further complicated when used to compare mutually exclusive projects. The NPV and IRR may give different rankings of alternatives. Thus, project A may be preferred to project B on the basis of IRR but the NPV criterion may suggest B. The IRR rule is misleading here as it discriminates against B because of the larger size of its capital outlay. The IRR, in such cases, needs to be supplemented by additional rules.

(iv) Multiple roots. In computing the IRR it is quite possible to obtain more than one solution as the IRR is the solution to a polynomial equation. This objection is considered by many to preclude the use of IRR as a decision criterion.

(v) Changes in discount rates. It has been argued that the social rate of discount may change over time. The calculation of a unique IRR, in these cases, would not permit any easy comparison. The NPV criterion, however, does enable discount rate changes to be incorporated easily into the calculation.

(vi) Comparison of different rotation ages. If two alternatives maturing at different ages are compared, the IRR approach implicitly assumes that the entire return from the earlier maturing alternative can be reinvested during the remaining period at the same rate. In the timber growing context this implies that only capital is scarce and the land, whether free or at a cost, is available to completely utilize the available capital (Rustagi, 1976).

2.3 The rate of discount

In the context of the NPV investment criterion, the discount rate calculation defines a functional relationship that makes outputs at different points in time commensurable with each other by assigning to them equivalent present-values (Feldstein, 1964). The literature on the search for a social rate of discount (i.e. the discount rate for evaluating social benefits and costs from publicly funded projects) is voluminous and growing. Several approaches have been advocated. These are summarised below.

2.3.1 Market rate of interest

Individuals, as well as society, show a time preference which favours present consumption more than future consumption. The social time preference (STP) rate is a normative measure of the relative value of present and future consumption. More specifically, the social marginal rate of substitution between consumption at time t and at time t-1 is equal to 1+i, where i is the STP (discount) rate between those two years (Feldstein, 1972).

In a mixed economy the most obvious indicator of time preference is the market rate of interest. In a perfectly competitive system in which borrowing and lending take place, the interest rate adjusts until it equates simultaneously the rate of time preference of all individuals in society and the rate of return on productive investment. This would be a Pareto optimal solution with the total amount of investment and its distribution between public and private sectors being optimal. Thus, Hirshleifer et al (1960) and other advocates of this approach argue that the social

rate of discount should be set equal to the marginal rate of return on private investment before tax (i.e. market rate of interest).

The ubiquitous imperfections of the capital market should be an adequate reason for rejecting the use of any market interest rate in a public policy decision. In particular, one should note the institutional imperfections impeding access to credit, the divergence between lending and borrowing rates, the interference of risk and uncertainty and related problems that give rise to the simultaneous existence of multiple interest rates (Feldstein, 1964). Hirshleifer et al (1960) have suggested that government should take action to push down the market rates of interest to the social rate so that all investment decisions, whether in the public or private sector, are taken on the same basis. It is doubtful if it is a practical possibility, however.

Even if a perfectly functioning capital market is assumed or created as a result of government action, the question remains whether the market rate would reflect social decisions when other assumptions of perfect competition are not fulfilled. Some writers, for example Eckstein (1958), Marglin (1963) and Dasgupta et al (1972), believe that society as a whole, being perpetual, has a longer time horizon and, hence, attaches more weight to the future than short-lived private individuals. Thus, it is the lower social rate which is relevant for determining the allocation of society's current resources between consumption and investment. An important external effect has also been pointed out. Individuals may be ready to save (i.e. sacrifice for the future) only if others are ready to do the same. While such joint action is possible through public

policy, there is no way of bringing it about in individual market behaviour (Dasgupta et al, 1972).

Therefore, in a non-optimal situation, the STP rate will be different (lower) from the marginal rate of return on private investment. If the STP rate is used, resources would be drawn from the private sector and used in less efficient public projects. Inefficient resource allocation would result. On the other hand, if the market rate of interest is used, less public projects would be undertaken and therefore less than socially optimal provision would be made for the future. Recognising these problems, some economists have proposed a discount (synthetic) rate between the STP and the market rate.

2.3.2 Synthetic rate of interest

Because of the impracticability of achieving an optimal rate of saving and investment, second best solutions in which the social rate of discount lies between the pure social rate of time preference and the marginal rate of return in private investment have been proposed (Baumol, 1968; Harberger, 1972). If for each one dollar of public investment, θ is drawn from private investment, and therefore $(1-\theta)$ from current consumption, then the opportunity cost of one dollar is

$$\theta\rho/i+(1-\theta)$$

where ρ = the marginal rate of return on private investment, and

i = the social rate of time preference (STP).

We could then use a synthetic discount rate given by

$$\theta\rho+(1-\theta)i \ .$$

Amalgamation of the social rate of time preference with the opportunity cost of capital diverted from private investment as a synthetic rate will distort the intertemporal allocation of resources since the selection of projects will be biased towards those whose benefits arise earlier (ceteris paribus) by use of a higher discount rate (Ferguson and Reilly, 1976). The approach has been severely criticized by Hirshleifer et al (1960) on the grounds that the synthetic interest rate finally derived has an unknown allowance for risk premium in it (Layard, 1972). Feldstein (1972) makes out a cogent case against it by pointing out several cases where the approach breaks down. Besides, state investments may not displace private investment.

2.3.3 The social rate of time preference and shadow price for capital

It has been demonstrated above that one rate of interest cannot perform two functions in a non-optimal situation, i.e., it cannot serve to compare benefits and costs at different dates and also to measure the opportunity cost of private capital displaced by the project in question. It is, therefore, necessary to consider the social rate of time preference and to impute a shadow price* for capital diverted from alternative uses (Dasgupta et al, 1972). The STP rate is a measure of society's marginal rate of substitution of

*A shadow price is the price that an economist attributes to a good or service on the argument that it is more appropriate for the purpose of economic calculation than its existing price, if any, (Mishan, 1976).

consumption in year t for consumption in year t-1. It may be expressed as

$$i = e \times g \qquad (2.2)$$

where e = elasticity of marginal utility

g = rate of growth of per capita consumption

i = social rate of time preference.

In other words, the approach is to maximise the NPV of a public project at the STP rate, but, in evaluating the social cost of a public project, an opportunity cost (shadow price) reflecting the social value of resources in alternative investments replaces the money cost. The shadow price for capital is given by

$$p^{inv} = \frac{(1-s)q}{i-sq} \qquad (2.3)$$

where s = marginal propensity to save

q = marginal rate of return on investment.

s and q, therefore, have to be estimated for the economy as a whole. In this formulation, which follows Dasgupta et al (1972), present consumption is taken as the numeraire and a constant value of STP is assumed through time. A public project may displace both marginal public and private investment in which case separate shadow prices for government and private capital are required (Dasgupta et al, 1972). Thus a more elaborate formulation of p^{inv} which takes these factors into account is required. However, the extent to which such a formulation is an improvement over the above formula

depends on the extent of differences between the public and private propensities to save and the extent of differences between the public and private capital productivities. The estimates of the propensity to save and the productivity of capital are, in general, highly aggregated and it is difficult to distinguish between the public and private s and q (Dasgupta et al, 1972). Therefore, in this study, the aggregated formula for P^{inv} given above will be used. The value of P^{inv} will change over time if any one of the parameters, s, q or i change over time. However, if the time horizon over which i exceeds s.q is large, and this is assumed in this study, formula (2.3) will remain a reasonable approximation to P^{inv} (Dasgupta et al, 1972).

2.4 Shadow pricing

The causes of market failure have already been discussed in Section 2.1 and the use of a shadow price which reflects the true social value of a good or service instead of the market price was suggested in Section 2.1.1. Methods of calculating shadow prices have been outlined by Little and Mirrlees (1974) and Dasgupta et al (1972). Shadow prices are discussed in detail in Section 2.3.3 and, in the project context, in Chapters 6 and 7.

2.5 Inflation, taxes and subsidies

Most countries have an experience of inflation and the only realistic assessment of the future is that inflation will continue (Gittinger, 1972). One method of coping with inflation in a project analysis would be to inflate all costs and returns by the expected

average rate of inflation. It may, however, be quite difficult to forecast the future rate of inflation. For cost-benefit analyses, it is simpler to assume that the prices associated with costs and with benefits will both increase uniformly as a consequence of inflation and will not, therefore, change their relative values. This means that all prices can be expressed relative to the purchasing power of the dollar at some particular point in time, say, in terms of 1980 dollars.

In a financial analysis the inputs and outputs are valued in terms of market prices which include the effects of taxes and subsidies. Taxes and subsidies, however, have no place in a social cost-benefit analysis since they are merely transfer payments - society in general will be no better or worse off as a result of their imposition. Therefore, the effects of taxes and subsidies should be excluded from the prices of goods and services to obtain the true social worth of inputs and outputs.

2.6 Approaches to evaluating indirect effects

Sinden (1967) critically reviewed the various approaches that have been taken to evaluate indirect benefits. The principal approaches are those based on actual or potential cash flows, willingness to pay and implicit evaluation by society. These are briefly outlined below.

2.6.1 Actual or potential cash flows

There are several methods for valuing indirect benefits using this approach.

(i) The cost of providing the benefit. The value of indirect benefits has frequently been set at the cost of their provision or replacement (Sinden, 1967). An application of this method has been the evaluation of benefits from dams and similar developments by the United States Bureau of Reclamation. In one of their analyses, the development costs were estimated in dollars and an equivalent amount was assigned to benefits. The United States National Parks Service has used a similar method in some of their work. However, the method only estimates the cost of providing the benefit and makes no assessment of the reaction to the project (i.e. total willingness to pay) of those who benefit. Presumably, the cost of providing the benefit is the minimum value of the benefit, although even this assumes the benefit was provided in the cheapest possible way.

(ii) The user expenditure method. This method estimates the expenditure made by tourists when visiting a particular area. The method is limited in that some of the expenditure will be spent again outside the area to purchase goods subsequently sold to other recreationists. Despite its obvious defects, this method has been used in some valuations and can be particularly useful in determining the local impact of recreation (Sinden, 1967).

(iii) The value added approach. "Value added" is the difference between the gross expenditure and the costs of raw materials or semi-finished products which are incorporated in the final product. This measure is an improvement over the user expenditure method because it excludes the portion of total expenditure which is respent outside

the local area to buy in recreational goods and services.

(iv) Imputed values. An imputed value for a resource benefit is one which is derived from a similar determinable benefit elsewhere. For example, in the evaluation of fishery resources the value of units of sport fishing is based on the dockside price of equivalent commercially caught fish. This application, however, tends to impute value to the fish caught rather than to the activity (fishing) itself.

The above methods can be criticized on the grounds that, first, there is a tendency to value the product, e.g. the fish, or the expenditure rather than the actual benefit or activity itself. Second, they are not based on the principle that the economic value of a benefit is measured by the willingness of consumers to pay for its consumption.

2.6.2 Methods based on willingness to pay

Knetsch and Davis (1966) point out that use of outdoor recreation differs only in kind, not in principle from consumption patterns of other goods and services. The most relevant economic measure of recreation values is willingness to pay on the part of the consumers for these services. Total willingness to pay may be determined by interviews or by estimating the cost of travel to a recreation area. In both cases, conceptually, the attempt is to measure the willingness to pay by consumers of outdoor recreation services as if they were purchasing these recreation services in the open market. This willingness to pay is measured by the area under

the demand curve. The demand curve is estimated from the relation between the quantity of use of specific areas and the expenditure required to use those areas.

The essence of the interview method for measuring recreation benefits is the use of a properly constructed interview approach to elicit from recreationists information concerning the maximum price they would pay in order to avoid being deprived of the use of a particular area for whatever use they make of it (Knetsch and Davis, 1966). Consumers are approached directly and, through questionnaires, are asked to relate their use of a facility to a range of entrance fees and alternative activities. In a survey in Maine, Knetsch and Davis (1966) found the willingness to pay of recreationists to be acceptably and significantly related to explanatory variables such as income and acquaintance with the area. They felt that the interview method provided a valuable approach.

