The Wood Production Outlook in Britain

a review

Forestry Commission 1977

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For the convenience of the reader a few of the tables and some of the discussion appear in more than one part of the review.