The theory of the travel cost method has been well expressed by Sinden and Worrell (1979). The central theme of the method is that the cost of travelling to a place influences the number of visits made to it. This can be expressed as a demand function

$$Q_i = f(TC_i, X_i, \ldots, X_n) \qquad (2.4)$$

where Q_i = quantity of activity i taken per unit of time by a given sample of people,

TC_i = the travel cost in activity i, and

X to X_n are other explanatory variables.

A demand curve for i is derived by plotting Q_i against TC_i for a range of travel costs. All other variables are held constant at their means.

The travel cost method is based on the following assumptions;

(i) all users obtain the same total benefit, and this is equal to the travel cost of the marginal (most distant) user;

(ii) the consumer's surplus of the marginal user is zero;

(iii) travel cost is a reliable proxy for price; and

(iv) people in all distance zones would consume the same quantities of the activity at given monetary costs.

The travel cost method commonly employed is also called The Method for the Whole Experience, after Clawson and Knetsch (1966). The method develops the data for a demand curve by measuring the number of visits to the resource being valued and the travel cost of those visits. Assumption (iii) above enables the substitution of travel cost for price and travel expenditure is taken as a measure of benefits. A demand curve relating the number of visits to the travel cost per visit is plotted. The total willigness to pay for the use of a resource is then estimated; the consumers' surplus indicates the net social benefit provided by the resource being valued.

The methodology for determining the whole experience can only estimate the minimum value of the resource because it assumes that users from the most distant zone have no consumers' surplus and, therefore, there is usually no opportunity for visitors to demonstrate their maximum willingness to pay for the recreational

opportunity itself (Sinden and Worrell, 1979). Clawson (1959) had an extended methodology in which the second problem did not occur. He investigated the effect of changes in the entrance fees on the total number of visits and derived a new demand curve for the recreational opportunity itself. This method, therefore, estimates the maximum willingness to pay by simulating what people would pay for the use of the site itself, after having paid the travel cost of getting to it (Sinden and Worrell, 1979).

A variant of the travel cost method is the use of travel distance rather than travel cost as a proxy for price in cases where travel costs were not significant in explaining the recreation use.

Further developments of the travel cost method have taken place in an effort to overcome its weaknesses. For example, the greater the travel distance the greater the likelihood of there being attractive substitute sites in the intervening distance. One approach to this problem has been to add a distance variable to the demand function. Income of consumers can also affect the slope and position of the demand curve but it may not affect all recreation activities. Some attempts have been made to adjust demand curves for income effects (Sinden and Worrell, 1979). Another weakness of the method pointed out by these authors is the limiting assumption that the dis-utility of overcoming distance is solely a function of money costs. However, the travel time (time costs) can also be important.

The travel cost method is suitable whenever travel cost is a significant determinant of use and the underlying assumptions of the method can be accepted. The method has been applied to a range of

situations in the U.S.A. with considerable success (Sinden, 1967). It was also applied by Ferguson and Greig (1973) in a study at Mt. Macedon, Victoria. They related the price of recreation (travel cost to the area) and the quantity of recreation (number of visitor days) through a demand curve and analysed the effect of changes in entrance fee on the total number of visits.

2.6.3 Implicit evaluation by society

Society also implicitly evaluates the uses of a resource through political or managerial decisions. Two methods can be used to quantify these implicit evaluations by society.

(i) Evaluation by analogy. Evaluation by analogy attempts to correlate past managerial or political decisions into a systematic set of monetary values. These values can then be applied to similar situations where no decision has been made. A scheme for the determination of the aesthetic or special appeal of single trees and woodlands was devised in England using this approach. The features of each tree or woodland were noted with respect to landscape, tree form, life expectancy and uniqueness and were assigned ordinal numbers from one to four. These values were then totalled and multiplied by monetary values derived from previously independent valuations of trees and woods (Sinden, 1967). The method has serious difficulties since it assumes that previous decisions were both rational and consistent and based on the features measured. Besides, past decisions may also be restricted in the range of

possibilities considered. Despite this, there may be situations in which consistency is evident and the range of decisions is sufficient to justify its application.

(ii) The opportunity cost method. If the management of a forest tract feels that the present balance of wildlife protection and timber production is optimal in some social sense, then the value of wildlife is derived from the marginal rate of substitution of timber output which is foregone at the margin. Gregory (1955) notes that the opportunity cost concept does not presume to determine the intrinsic value of wildlife but it does identify the value which management sets through its decisions. Similarly, if a fixed budget is to be spent on projects which yield water and recreational benefits, it is usually necessary to reduce water yields. Thus, the value of recreation is the opportunity cost which is represented by the value of the water which is foregone.

In this chapter the theory of cost-benefit analysis has been briefly reviewed to develop the background for the analysis of forest plantation projects. The literature on the methodology of evaluating indirect benefits, as summarised here, is still at an early stage, and because of the data and time constraints, indirect effects have not been evaluated in this study. The next chapter describes the plantations in the A.C.T. which form the basis of the project under study.

CHAPTER 3

DESCRIPTION OF PLANTATIONS IN THE A.C.T.

3.1 History of plantation management

Forest management in the A.C.T. began in 1908. Its subsequent history can be placed into three phases as follows.

Early plantings occurred in the period 1908-1925. These were necessarily exploratory to establish which species would thrive in the area. T.G.C. Weston, who was appointed as Officer in Charge of afforestation in 1913, dominated this phase. He made trial plantings of numerous trees in Westbourne Woods, and in 1915 established the first pine forests on Mount Stromlo. His work laid a strong foundation for later developments (Rodger and Jacobs, 1955).

The afforestation phase, which followed early plantings, covered the period 1926-60. Its initiation followed from the recommendation of C.E. Lane-Poole, the Commonwealth Forestry Adviser, in a report to the Commonwealth Government. In 1925, Lane-Poole, recognising the limited commercial value of native eucalypt forests, recommended the planting of 20 000 acres (about 8 000 ha) of Pinus radiata for commercial forestry. A planting programme of 500 acres (about 200 ha) per year, based on a 40 year rotation, was implemented in 1926.

Some of the early plantings of this period had other objects of management apart from wood production. For example, the Stromlo forest was planted to improve operating conditions for the observatory and to control soil erosion. At the Cotter Dam, the control of soil erosion and improved water quality were prominent

considerations.

During the Depression the forests provided much unemployment relief and after World War II, local forests provided the only timber available to the developing national capital. In 1954, the Minister for the Interior approved an increase in the target plantation area to 40 000 acres (about 16 200 ha).

The integration phase which commenced about 1960 involved the integration of the management of A.C.T. forest resources with that of all other lands and natural resources with the aim being to maximise benefits to the community. In 1967, Cabinet reaffirmed the programme for 40 000 acres (16 200 ha) net of Pinus radiata and by 1970, 31 000 acres (about 12 550 ha) had been planted with exotic commercial species (Boden, 1971). As large quantities of wood became available from the plantations, new industries were planned and encouraged to make profitable use of wood. Since 1970, the Commonwealth Government, through A.C.T. Forests, has entered into a number of agreements with forest industry for the supply of pine logs. Most agreements are long-term, extending into the next century. At present A.C.T. Forests' log supply commitments are 177 000 m^3 per annum with most of the demand (134 000 m^3) being for logs over 20 cm diameter. The main buyer is Integrated Forest Products (90 000 m^3), a company producing plywood and scantlings for house frames. Other buyers are local sawmills cutting specialist products as well as general building materials, and firms utilising roundwood, particularly for treated posts and poles.

3.2 Plantation sites

A.C.T. Forests currently has about 15 000 ha of established pine plantations out of which nearly 14 000 ha are of *Pinus radiata*. These plantations are concentrated in the following four forests (Map 1).

3.2.1 Uriarra plantation

This plantation, with compartments varying in age from 1 to 40 years, is spread over 4 000 ha and has the largest area of older stands among all forests in the A.C.T. It contributes nearly 40% to the total supply of sawlogs to local industry. Topography in this plantation is undulating to steep with altitude varying from 610 to 1160 m above mean sea level. Soils are generally a good deep grey to chocolate loam with occasional outcrops of hardened shale and slate overlying igneous quartz, porphyry or diorite (Shoobridge, 1951). It is well drained and fertile. Trees here have put on almost twice as much volume growth as in the Stromlo plantation. Rainfall is 71 cm per annum (Shoobridge, 1951).

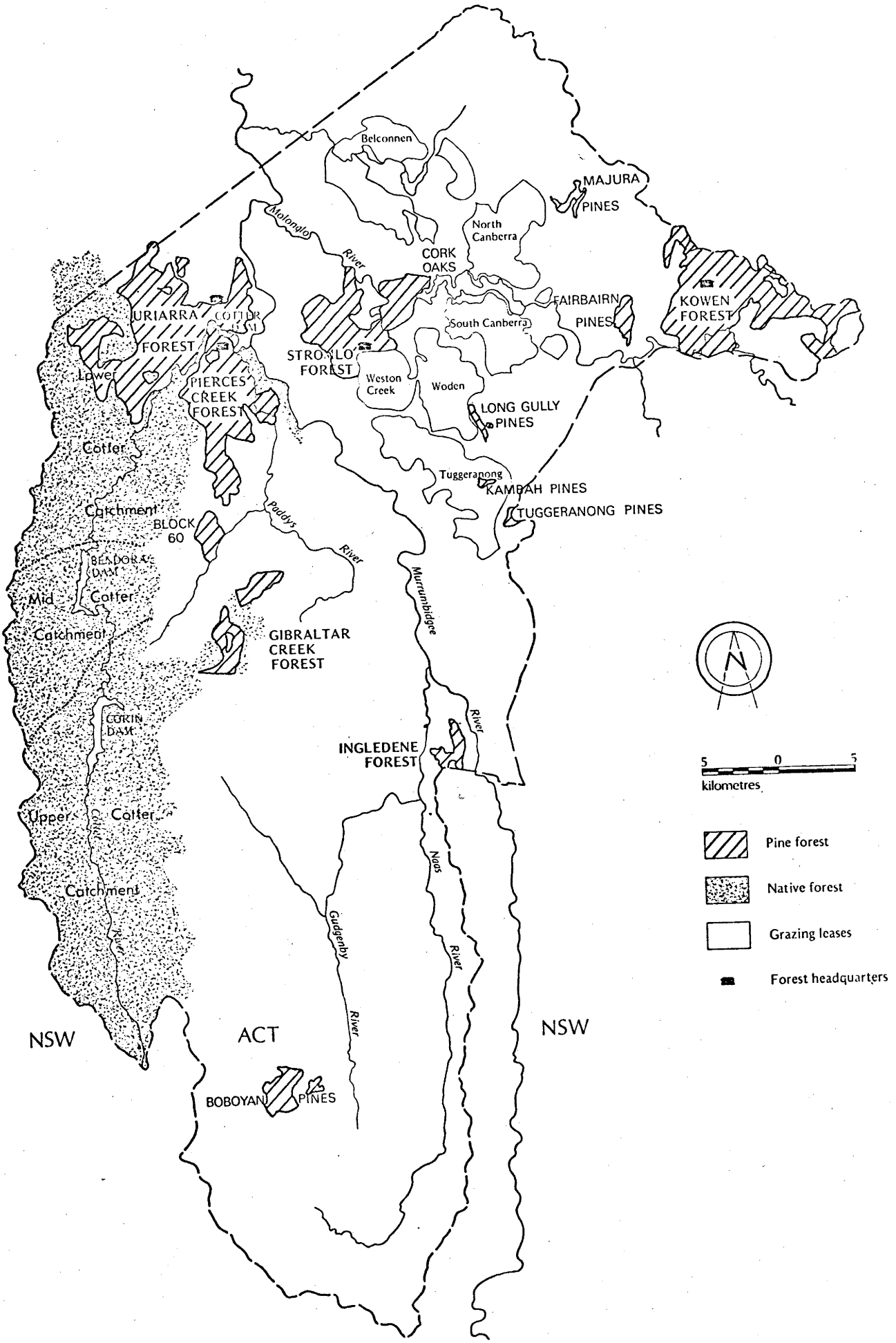
Two types of areas have been planted in Uriarra;

i) degraded grazing lands for soil conservation purposes, and

ii) dry to intermediate sclerophyll eucalypt forests.

Indigenous eucalypts in the area were *Eucalyptus stuartina*, *E. radiata*, *E. dives*, *E. macrorrhyncha*, *E. maculosa*, *E. rubida* and *E. viminalis*. The native forest had an average height of 21.35 m rising to a maximum of 30.50 m and with an average diameter at breast height (d.b.h.) of 38.10 cm up to a maximum of 101.60 cm (Shoobridge, 1951).

Map 1 FORESTS OF THE AUSTRALIAN CAPITAL TERRITORY



3.2.2 Kowen plantation

This is the biggest block of plantation in the A.C.T. covering an area of 4 500 ha. Plantation compartments vary in age from 1 to 40 years. Most of the planted area was old grazing land which had been taken over by wattles (Acacia spp.) before being reclaimed for plantation purposes. Some poor, dry sclerophyll eucalpyt forest was also cleared for plantation establishment. According to Shoobridge (1951), the species present in that forest included Eucalyptus melliodora, E. rossii, E. polyanthemos, E. macrorrhyncha, E. maculosa, E. dives, and E. stuartina, with an average height of 12.20 m rising to a maximum to 21.35 m in the gullies, and an average d.b.h. of 25.40 cm, approximately. He also noted the general absence of natural grasses, except in clearings, gullies with deeper soils and moister easterly slopes.

The topography of the area varies from undulating lowlands to rather steep, hilly country (on the north-eastern boundaries in particular), intersected by some creekbeds and gullies (Byron, 1971). The altitude varies from 650 to 920 m. Both deep massive-earths and uniform medium-textured soils are found, the latter being characteristically stoney and gravelly, shallow and of low natural fertility. Generally however, shallow sandy-clay-loams predominate in the area, except for the alluvial beds (Byron, 1971). Drainage on the slopes is good and the rock is well-broken so that roots penetrate easily to moister subsoils (Shoobridge, 1951). The average annual rainfall is 60 cm.

It is a lower quality site compared to the two western forests of Uriarra and Pierce's Creek. However, the form of the trees is

excellent and, given the same site index, Kowen would produce the most basal area increment across all forests.

3.2.3 Stromlo plantation

This plantation, 2 500 ha in extent, was established on grasslands which originally carried open savannah woodland primarily composed of *Eucalyptus melliodora*, *E. blakelyi* and *E. macrorrhyncha*. The average annual rainfall is 60 cm. Topography is generally undulating with rather steeper slopes on the low hills (Shoobridge, 1951). Plantation compartments vary in age from 1 to 55 years. Soils are acid volcanics of low fertility and poor internal drainage. As the rainfall is also low, this forest has the lowest site quality of the four forests in this study.

3.2.4 Pierce's Creek plantation

The total area of Pierce's Creek forest, including Gibraltar Creek, is 4 000 ha with compartment ages varying from 1 to 40 years. The plantation was established mainly on cleared dry sclerophyll forest. Some degraded grazing lands were also planted. The original vegetation in the area was a *Eucalyptus melliodora* - *E.blakelyi* alliance with an *E. macrorrhyncha* - *E. rossii* alliance on the higher country to the south (Pryor, 1955). The mean annual rainfall is 78.8 cm (Herberle, 1968) and is fairly evenly distributed although December is the driest month and October the wettest.

The sandy soils are derived from granodiorite parent material and are of moderate fertility. They are slightly better drained

than the soils in Kowen and Stromlo. Altitude in the forest varies from 518 to 1160 m.

The following sections describe the plantation establishment and management practices for the four forests.

3.3 Nursery practice

The nurseries of A.C.T. Forests produce only about half of the required planting stock. The balance is obtained from the Forestry Commission of New South Wales.

The soil in the nursery is worked and mounded to form seed beds about 1.20 m wide with standard agricultural implements attached to a tractor. Seed is treated and selected by dropping it into a drum of water. Seed which continues to float after 24 hours is discarded while the remainder is ready for sowing in the seed bed. Sowing is done in September-October with a Stanhay Seeder, a three-point linkage implement that plants a bed at a time with seven seedling rows. Seedlings are spaced with about 40-45 per metre. The beds are covered with mulch of well-rotted sawdust or pine litter and watered with a sprinkler. Germination starts after about two weeks and extends for 7-10 days with a 90% success rate on the average. Irrigation at this stage is critical for the survival of seedlings. A pre-emergent weedicide, a mixture of Gesamil and Dacthal, is applied as a low volume spray from a tractor mounted boom. Three beds are sprayed at a time.

The seedlings are ready for planting out in June-July (9-10 months old) when they should be 30-35 cm high. Before lifting, seedlings are loosened by running a blade underneath the bed with a

tractor.

The seedlings may be root-wrenched once if they are growing well. This is done by cutting the tap root 8-10 cm below the surface with a tractor-mounted bar or a thick wire. If this is done it is necessary to irrigate immediately to avoid excessive wilting of seedlings. Lateral root development, hardening of seedlings and an increase in mycorrhizal development are favourable responses to root-wrenching. However, root-wrenching does temporarily slow down seedling growth and can cause problems in obtaining planting stock of the right size by June. In consequence it may not always be done.

There is little damage to seedlings in the nursery from insects and birds. However, fungal diseases do cause some losses. Efforts to control these diseases are mainly by soil fumigation and crop rotation. In the nurseries of the Forestry Commission of New South Wales crop rotation and root-wrenching are routine practices.

The cost of production is $30 per 1 000 seedlings.

3.4 Current plantation establishment practices

Current plantation establishment, like most of the area now under Radiata pine plantations in the A.C.T., is on previously degraded grazing land. Therefore, the plantation establishment techniques described hereunder are for such grazing lands.

Currently, soil preparation is done by ripping using a bull-dozer with a ripper attachment. The operation is done about a year in advance of planting and is beneficial in several ways. Ripping loosens the soil compacted by grazing, reduces run-off considerably and restricts weed competition. This enables seedlings to get a

good start. The bull-dozer usually makes only one pass over the area and the operation costs about $50 per ha.

Open-rooted stock are planted by hand in winter (June to August) by making slits along the rip line. Rarely, but when weather conditions are favourable, planting may also be done in May and September. Usually about 1 000 - 1 200 seedlings are planted per hectare by contract labour at an average cost of $90 per ha.

Most soils are deficient in phosphorus and nitrogen. Therefore, ammonium sulphate (P - 11%, N - 12%) is applied at or just before planting. In the former case, individual plants are given 150 grammes of fertilizer, applied in a slit near the plant. In the latter case, fertilizer is spread along the rip line. Borax mixture has also been used, especially on volcanic soils (e.g. Stromlo), to overcome boron deficiency. It appears to have a favourable effect on the plantation, especially in drought years.

Spot application of a broad spectrum herbicide (trade name Velpar) is done by hand with a knapsack spray in the spring following planting to restrict weed competition. The treatment is generally a once only operation.

The plantation is surveyed in March-April following planting to determine the survival rate. Refilling is done in winter, i.e. a year after planting, but only if the survival rate is below 80%.

In the second and subsequent rotations, planting is not done as natural regeneration is adequate to restock the felled area. The natural regeneration is thinned out two years after clearfelling to leave 600-700 stems per ha and is then pruned as in the first rotation. No fertilizer or herbicide is used.

3.5 Plantation management

Pruning is done with the aim of producing the maximum quantity of high quality wood per tree. The operation is done by hand with shears and saws when the plantation is 8-10 years old. The height to which stems are pruned varies from 2.2 m to 2.4 m.

Thinning aims to produce the maximum possible quantity of bigger logs (more than 20 cm diameter) since demand for small-sized material is limited (Section 3.1). The plantation is thinned from below 3-5 times at 4 to 8 year intervals starting at about age 15-20. Normally four thinnings are done at 5-year intervals.

A.C.T. Forests currently plans to stabilize the rotation length of Pinus radiata plantations at 35 years. It uses a simulation model of these plantations to guide its management decisions. Growth and yield vary among different forests because of the differences in site quality. The present study, however, is based on the log yield obtainable from a 'typical' hectare (which may be a rough average across all forests) of A.C.T. Forests.

3.6 The project in this study

This study assumes a hypothetical forest estate of 14 000 ha which would be developed by establishing 400 ha of Pinus radiata plantation annually over a 35-year period. A planning horizon of 71 years (two rotations plus one year for advanced planning) has been considered for each block (year of planting) of 400 ha. Data regarding costs, yields and revenues used in this study are based on those for A.C.T. Forests and are summarised in Chapter 4 and in

Appendix Table A.1. All costs and revenues (except those for 7-14 cm diameter class material) are those prevailing at the beginning of 1979. This cost-price structure is assumed to hold throughout the project life.

Though this hypothetical project has been conceived on the basis of the A.C.T. data, it is in no way a representation of A.C.T. Forests itself. Forests in the A.C.T. have been established by a variety of methods over varying sites using several silvicultural regimes. The rate of plantation activity has also been uneven with the result that there is now an uneven distribution of age classes in the forests. The project in this study, on the other hand, considers only the current method of establishment over one uniform site type and under one silvicultural regime. It does not consider past (sunk) costs incurred in plantation establishment and management. The results of this study, therefore, cannot in any way be taken as an indication of the profitability of A.C.T. Forests as an organization.

CHAPTER 4

PROJECT COSTS AND BENEFITS

Before valuing costs and benefits it is first necessary to identify them. Any effect (cost or benefit) of the project should be identified and measured on the basis of the difference in a given situation with and without the project. The costs and benefits of a project fall into three broad categories : direct, external or indirect, and secondary. A discussion of these effects and their estimation in the project context follows.

4.1 Direct costs and benefits

Direct costs and benefits are those which enter into the financial analysis of a project, i.e., are directly traded for money in a market. Direct costs comprise the value of goods and services needed to establish, maintain and operate a project, and to make the immediate products of the project available for sale (Watt, 1973). Direct benefits of a project are the value of the immediate products and services arising from incurring the direct costs. In the context of this project, they are the revenues realised from the sale of logs.

Ideally a physical flow table should be developed to identify the various inputs by categories, such as manpower, land, equipment and materials that would be needed over different years of the project life. Similarly, to complete the physical flow table, the resulting outputs should be identified in terms of when they would be sold. Later, unit values can be assigned to these inputs and

outputs to develop cash flows. This two-step procedure is particularly helpful in identifying the relative importance of individual components of costs and benefits and, later, in developing shadow prices for the social cost-benefit analysis.

Direct costs and benefits of the project, based on those for A.C.T. Forests, are summarised below.

4.2 Direct costs

Data regarding physical quantities of inputs were not available. Costs have, therefore, been presented only in money terms for various plantation operations and other components of direct project costs. These costs have been divided into four components - field costs, capital costs, administration costs and annual maintenance costs.

4.2.1 Field costs

Field costs comprise the labour costs, machine costs and local overhead costs incurred in establishing and managing the plantation. Overhead costs include the labour overheads such as annual leave, sick leave, wet time, travelling time, public holiday pay, etc., and local supervision costs. Field costs are given in detail in Appendix Table A.1.

4.2.2 Capital costs

The costs of land, buildings, fire equipment, machinery and roads are included under this component of direct costs.

It is necessary to consider explicitly the value of land at the beginning and at the end of the project because the project NPV is not being calculated over an infinite series of rotations. However, land in the A.C.T. is owned by the Government and leased to the public. One way of valuing the project land would be on the basis of the rental cost of similar land. Therefore, even though no rent is to be paid, the rental equivalent may be a convenient proxy to use in the financial analysis for the net value of production forgone. A study of land records and prices/rentals could help determine the appropriate rental for project land. Another measure of land value is the net value of production foregone directly due to the project. This approach can be used both for financial and social cost-benefit analyses. However, none of these approaches could be pursued in detail because of data and time constraints. Imputing a value to land at the end of the project could be equally difficult. It is reasonable to expect that during the life of the project the real value of land may change. This is because the alternative uses of land may change during the project life and so the opportunity cost of land will also change. This change in price of land reflects a true change in the contribution of land to production and, therefore, should be taken into account. Needless to say, it is extremely difficult to foresee future changes in the value of land.
However, despite the difficulties mentioned above, it is necessary to place proper values on land both at the beginning, and at the end, of the project.

One way of sidestepping the question of changing land value is to assume a constant value in real terms since this approach, which

is normally used for other project costs and benefits, can be applied to land values too. Reliable estimates of land prices/rentals could not be obtained because of the previously mentioned constraints. Discussions with managers from A.C.T. Forests revealed that the current price of degraded grazing lands in the hilly country close to the forests may be about $30 per ha. This value for land has, therefore, been assumed in this study.

The cost of buildings includes expenditure on housing for plantation workers, garages, workshops, stores, general office buildings, etc. Precise data on the breakdown of capital costs are not available. The present (written down) value of the capital assets of A.C.T. Forests is about $2.4 million. However, with the improvement in transportation facilities there would be little need in the future for housing the plantation workers in the project area. Therefore, housing costs were ignored while estimating the capital costs. Discussions with the managers from A.C.T. Forests and the work of Sar (1978) were used as guides in preparing these estimates. It is assumed that, apart from logging roads, most of the capital cost would be incurred during the first year of plantation establishment. This cost has been taken as $200 000. It has been further assumed that another $60 000 would be incurred in year 5 and that thereafter $60 000 would be needed every 10 years for replacements, major overhauls, renovations, etc. up to year 65.

The road costs are incurred just before the commencement of harvesting, i.e., first thinning. The expenditure is, therefore, incurred in year 15 of plantation establishment, a year before the start of harvesting. Based on the information supplied by A.C.T

Forests, an average road density of 30 m per ha has been assumed. The road costruction cost varied from $4 000 to $6 000 per km. The median figure of $5 000 per km has been taken as the road construction cost for the purpose of this study.

The costs of land and the logging roads (apart from main roads) can be easily allocated to a particular year of planting. Other capital costs are distributed over the entire project and cannot be so allocated.

4.2.3 Administration costs

These costs include the salaries of and administrative expenditure by the head office which can be directly attributed to the development of plantations. They also include other overhead costs such as rents, stationery, pay roll tax, worker compensation, etc.

It was necessary to estimate administration costs since no records of the proportion of time spent (by head office staff) in connection with the development of plantations were available. Current administration costs of A.C.T. Forests are in the region of $700 000 annually. However, this expenditure includes the costs incurred by head office in activities not connected directly with plantation management, for example, developing trail bike and other recreational facilities, land management for conserving the environment, participation in the deliberations of inter-departmental committees and answering government and public inquiries.

Discussion with managers from A.C.T. Forests revealed that administration costs in Australia vary widely from state to state.

Sar (1978) has taken them to be 20% of the direct field expenditure. In this study, administration costs have been assumed to be 25% of all costs (except land) which can be allocated to a particular year of planting. These costs comprise the field costs, costs of logging and the annual maintenance costs described below. It is obvious that little reliance can be placed on this estimate of administration costs. Therefore, the sensitivity of project profitability to variation in these costs has been assessed in Chapter 5.

4.2.4 Annual maintenance costs

These costs comprise expenditure incurred in protecting the plantations from fire, maintenance of fences, roads, etc. Based on the information supplied by A.C.T. Forests these costs have been taken as $30 per ha per year starting from year 1 and terminating in year 70.

4.3 Direct benefits

Data regarding direct output (logs) are available in physical terms. The project revenues have been developed by multiplying (log) volume yields from plantations with unit prices. The costs incurred in harvesting and transporting the logs to the mill have been developed in a similar manner. The procedure is outlined in the following sections.

4.3.1 Volume yield

The volume of logs, in different size classes, obtainable from

a representative hectare of plantation at specific ages was developed with the help of a simulation model of A.C.T. Forests.* The data were supplied by A.C.T. Forests and are presented in Table 4.1. The volume yield corresponds to an average site index** of 23 (approx.). Two categories, high (regime R_1) and low (regime R_2) demand for small-sized material (7-14 cm class) were included.

At present the demand for small-sized material is low and some of this material is left in the forest. That which is extracted is sold as fence posts and case logs. Current harvesting and sale of this material barely cover costs and sometimes even result in a small loss, especially in difficult terrain. A.C.T. Forests expects, however, that in the next few years, the demand for wood chips for making pulp and particle board will rise sufficiently for the logging and sale of small logs to be economic. In such circumstances, most of the small-sized material would be extracted. Therefore, this expectation has been built into the basic model described in Section 4.3.4.

4.3.2 Delivered prices of logs

The logs are sold delivered to the mill under agreements between A.C.T. Forests and the local forest products industry. The mill door prices used for this study are based on the data supplied by A.C.T. Forests and are shown in Table 4.2.

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* Developed by I.S. Ferguson, Department of Forestry, A.N.U.

** Defined as the mean height in metres of 40 tallest trees per hectare at age 20.

TABLE 4.1

VOLUME YIELD FROM PINUS RADIATA PLANTATIONS IN THE A.C.T.

SITE INDEX = 23

Age (yrs.)	B.A. pre-thin (m^2/ha)	B.A. post-thin (m^2/ha)	New Stocking No.	Log volume (m^3 u.b.) in size classes (cm)									Total Volume Regime	
				7 - 14 Regime		15-19	20-24	25-29	30-34	35-39	40-44	45+		
				R_1	R_2	Regime R_1 and R_2							R_1	R_2
15	33.1	22.3	596	37.8	18.9	8.4	3.9	0.4	0.0	0.0	0.0	0.0	50.5	31.6
20	33.7	25.0	410	12.4	5.0	12.7	12.3	5.1	1.1	0.0	0.0	0.0	42.9	36.2
25	35.1	27.4	296	4.2	2.3	9.2	14.7	9.5	4.4	1.1	0.1	0.0	43.2	41.3
30	36.3	29.6	230	1.0	0.7	5.0	11.1	12.4	9.3	7.5	3.9	0.8	51.0	50.7
35	37.5	45.6*	0	1.3	1.3	4.7	33.2	75.6	76.6	68.4	44.7	32.7	337.2	337.2

*This figure is the mean tree diameter at clearfall.

Source : A.C.T. Forests, Department of the Capital Territory.

The prices for small-sized material (7-14 cm class) have not yet been firmly established. Sale of this material is conducted on an individual basis. A delivered price of $16.0 per m^3 has been assumed throughout this study.

TABLE 4.2

DELIVERED PRICES OF LOGS

Log diameter class (cm)	Delivered price ($/$m^3$ log volume)
15 - 19	17
20 - 24	22
25 - 29	24
30 - 34	26
35 - 39	29
40 - 44	30
45 +	32

Source : A.C.T. Forests, Department of the Capital Territory.

4.3.3 Logging costs

Net revenues from forest growing operations must be estimated by deducting harvesting and transport costs from the prices received for logs delivered to mills. Harvesting and transport of logs is done on behalf of A.C.T. Forests by private operators under contract. These costs (assuming easy to moderate terrain conditions) are given in Table 4.3.

TABLE 4.3

LOGGING COSTS*

Operation	Cost ($/m^3 log volume)		
	Range	Average	Maximum
Early thinning (years 16,21)	13.5 - 17.0	14.0	17.0
Late thinning (years 21,26)	10.5 - 13.0	12.0	13.0
Clearfelling (year 36)	6.6 - 9.5	8.0	9.5

*Includes costs of harvesting and transport to mill.
Source : A.C.T. Forests, Department of the Capital Territory.

4.3.4. The basic model

The basic model for this study assumes a high demand for small-sized material (regime R_1, Table 4.1) and average logging costs. Therefore, under such conditions most of the small-sized material is extracted from the forest. The flow of costs and revenues using this model are presented in Table 4.4.

4.4 External effects

An external or indirect effect was defined and discussed in Section 2.1.

The principal management objective of the pine plantation project in the A.C.T. is commercial wood production. Indirect benefits of the project include recreational opportunities, conservation of the environment and preservation of aesthetic values. Another indirect benefit may be better transport and access

TABLE 4.4

FLOW OF COSTS AND REVENUES OVER TWO ROTATIONS

FOR EACH BLOCK (PLANTING YEAR) OF 400 Ha*

($,000)

Year	Item	Cost of operation	Administration Costs	Total Costs	Revenue
0	Land purchase	12.00	-	12.00	-
0	Site preparation	36.00	9.00	45.0	-
1	Planting	82.00	20.50	102.50	-
2	Tending	25.60	6.40	32.00	-
11	Pruning	64.00	16.00	80.00	-
15	Construction of logging roads.	60.00	15.00	75.00	-
16	1st thinning	282.80	70.70	353.50	337.28
21	2nd thinning	240.24	60.06	300.30	334.36
26	3rd thinning	207.36	51.84	259.20	369.72
31	4th thinning	244.80	61.20	306.00	489.88
**36	Clearfalling	1079.04	269.76	1348.80	3603.24
38	Spacing regeneration	90.00	22.50	112.50	-
42	Pruning	64.00	16.00	80.00	-
51	1st thinning	282.80	70.70	353.50	337.28
56	2nd thinning	240.24	60.06	300.30	334.36
61	3rd thinning	207.36	51.84	259.20	369.72
66	4th thinning	244.80	61.20	306.00	489.88
71	Clearfalling	1079.04	269.76	1348.80	3603.24
71	Residual land value	--	-	-	12.00

* In addition the following costs are incurred;

(i) annual maintenance cost of $12 000 from year 1 to 70;
(ii) annual administration costs (@ 25% of (i)) of $3 000 throughout the project life; and
(iii) capital costs common to the entire project, i.e. costs other than those on logging roads and purchase of land (see Section 4.2.2).

**End of first and start of second rotation.

facilities as a result of provision of logging roads. It is also necessary to appraise carefully the indirect costs that the project may impose on society. Where eucalypt forests have been cleared for pine plantations, the loss in wildlife values (if any), increased erosion before plantation establishment and the effect on water quality and landscape need to be assessed. Therefore, only net indirect benefits should be considered.

Quantification of indirect effects depends on the availability of input/output information which describes the changes in output caused by the plantation project. Unfortunately, this input/output information is not available. Because of time constraints little can be done other than to outline an approach appropriate to the evaluation of indirect effects. In Chapter 2 (Section 2.6) several methods for assessing the indirect effects of a project were discussed. While methods based on willingness to pay have general application, each method has its specific role. A frequently stated management objective of A.C.T. Forests (e.g. for Kowen and Pierce's Creek forests) is to meet the recreation needs of the public. It may be possible to evaluate the local impact of recreation by the User Expenditure method. Conservation of the environment is another common objective of management. In the Cotter catchment in the A.C.T., the supply of adequate quantities of quality water is the major objective. Some of the other objectives are economic utilization of pine forests and recreational development. Here, possibly, the opportunity cost method might be applied to determine the trade-off between water yield and quality. In general, the demand curve approach appears practical because of its attempt to

determine the amount the population is willing to pay for the benefit. The opportunity cost method tends to give some range of actual alternative costs which may not be related to, or actually measure, the amount that the population is willing to pay (Sinden, 1967).

As noted previously, lack of data and time precluded the quantification of indirect benefits and costs of the project.

The administration costs of A.C.T. Forests also include expenditure on provision of services not directly related to wood production such as the development of walking trails, trail bike facilities, erosion control, public service functions not connected with plantations directly, etc. The difference between the administration costs directly related to wood production and the total administration costs may be taken as a rough measure of the opportunity cost of management for non-wood benefits in the A.C.T. However, because of lack of data this approach could not be pursued further.

4.5 Secondary effects

While discussing external effects in Chapter 2 it was argued that pecuniary effects should be excluded as they do not constitute an element of benefit or cost. However, other non-technological external effects have been argued as constituting proper benefits or costs. These comprise output effects which result because of an increased (or decreased) scale of activity on the part of the third party, and which are not offset by losses (or gains) elsewhere (Dasgupta and Pearce, 1978). Such non-technological output effects

occur in economies with underemployment. However, the inclusion of such output effects presupposes the continuation of less than full employment, conditions which are extremely difficult to forecast. Therefore, secondary effects have been ignored in this study.

CHAPTER 5

FINANCIAL ANALYSIS OF THE PROJECT

The financial analysis develops the commercial profitability of the project by considering its direct costs and direct benefits. These costs and benefits have already been estimated in Chapter 4. However, it is necessary to choose an appropriate measure of profitability for expressing the worth of a project in precise terms. The following sections discuss the choice of a measure of profitability and the discount rate for this study prior to the actual determination of the project's commercial profitability or worthiness. In addition, a sensitivity analysis for testing the sensitivity of project profitability to changes in some elements of costs and benefits is performed.

5.1 The measure of profitability for this study

This study is concerned with the question of accepting or rejecting an investment proposal for commercial wood production. Any one of the three measures of profitability discussed in Chapter 2 can be used because an internal rate of return greater than the predetermined discount rate generally corresponds to a positive net present value and to a benefit-cost ratio greater than unity. However, in view of the difficulties associated with the benefit-cost ratio (see Chapter 2) the choice is usually between the internal rate of return (IRR) and the net present value (NPV). In the context of

the present study, both measures, properly interpreted, should lead to the same results, and the choice then becomes, largely, one of convenience (Henderson, 1965).

The NPV would appear to be the most convenient for use as a measure of profitability for this study.

5.2 The discount rate for this study

The STP rate, as noted in Chapter 2, can be interpreted as the product of the elasticity of marginal utility and the rate of growth of per capita consumption. The future rate of growth of per capita consumption can be estimated from the national development plan. However, it is difficult to estimate the elasticity of marginal utility of aggregate consumption with respect to per capita consumption. The value seems to be in the range 1 to 2.5 (Layard, 1972). Ferguson and Reilly (1976) observe that this range, when multiplied by the growth rate of per capita consumption, gives too wide a band (2.5% to 6.25%) of STP rates for practical decision making and may introduce personal bias and inconsistency in project selection. They concluded that the rate of interest, with allowance for inflation, payable on Australian securities sold in overseas markets can be taken as a measure of STP. On this basis, they arrive at a range of 4% to 6%.

The choice of a discount rate has important implications for the profitability of public investment for commercial wood production because of the usually long investment horizon. A survey by Schleicher (1972) showed that discount rates ranging from 6.5% to 10% were being used by various European countries in cost-benefit

analyses (Ferguson and Reilly, 1976). In the United Kingdom, the discount rate is 10% while France uses 7% (Perry, 1974). In the U.S.A. the rates varied from 3% to 9% (Baumol, 1968). From the range of values stated above, and the foregoing discussion, it is obvious that the choice of a discount rate is a difficult one. Nonetheless, a choice has to be made, and in advance of project evaluation to maintain objectivity.

In the financial analysis of a project for commercial wood production, the proper rate of discount should be similar to the market rate of interest with allowances for risk, inflation and income-tax payments. The commonly used estimate of private (and social) time preference is the rate on long-term government bonds, reduced to allow for expected inflation and income-tax payments (Layard, 1972). These bonds are generally considered risk free. However, since the future price level is uncertain, there is, in fact, no truly risk-free rate of interest, nor are there any long-term bonds whose nominal yield is independent of unknown future interest rates, unless they are held to maturity. Nevertheless, in uncertain and imperfect capital markets, it remains true that for the ordinary lender, the adjusted long-term bond rate probably gives as good evidence as is possible on his risk-free time preference (Layard, 1972). Baumol (1969) argues that this bond yield is the lower limit of the STP because those who do not buy bonds have a higher preference for consumption today than buyers do. On the other hand, Perry (1974) cites Henderson and Mishan who argue that this yield is the upper limit, as there is still some risk in bonds. He therefore proposes the average bond yield of 5% in

Australia during 1960-68 as the most likely measure of STP and opines that adjustment to this rate should not be made for taxes and inflation.

In the light of the above discussion, the social rate of discount (STP) will be taken as 5% in this study, being the median value of the range 4% to 6% suggested by Ferguson and Reilly (1976) and coinciding with the figure suggested by Perry (1974). Leslie (1967) also suggests a rate of 5% for government forestry projects. The above discussion also suggests that a discount rate in the neighbourhood of 5% may be appropriate for the financial evaluation of the project. A range of values from 4% to 6% will, however, be considered in the financial evaluation with 5% being considered the most likely value. When allowance is made for risk, inflation and taxes, a discount rate of 5% is not expected to be vastly different from the private market rates. Moreover, this is the rate of government borrowing and is therefore the opportunity cost of capital to the government.

5.3 Calculation of net present value

As mentioned before, the proposed *P. radiata* plantation would be established over an area of 400 ha each year starting from year 1 but following advance planning (e.g. site preparation) in year 0. Since the rotation period is 35 years, 35 plantation blocks of 400 ha each would be established, the last establishment being in year 35. Each plantation block would be managed for two rotations (71 years in all, including one for advance planning). The net present value of the project (at year zero) would be the algebraic sum of the

net present values of the above 35 blocks and the present value of capital costs of the project (estimated in Table 5.1).

Since the costs and benefits for all plantation blocks are the same, the net present value of each of these blocks, calculated over a planning horizon of 71 years, would be the same. Thus, there will be an annual series of constant NPVs from year 0 to year 34 for the 35 blocks. The present value (at year zero) of this series can be calculated by the formula

$$a + \frac{a[(1+i)^n - 1]}{i(1+i)^n} \qquad (5.1)$$

where a = annually recurring (annuity) value, i.e., NPV of each block,

n = number of years of compounding or discounting, 34 in this case, and

i = the discount rate.

The net present value of the project, considering the basic model, has been calculated by the procedure outlined above using a computer programme*. The results, shown in Table 5.2, show that at the chosen discount rate (5%) the project incurs a loss of $959 100. This suggests that if the assumptions underlying the basic model hold, the project would not be profitable at a 5% rate of discount.

5.4 Sensitivity analyses

The identification and valuation of costs and benefits of a

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*Developed by J.A. Miles, Department of Forestry, A.N.U.

TABLE 5.1

PRESENT VALUE OF THE CAPITAL COSTS* OF THE PROJECT
($,000)

Year	Capital Cost	Discounted Present Value		
		4%	5%	6%
0	200.00	200.00	200.00	200.00
5	60.00	49.30	47.02	44.84
15	60.00	33.31	28.86	25.03
25	60.00	22.51	17.72	13.98
35	60.00	15.21	10.88	7.81
45	60.00	10.27	6.68	4.36
55	60.00	6.94	4.10	2.43
65	60.00	4.69	2.52	1.36
Total (rounded)		342.20	317.80	299.80

*Excludes the costs of land and logging roads which are allocated to the relevant year of planting.

project involve estimating the future. Estimated future values are, however, uncertain and therefore it is necessary to recognize and to treat explicitly the uncertainty surrounding project estimates of future events and values (F.A.O., 1979). Sensitivity analyses will be used in this study to incorporate the uncertainty, i.e., to test the sensitivity of the NPV to alternative assumptions about the value of inputs (costs) and outputs (benefits) and various technical relationships.

The basic model uses the most likely values of inputs and outputs. To make the analysis complete it is desirable to obtain some idea of the change in NPV as a result of changes in the values of inputs and outputs, especially those whose values are relatively uncertain. The sensitivity of the basic model was tested under a

range of discount rates, and separately under each of the following assumptions:

(i) Administration costs @ 20% of all costs which can be allocated to a year of planting.

(ii) Administration costs @ 30% of all costs which can be allocated to a year of planting.

(iii) Lower sales of smaller-sized (7-14 cm) material (regime R_2, Table 4.1) and average cost of logging. This has been called the subsidiary model (Table 5.2).

The results show the great sensitivity of the NPV to changes in discount rate. While the project incurs a loss at 5% (NPV = -$959 100), a fall of 1% in the discount rate (to 4%) results in an NPV of +$2.4394 million (Table 5.2). In other words, the project is a highly profitable use of resources if the appropriate discount rate is 4%. On the other hand, at 6% the project shows heavy losses (NPV = -$2.5528 million).

Reduction of administration costs to 20% results in an NPV of -$12 800 at 5%. As this amount is insignificant, it may be said that the project just breaks even when the administration costs are taken as 20% instead of 25%. On the other hand, when administration costs are increased from 25% to 30%, the project NPV at 5% becomes -$1.8657 million, i.e., the project incurs a substantial loss.

Under conditions of low demand for the smaller-sized material, the project NPV turns out to be -$406 800 at the 5% discount rate. Comparison with the basic model reveals that under conditions of low demand the project losses are much less than those under conditions of high demand (NPV= -$959 100). This can be explained as follows.

TABLE 5.2

NET PRESENT VALUE OF PROJECT UNDER VARYING COSTS AND REVENUES

($,000)

	Discount Rate		
	4%	5%	6%
1. Basic Model			
Value of annuity	+143.3	-37.3	-146.6
Present value of series	+2638.3	-604.0	-2106.4
Discounted capital costs	-342.2	-317.8	-299.8
Project NPV	+2439.4	-959.1	-2552.8
2. Administration Costs @ 20%			
Value of annuity	+212.1	+17.8	-100.7
Present value of series	+3905.0	+287.8	-1446.9
Discounted capital costs	-342.2	-317.8	-299.8
Project NPV	+3774.9	-12.8	-1847.4
3. Administration costs @ 30%			
Value of annuity	+74.6	-90.0	-187.8
Present value of series	+1373.1	-1457.9	-2698.3
Discounted capital costs	-342.2	317.8	-299.8
Project NPV	+1105.5	-1865.7	-3185.9
4. Subsidiary model			
Value of annuity	+197.6	-5.2	-125.9
Present value of series	+3636.2	-83.8	-1808.9
Discounted capital costs	-342.2	-317.8	-299.8
Project NPV	+3491.5	-406.8	-2234.6

An assumption was made in Chapter 4 that the price of 7-14 cm diameter class material would be $16 per m^3 regardless of the volume demanded. The average cost of logging this material is $14 per m^3 (Table 4.3). Under conditions of low demand less material of the 7-14 size class is extracted. This reduces both costs and revenues but the total costs show a greater change because the administration costs, which are taken as 25% of all costs allocatable to a year of planting, are also reduced. This would reduce the project losses, therefore.

Similar sensitivity analyses can be done for other project parameters if necessary.

5.5 Result of the analysis

The financial analysis has shown that the proposed plantation project would not be commercially viable from the point of view of an individual agency undertaking a commercial wood production project, given the assumptions of the basic model. As stressed before, the above result cannot in any way be taken as a measure of the profitability of A.C.T. Forests as an organisation.

CHAPTER 6

SOCIAL COST-BENEFIT ANALYSIS OF THE PROJECT

The social cost-benefit analysis develops the social profitability of the project by considering its costs and benefits from the viewpoint of society. As pointed out in Chapter 4, the limitation of this study is that it considers only direct costs and benefits, i.e. costs and benefits which arise only from wood production. The analysis, therefore, will be a considerable understatement of the true social benefit which could be derived from the multiple use of the plantation. For example, wood production, water production and recreation are complementary forms of land use in many areas. Multiple use of areas may require some modification of the timber management regime (it is already being done in the A.C.T.) but a proper mix of uses can generally be found which will yield a higher net social gain than any single use (Gregory, 1972).

Before undertaking the SCB analysis it is first necessary to estimate the social costs and social benefits of the project. The estimates of social costs are dependent on the shadow price of investment, a concept that was discussed in Chapter 2. The following section deals with the calculation of the shadow price of investment.

6.1 Shadow price of investment

The estimation of the social rate of time preference (STP) was discussed in section 5.2 and a value of 5% was adopted. With the

decision on STP, the shadow price of investment, P^{inv}, can be estimated. Based on national income statistics, Haig (1971) has estimated the marginal propensity to save to be 0.19 (Ferguson and Reilly, 1976). These authors themselves suggest a figure of 0.12 for the marginal rate of return before tax in private investment, after making allowance for risk and inflation. Taking this as the marginal rate of return on investment,

$$p^{inv} = \frac{(1- 0.19) \times 0.12}{0.05 - 0.19 \times 0.12} = 3.6$$

Therefore, a value of 3.6 will be used for P^{inv} in the SCB analysis.

6.2 Social profitability of the project

The aim of a public project is to maximise its net social benefit, that is to maximise the discounted value of the benefits net of the discounted value of the costs. In Chapter 2, the net social benefit was seen to be the sum of the consumers' and producers' surpluses.

The project under study is quite small relative to the total wood resources of the region, which includes the State of New South Wales. Therefore, the project output will not cause a significant change in the volume of wood products available, nor in the market price of those products. Under these circumstances, the consumers' surplus will not change significantly and the net social benefit can then be measured by the change in producers' surplus only (Ferguson, 1973). With this assumption, the benefits and costs of the project

relate strictly to the social revenues and costs derived from producing wood.

The estimation of social costs and revenues is discussed in the following sections.

6.2.1 Social costs

As noted in Chapter 4, the project costs have been divided into four components: field, capital, administration and annual maintenance costs. These costs can be further broken down into wages, salaries and supplements, equipment and material costs. In a SCB analysis, the cost of using an input should be the value foregone by not being able to use it in its next best alternative use, i.e. its opportunity cost.

There is little unemployment in the A.C.T. and as conditions of full or near full employment are expected to hold in the future, the going wage rate is considered a reasonable measure of the opportunity cost of labour. The actual equipment and material costs, likewise, have been assumed to be reasonable measures of their opportunity costs.

It was pointed out in Chapter 2 that funds used in financing the project had an opportunity cost in terms of the benefits forgone from alternative investments, both in the public and private sectors. The shadow price of funds, P^{inv}, used in the project was calculated to be \$3.6/\$ invested (Section 6.1). Usually resources required for investment come out of both consumption and alternative investment. Since consumption is the unit of account, \$1 of

consumption currently forgone should be debited to the project account as $1 (Dasgupta et al, 1972). In general, if the fraction a^{inv} of a project's costs is drawn from investment and the fraction a^{con} is taken out of consumption, the net present value is given by

$$NPV = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} - \sum_{t=1}^{n} \frac{(a^{inv} p^{inv} + a^{con}) K_t}{(1+i)^t} \qquad t = 1,2,.....,n.$$

where B_t = the stream of benefits;

K_t = the stream of costs;

i = rate of discount; and

n = life of project.

The administration costs of the project are essentially incurred in the discharge of public service functions. It has been assumed that this part of the project's costs comes out of consumption. Since, as noted above, consumption is the unit of account, administration costs have a shadow price of unity. Funds to meet all other costs are then drawn from investment and therefore have a shadow price of 3.6. In other words, all money costs other than administration costs have been multiplied by 3.6 and added to the administration costs to determine the social costs of the project. The flow of social costs (basic model) for a block of 400 ha is presented in Table 6.1.

6.2.2 Social revenues

In the financial analysis in Chapter 5, the project output was valued on the basis of prices negotiated by A.C.T. Forests with log buyers. One of the factors influencing these prices is the general belief that the wood using industry should be assisted by A.C.T.

TABLE 6.1

FLOW OF SOCIAL COSTS OVER TWO ROTATIONS

FOR EACH BLOCK (planting year) of 400 ha*

($,000)

Year	Item	Cost of Operation	Administration Cost	Social Cost
0	Land purchase	12.00	-	43.20
0	Site preparation	36.00	9.00	138.60
1	Planting	82.00	20.50	315.70
2	Tending	25.60	6.40	98.56
11	Pruning	64.00	16.00	246.40
15	Construction of logging roads	60.00	15.00	231.00
16	1st thinning	282.80	70.70	1088.78
21	2nd thinning	240.24	60.06	924.92
26	3rd thinning	207.36	51.84	798.34
31	4th thinning	244.80	61.20	942.48
**36	Clearfalling	1079.04	269.76	4154.30
38	Spacing regeneration	90.00	22.50	346.50
42	Pruning	64.00	16.00	246.40
51	1st thinning	282.80	70.70	1088.78
56	2nd thinning	240.24	60.06	924.92
61	3rd thinning	207.36	51.84	798.34
66	4th thinning	244.80	61.20	942.48
71	Clearfalling	1079.04	269.76	4154.30
71	Residual land value	-12.00	-	-43.20

* In addition the following costs are incurred;
  i) annual maintenance cost of $43 200 from year 1 to 70;
  ii) annual administration costs of $3 000 throughout the project life; and
  iii) capital costs common to the entire project, i.e. costs other than those on logging road and purchase of land (estimated in section 6.3).

** End of first and start of second rotation.

Forests. This approach to price setting is likely to prevent demand and supply from achieving equilibrium at a price indicative of the true social value of logs. This is implicit in A.C.T. Forests' claim that the demand for logs is much higher than it can possibly meet. It is further emphasised by the fact that a particular A.C.T. mill is reported to have bought quality logs from outside the A.C.T. at a price which is several times greater than the price it pays for similar logs from within the A.C.T.

Under such circumstances the prices (royalties) charged by A.C.T. Forests for logs cannot be taken as a guide to their true social values. It is, therefore, necessary to develop social values (shadow prices) for logs.

The shadow prices for logs may be estimated by using the residual value approach. It assumes that the world market price of a similar product is more nearly the perfect market price than the domestic price. In other words, the approach assumes that the project output will substitute for imports of forest products of equivalent end use (e.g. New Zealand Radiata and Oregon pine). The shadow prices for logs are then calculated by deducting from the duty free landed cost of imported forest products all costs of harvesting, processing and transport to the main market of the project output. This approach has been taken, among others, by Reilly (1978) and Sar (1978). Working backwards from the duty free landed cost of imported timber, the following costs are essentially considered in arriving at the shadow prices for logs or stumpage;

a) the cost of transport from the port to the merchant's yard;

b) the cost of transport of domestic production from sawmill

to the merchant's yard;

c) the cost of sawmilling; and

d) the cost of harvesting and transport of domestic production to the sawmill.

The first item of cost is added to the duty free landed cost to arrive at the import replacement cost to the merchant. The other items of cost are subtracted from this import replacement cost to determine the shadow price of logs, making due allowance for normal profits. Sawn timber is converted to equivalent log volume with the help of appropriate sawn recovery factors.

In some analyses sawmill wastes (e.g. slabs, edgings and offcuts) suitable for chipping are also shadow priced and added to the calculated shadow price. The shadow price of chippable sawmill waste is calculated as a residual by deducting from the free on board (f.o.b.) price of chips all other costs of producing and transporting chips to the port (assuming that the chips have an export market).

There are several difficulties associated with this method. First, the production-marketing-distribution chain from the port of entry to the merchant's yard on the one hand, and from stump to the merchant's yard on the other, is very long. It is quite likely that some of the links may be overlooked. Second, the sawmills may not be efficient, i.e. may not be properly designed or working to full capacity. Third, it is difficult to estimate the importers', merchants' and sawmillers' mark-ups or profits. In any case, the whole exercise looks at the existing production-marketing-distribution system to determine the prices that the market can bear. The existing system may in no way be competitive or

efficient.

Since the intention is to establish the true social value of logs, and because of the time constraint and the difficulties mentioned in pursuing the above approach, it has been decided to treat the shadow price for logs as an unknown of the analysis. Assuming the existing relative (money) prices for different log diameter classes to hold, the factor by which the log prices should be multiplied so that the project NPV is approximately zero at 5% discount rate has been determined. This would establish the floor for the shadow price for logs.

6.3 Result of the analysis

On calculation, the multiplication factor for shadow pricing logs is found to be between 3.21 and 3.22. When the money prices of logs are multiplied by 3.21 the project NPV, at a 5% discount rate, works out to be -$181 170 while in the latter case, when the multiplication factor is 3.22, the NPV is found to be +$44 060. The multiplication factor may therefore be rounded to 3.22.

The project NPV, as in the case of the financial analysis, is the algebraic sum of the present value of an annual series of NPVs of 35 plantation blocks from year 0 to 34 and the present (discounted) value of project capital costs, appropriately shadow priced. The shadow capital costs have been calculated by multiplying the actual costs by the shadow price of investment, 3.6. These costs, together with their present value at the social rate of discount (5%), are given in Table 6.2.

TABLE 6.2

PRESENT VALUE OF (SOCIAL) CAPITAL COSTS OF THE PROJECT

($,000)

YEAR	0	5	15	25	35	45	55	65
Actual costs	200.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
Shadow costs	720.00	216.00	216.00	216.00	216.00	216.00	216.00	216.00

Present value (year zero) of shadow capital costs at 5% = 1143.98

The calculation of the project NPV using the multiplication factor of 3.22 for shadow pricing logs is summarised below (all figures are in thousands of dollars).

Value of the annuity	: +69.10
Present value of series using formula (5.1)	: +1118.94
Discounted value of capital costs	: -1143.98
NPV of the project	: +44.06

The above analysis indicates that if society is prepared to impute values to logs that are 3.22 times the actual prices, the project, given the assumptions of the basic model, is a profitable use of resources. These imputed values are given in Table 6.3.

Several confidential, unpublished studies have estimated the shadow prices of *P. radiata* logs to be about 2.5 to 6 times the actual prices. Actual prices in the A.C.T., therefore, appear to be conservative. This may be due to several factors, for example lack of information, monopoly power in bargaining or political influence.

TABLE 6.3

MINIMUM SHADOW PRICES OF LOGS

Log diameter class (cm)	Delivered prices of logs ($/m^3 log vol.)	
	Actual	Shadow
7-14	16.00	51.52
15-19	17.00	54.74
20.24	22.00	70.84
25-29	24.00	77.28
30-34	26.00	83.72
35-39	29.00	93.38
40-44	30.00	96.60
45+	32.00	103.04

Given the uncertainties attached to the price multiplier for shadow prices and other uncertainties attached to other estimates, the results suggest that the project is marginal in social terms. Much would depend on the weight to be given to any non-wood benefits involved.

CHAPTER 7

EXTENSION OF ANALYSIS TO THE INDIAN SITUATION

In Chapters 5 and 6, respectively, financial and social cost-benefit analyses of a Pinus radiata plantation project in the A.C.T. were carried out. It is now the intention to transpose the methodology of the SCB analysis to a similar, but hypothetical, project in India. Such a project would fall under the production forestry program in India discussed under Section 1.3. Plantations of tropical pines (e.g. Pinus caribaea, P. patula) have been established in India but their main objective has been to meet the domestic demand for long-fibre pulp and not for sawlogs. The objectives of such a plantation project, within the framework of the Indian development plans (see Section 1.1), may therefore be;

(i) increased aggregate consumption, i.e. raising the average standard of living in India;

(ii) redistribution of income to the landless labourers and marginal farmers;

(iii) creation of new employment opportunities; and

(iv) greater self-reliance through increased domestic production of pulp and paper and reduced imports.

The first two social objectives are quite clear and distinct. The last two, however, are really a reflection of the limited ability of market prices - the wage rate and the foreign exchange rate - to reflect true social costs and benefits with respect to the aggregate consumption objective. For example, more

employment opportunities may be desired primarily for the contribution that a large workforce could make to national income and hence to consumption. Only if additional employment is considered desirable for its own sake should it be regarded as a separate objective (Dasgupta et al, 1972).

However, such is not the intention in the Indian plans where employment is not considered as an objective in itself (Government of India, 1973). Likewise, self-reliance (i.e. improvement in balance of payments) is desired because the saving in foreign exchange permits the country to import other economic resources from abroad for improving the standard of living of its people ,i.e., aggregate consumption. Therefore, self-reliance is not desired for its own sake but for the sake of aggregate consumption to which it contributes (Dasgupta et al, 1972).

In view of the foregoing, the methodology presented in this study considers the first two objectives only.

7.1 A similar project in India

The Indian project design would differ from the Australian design because of differences in economic conditions between the two countries. Any project, or project component, can be undertaken using different technologies based on varying combinations of land, labour and capital determined by the relative factor endowments. In other words, the production function for plantation forestry is flexible, not fixed. For example, forest plantation projects can be established using different establishment and maintenance practices or different combinations or intensities of inputs. Similarly,

harvesting operations can be labour-intensive with use of simple hand tools or capital-intensive using sophisticated machinery and only a few men. The choice of appropriate technology would depend on the relative factor costs. If labour is relatively cheap compared to capital, then labour- intensive technologies will generally have lower average costs per unit of output than capital intensive ones. Similarly, if the cost of an input is relatively high (e.g. fertilizer) compared with other inputs, it is less likely to produce a favourable effect on a project's NPV.

In India, where in sharp contrast to Australia, labour is relatively cheap and readily available, labour-intensive technologies are used to establish plantations. The use of machinery is minimal. The site to be planted is cleared manually about six months in advance of planting. Sites are not usually ploughed. Planting pits are dug by hand using spades, pickaxes and similar local hand tools. All works in advance of planting, usually termed advance works, are undertaken in the agricultural slack season when a large workforce can be organised to clear the brushwood and prepare the site for planting. Planting is done at the break of monsoon rains in summer.

Fertilizer is expensive since it is very much in demand for agricultural, use and part of the supply has to be imported. Consequently it is not freely used in plantations although its use in nurseries is common. No herbicide is used and spot weeding is done with hand hoes. Pruning, thinning and final harvesting are also done manually with simple hand tools, e.g. pruning saws, bill hooks, axes and two-man cross-cut saws. Sometimes, power chainsaws are

also used for harvesting but the practice is mainly restricted to natural forests with large trees. The rise in oil prices, the high cost of chainsaws and the difficulties of maintaining them in the forest have also contributed to their limited usage.

The project output, as mentioned previously, would also differ from that in the A.C.T. and consist mainly of pulpwood grown on a somewhat shorter rotation (25 years). Fuelwood would be an important by-product of the project. In Australia, loppings from thinning and clear-falling operations are left in the forest, whereas in India they would be used for fuelwood. Also, and unlike the A.C.T. situation, there would be no need to delay thinning or carry out non-commercial thinnings because of the high costs of the operation or limited markets. In India, such material would be saleable as fuelwood. In fact, fuelwood may form 20-25% of the total output from a plantation forest with pulpwood constituting the remainder.

7.1.1 Identification of principal inputs and outputs

In the analysis to follow, and as discussed in Chapter 4, it will be necessary to distinguish between the different types of labour and material inputs in the Indian situation. It will also be necessary to distinguish export earnings (or reduced imports) from domestic sales of project output because of the importance of foreign exchange to a developing economy. This is elaborated in Section 7.1.2.

Available resources can be grouped into the following categories: skilled and unskilled labour, domestic inputs and outputs

and foreign exchange inputs and outputs. In any Indian forestry project, unskilled labour would be the main input and may account for 70-75% of the direct costs of the project; skilled labour and materials would make up the remainder. Skilled labour, apart from the professional staff and technicians, would include masons, carpenters and vehicle and equipment drivers.

Materials can be subdivided into those which are imported (or would have been exported in the absence of the project) and those which are produced domestically. The common materials of the first kind are steel for construction, petroleum products, polythene granules for the manufacture of polypots for raising seedlings, etc. Common domestic materials would be seed, cement, pickaxes, spades and other hand tools and equipment.

7.1.2 Shadow price of foreign exchange

Some inputs and outputs of a project may be traded or be potentially tradeable. However, trade is conducted in foreign currency. In many developing countries, including India, foreign exchange is controlled by the government. The various measures of exchange control (as well as tariffs, quotas on imports and subsidies and taxes on exports) interfere with free trade and there is a divergence between the official exchange rate and the exchange rate that would obtain under free trade. In other words, the official exchange rate does not adequately reflect the gains and losses to the economy from obtaining or giving up an additional unit of foreign exchange. In general the official exchange rate is overvalued. There is, thus, scarcity of foreign exchange due to government

control of the foreign exchange market. Under these circumstances, it is necessary to determine the true (shadow) price of foreign exchange in a SCB analysis of the project.

The shadow price of foreign exchange is a national parameter and its value is supplied by the Central Planning Organisation (C.P.O.). It can, however, be estimated fairly readily by the method outlined in Dasgupta et al (1972). Beyer (1972) has estimated the probable range of the foreign exchange scarcity premium in India as 33% to 60% (Sinha and Bhatia, 1976). Thus an appropriate premium on foreign exchange based on the above estimate should be used when valuing inputs and outputs of the project in terms of foreign exchange.

7.1.3 Valuing inputs

(i) Unskilled labour

Unskilled labour comes from the ranks of the landless labourers, share croppers and marginal farmers who seek wage employment in the agricultural slack season to supplement their incomes. In economic terms, the cost of labour is the opportunity cost of not employing that labour in the next best alternative use. In a perfectly competitive economy, the market wage rate should equal the value of the marginal product of labour and in such a case, given that the savings rate is socially optimal, the market wage is a measure of the opportunity cost of labour to the economy and the project (Dasgupta et al, 1972).

However, these conditions are not applicable to India where unemployment (and underemployment) is widespread and where aggregate

savings are below the socially optimal level. In such a situation, the market wage is not the appropriate measure of the cost to society of hiring an unskilled worker on the plantation project, instead, a shadow wage for unskilled labour should be used. The shadow wage would differ from the market wage for two reasons. First, the market wage is higher than the value of output forgone by hiring an unemployed (or underemployed) individual. This is because of the existence of minimum wage laws which keep the market wage rates above the levels corresponding to labour productivity.

Second, the money cost of labour hired for a public project is financed by a transfer of funds from the private to the public sector through fiscal measures. The marginal propensity to consume of taxpayers as a whole is lower than that of unskilled workers. Thus, although this transfer of funds will increase current aggregate consumption, the reduction in private investment reduces the present value of current plus future aggregate consumption. This is because the aggregate consumption objective places a weight on current investment equal to the discounted present value of future contributions to consumption attributable to the marginal unit of investment (Dasgupta *et al*, 1972). As seen in Chapters 2 and 6, this weight, the shadow price P^{inv}, is likely to be more than one.

The following presentation on shadow wages is drawn largely from the work of Allal *et al* (1977).

The shadow wage of unskilled labour, w^*, is the algebraic sum of the gains and losses referred to above, and can be described as follows. First, the shifting of a worker from his current occupation to the project means that his current output, valued at O_p

will be sacrificed. The social cost of this forgone output is equal to a decrease in aggregate consumption, the value O_p. Second, at the project the worker will also be paid a wage, w, which is financed by a tax on the private sector whose marginal propensity to save is s^t. In the absence of the tax, $w.s^t$ would have been invested and $(1-s^t).w$ consumed. Therefore the imposition of the tax causes a loss in the aggregate consumption of the private sector equal to

$$w(1-s^t) + w(s^t\ p^{inv})$$

where w = project wage rate

s^t = aggregate marginal propensity to save for the private sector

p^{inv} = shadow price of investment, defined in section 2.3.3.

Third, there is a gain to the worker, and therefore to society, equal to the wage rate, w. Combining this gain with the above two losses, the shadow price of unskilled labour, w*, is given by

$$w^* = O_p + w.s^t\ (p^{inv}-1) \qquad (7.1)$$

Formula (7.1) is based on two assumptions:

(i) the marginal propensity to save of unskilled workers is equal to zero ($s^w=o$); and

(ii) the forgone output (O_p) is the only cost to society resulting from the employment of workers on a public project.

While the first assumption may be valid in some cases, the second assumption is rarely tenable. Usually, an additional cost is

involved in inducing a worker to change his current situation. An unemployed (or underemployed) worker will have to give up some leisure when he is employed full-time and may also have to stay away from his family if the job requires that he live in a workers camp. This psychological cost, P_c, must be added to O_p and therefore the marginal supply price of labour, L, will be higher than O_p; $L=O_p+P_c$. The value of L is expected to lie between O_p and w as the public sector wage is influenced by the wage in the industrialised sector and minimum wage laws. If both these assumptions are relaxed, then formula (7.1) is modified to yield

$$w^* = L[(1-s^w) + s^w p^{inv}] + w[(s^t-s^w)(p^{inv}-1)] \qquad (7.2)$$

where s^w = the marginal propensity to save of unskilled workers.

Formula (7.2) however ignores income distribution considerations. In other words, it assumes that consumption by all sections of society is equally weighted. However, as reduction of income inequality has been taken as one of the objectives of this project, this assumption is not valid for this study. A greater weight should, therefore, be assigned to the consumption of unskilled workers. If a weight of u, where $u>o$, is attached to the consumption of unskilled workers and the aggregate consumption of tax payers is assigned a neutral weight (i.e. a weight of zero), formula (7.2) takes the form

$$w^{**} = w^* - u(w-L)[(1-s^w) + s^w p^{inv}] \qquad (7.3)$$

where w^{**} = shadow wage of unskilled labour when income distribution is taken into account.

u = weight on the consumption of unskilled workers.

Formula (7.3) therefore, should be used for the SCB analysis in the Indian situation. This formula shows that the shadow wage is further lowered when income distribution considerations are taken into account since both (w-L) and the term in the square brackets are positive.

The weight on the consumption of unskilled workers is a national parameter whose value is decided by the C.P.O. The calculation of the shadow wage requires the estimation of L, s^t, s^w and p^{inv}, the project wage, w, being known. s^t and p^{inv} are national parameters whose values apply regardless of the region. Their values can be obtained from the C.P.O. or estimated from the national plan. In the absence of such estimates, they may be estimated along with L and s^w as follows.

The shadow price of investment, p^{inv}, is given by

$$p^{inv} = \frac{(1-s)q}{i-sq}$$

where q = marginal productivity of capital

s = marginal propensity to save

i = social rate of discount.

The social rate of discount, as was noted in Chapter 2, can be interpreted as the product of the rate of growth of per capita consumption, g, and the elasticity of marginal utility with respect to per capita consumption, e. Lal (1972) has estimated e to be -2.3

for India. Sinha and Bhatia (1976) mention a range of values for e between -1.8 and -1.95 for the United States, Japan and Canada and question the estimate of e given by Lal. For example, if e, the elasticity of marginal utility with respect to per capita consumption, was -2.0, this would imply that the social significance of extra consumption would decline 2% with each 1% increase in per capita consumption. In an economy like India's, where the present level of consumption is low and the increases in consumption are mainly in terms of necessities such as food, clothing and housing, it is difficult to accept the suggestion that a 1% increase in average consumption would be associated with a 2% decline in social significance of this extra consumption. Although specifying the value which society places now on the marginal utility of consumption in future time periods is purely a normative judgement, it would be difficult to justify a value for e which is higher than the corresponding values for the United States, Canada and Japan (Sinha and Bhatia, 1977).

The Draft Plan for 1978-83 (Anon., 1978) projects a rate of growth of consumption of 3.18% for the period 1983-88. On this basis, and in the light of the above discussion, the social rate of discount seems to lie in the range 5.5% to 7.25% with 6.0% as the most likely value (e varying from -1.7 to -2.3).

Beyer (1972) has provided estimates of various parameters for project analysis in India (Sinha and Bhatia, 1976). By taking different values of the parameters i, q and s, he arrived at a range of values between 1.2 and 4.5 for P^{inv}. Using the most likely values, in his judgement, he has suggested a range of 1.5 to 2.5 as

the shadow price of investment in India.

It only remains to determine the value of s^w and L to estimate the shadow wage of unskilled labour, w**. For a country the size of India, given the constraints to labour mobility, regional variation in labour productivity and differing unemployment - employment patterns from one area to another, the shadow wage will need to be calculated on a regional basis. This wage may also need to be modified for the particular project being analysed.

Thus, the value of L would have to be calculated for the region from which labour would be drawn for the project and within that region for different seasons of the year. This is necessary because during the peak agricultural season the demand for unskilled labour is usually high. Conversely, the demand is low during the slack season. Estimates of s^w and L by region and season, therefore, will be required. s^w can be estimated from household expenditure surveys. In the absence of such surveys s^w may be taken as zero or as a fraction of s^t, the aggregate marginal propensity to save of the private sector.

The estimation of L requires knowledge of the value of output foregone, O_p and the psychological cost, P_c. O_p is difficult to estimate as it requires a knowledge of the production functions in the agricultural sector for which studies have to be undertaken. Also, it is almost impossible to estimate the psychological cost, P_c. In many cases, because of lack of time and resources to undertake these studies, wages paid in the rural area may be used as a proxy for the supply price of labour, L. This will probably tend to overestimate the true value of L.

Once all the parameters have been obtained from the C.P.O. or from field survey, the shadow price of unskilled labour can be estimated using formula (7.3).

(ii) Skilled labour

Skilled workers are usually scarce in developing countries and their wages tend to be high whenever the private sector competes with the public sector to employ such workers. In India, however, there is considerable unemployment (or underemployment) of skilled labour. Formula (7.2) can be readily modified to estimate the shadow wage of skilled labour: w^*, L, w and s^w here referring to skilled labour.

(iii) Materials

(a) Imported materials

A part of the supply of polythene granules required for the manufacture of polypots is imported. It can be assumed that, at the margin, the raw materials for the polypots would be imported. This raw material should be valued on the basis of its c.i.f. price adjusted by the shadow price of foreign exchange. A similar approach should be followed in respect of petroleum products and fertilizers.

Another input to the project would be steel for construction. Usually the quantity required is small as fairly intensive use is made of local materials such as bricks, timber, bamboo and grass in the construction of workers' camps, stores, garages, etc. In that

case, the market price of steel can be used as a reasonable approximation of its shadow price, particularly since steel is mainly manufactured in the public sector. However, if the cost is substantial, it can be estimated on the basis of export price (net of transport costs) adjusted by the shadow exchange rate on the assumption that in the absence of the project steel would be exported. This would be a realistic assumption as steel is a major export item in India.

(b) Domestic materials

Like steel, cement is also required for construction. Again, and as noted earlier, the quantity is not likely to be large. Cement also, is manufactured mainly by public sector companies. Therefore, its market price, adjusted for transport costs to the project site, can be taken as an approximate measure of its opportunity cost.

Seed is usually collected by the forest service or other government organisations. Its cost of collection can be taken as its true social value.

The market prices of tools and equipment can be taken as reasonable measures of the opportunity cost of using them in the project as the market is generally competitive. Besides, estimation of the opportunity cost of commodities produced in the private sector is difficult to carry out. This additional work may not be justified if adjustments to market prices are believed to be minor, especially when these costs form a small part of the total cost of the project.

For the government to acquire the materials mentioned above,

funds have to be transferred from the private sector to the government. The market or adjusted prices must then be corrected to take account of the transfer. This can be done by multiplying the calculated prices (market or adjusted) by the factor

$$(1-s^t) + s^t p^{inv}$$

The result would be the aggregate consumption cost of materials. Note that the transfer cost of funds, represented by the above factor, was also considered in the case of labour.

7.1.4 Valuing outputs

The direct outputs of the project would be pulpwood and fuelwood. Since woodpulp is imported, it can be assumed that at the margin the project output would substitute for imports. Pulpwood stumpage, therefore, should be valued on the basis of the duty free landed cost of woodpulp of equivalent end use. This cost should be multiplied by the shadow price of foreign exchange to reflect its relative scarcity. To this must be added the port handling costs and the costs involved in transporting it to the paper mill. From the mill door cost of imported pulp thus calculated should be subtracted the costs of

a) harvesting and transporting the plantation output to the mill;

b) pulp manufacture; and

c) any other handling costs

to arrive at the shadow price of stumpage.

In Chapter 1 it was mentioned that shortage of fuelwood has forced people to use animal dung as fuel to the detriment of soil fertility and structure. Fertilizer consumption per hectare in

Indian agriculture is considered to be one of the lowest in the world. Fuelwood produced by such an afforestation project would help in releasing dung for use as fertilizer. Estimates (Srivastava and Pant, 1979) show that every year 458 million tonnes of wet dung is used as fuelwood in India, which, at 5 tonnes per ha, could fertilize about 91 million ha of agricultural fields yielding an additional 0.5 tonne of foodgrains per hectare. The loss in foodgrain production thus works out to be about 45 million tonnes, valued at Rs36 000 million. If we assume that five tonnes of wet dung is equal to one tonne of dung cake (in which form dung is burnt), the opportunity cost of using dung, in terms of foodgrain output foregone, can be estimated as shown below, based on the data provided by Singh (1978).

The heating value of fuelwood in India is 4 702 kilocalories (kcal) per kilogram (kg) and its heat utilization efficiency is 18.9%. The corresponding values for dung cake are 2 444 kcal per kg and 11.2%. Therefore, the effective heating value for fuelwood is 889 kcal/kg (4 702x0.189 = 889) and that for dung cake 274 kcal/kg (2 444x0.112 = 274) giving a ratio of about 3.25:1.

As stated above, 5 tonnes of wet dung (or 1 tonne of dung cakes) can increase output of foodgrains by 0.5 tonne; the value of this additional output is then Rs400($\frac{36000}{45}$ x 0.5 = 400). In other words, one tonne of fuelwood is worth Rs1 300(3.25x400 = 1 300). From this must be subtracted the harvesting and transport costs to arrive at the value of fuelwood stumpage. The cost of collecting dung and making cakes must also be considered. The prices of foodgrain used in the above estimation can be regarded as a

reasonable approximation to their true opportunity costs because the prices are set by the Agricultural Prices Commission. It may be mentioned in passing that the current price of fuelwood in some towns in India is about Rs300 per tonne.

7.1.5 External effects

The external effects of the project - recreation, wildlife protection, soil and watershed protection - will depend on the location of the project. The use of forests for recreation is not great in India at this time and this situation may obtain for some time to come. The main reason for this is considered to be the general low level of income. Wildlife and soil protection benefits from forests, however, could be important. The approach outlined in Chapter 2 could be followed to value them.

7.1.6 Social cost-benefit anaysis

In the preceding sections the valuation of inputs and outputs was discussed. The use of labour-intensive technologies for plantation establishment in India makes it imperative that the shadow price of labour (particularly unskilled labour) be estimated carefully. The methodology for its estimation was presented in Section 7.1.3. The difficulties involved in the estimation of the supply price of labour, L, and the propensity to save, s^W, necessary for the calculation of the shadow price of labour were also noted. Often, the studies required to estimate these parameters cannot be undertaken because of lack of time and resources. In practice, therefore, it is sometimes not possible to adopt the above

methodology. Subjective estimates for the shadow price of labour (both skilled and unskilled) could then be made, based on local knowledge. For example, Sinha and Bhatia (1976), analysing an irrigation project in India, assumed a shadow price of one-half the market wage for skilled labour and zero for unskilled labour. Similar estimates based on the unemployment situation and labour mobility could be made for the plantation project.

Having estimated the costs and benefits of the project to society in terms of aggregate consumption, they should be discounted by the social rate of discount (6%) to determine the net social benefit as discussed in Chapter 6.

The sensitivity of the results to changes in the discount rate, shadow prices of labour and foreign exchange and costs and benefits should be tested using sensitivity analyses.

7.2 Summary

In this essay, the methodology of cost-benefit analysis for evaluating forest plantation projects in both developed and developing countries has been presented. The study developed a hypothetical plantation project based on Australian data. This project was subjected to a financial analysis - which considers market prices of inputs and outputs - to determine its commercial profitability. The analysis revealed that the proposed project would not be commercially viable.

However, as discussed in Chapter 2, projects involving public expenditure should be evaluated in terms of their contribution to the aggregate of goods and services available to society. A social

cost-benefit analysis, which looks at the project from society's viewpoint by valuing project inputs and outputs in terms of social losses and gains (i.e. using shadow prices), was therefore undertaken. The analysis, carried out in Chapter 6, indicated that the proposed project may be socially profitable, in contrast with the result of the financial analysis.

The study also extended the methodology of cost-benefit analysis to the Indian situation where the economy is characterised by a high rate of unemployment (or underemployment), income inequalities and balance of payment difficulties. These features necessitated the calculation of the shadow prices of labour and foreign exchange in the Indian situation. However, because of the paucity of the Indian data, this discussion has been mainly qualitative. Shadow pricing labour means assigning it a social value lower than the project wage. The adjustment is thus negative, i.e. the social cost is less than the money wage actually paid. On the other hand, shadow pricing of foreign exchange means that in terms of the local currency, the foreign exchange is undervalued. This adjustment is, therefore, positive, i.e. the social cost of imported inputs is higher than actual prices paid, and the social benefits of exports, if any, are greater than the money revenue received. The shadow wage of labour can be further adjusted to meet the Indian objective of equitable income distribution. Once these adjustments are made, the rest of the analysis is similar for both developed and developing countries.

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APPENDIX A.1

PLANTATION ESTABLISHMENT COSTS

($)

FIRST ROTATION ON BARE LAND

YEAR		0				1				2				6				11			
S.No.	OPERATION	Machine/ Material Costs	Wages	Over- heads	Total	Material Costs	Wages	Over- head	Total	Material Costs	Wages	Over- heads	Total	Material Costs	Wages	Over- heads	Total	Material Costs	Wages	Over- heads	Total
1	Surveys	(1)	(7)	(2)	(10)*																
2	Roading	5	3	2	10																
3	Fencing	(5)	(4)	(1)	10																
4	Cultivation	24	16	10	50																
5	Rabbit control		(5)	(3)	(2)	(10)															
6	Planting	-	-	-	-	30	60	30	120												
7	Refilling	-	-	-	-	-	-	-	-	(6)	(30)	(20)	(56)								
8	Application of herbicides	-	-	-	-	10	15	5	30	(2)	(4)	(2)	(8)								
9	Application of fertilizer	-	-	-	-	30	20	5	55												
10	Pruning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10)	125	25	160
11	TOTAL COSTS	40	33	17	90	70	95	40	205	8	34	22	64	-	-	-	-	10	125	25	160
						SECOND AND SUBSEQUENT ROTATIONS															
12	Spacing of natural regeneration.	-	-	-	-	-	-	-	-	(10)	190	25	225								
13	Pruning	-	-	-	-	-	-	-	-	-	-	-	-	(10)	125	25	160				
14	TOTAL COSTS	-	-	-	-	-	-	-	-	10	190	25	225	10	125	25	160				

*Numbers within brackets have been estimated.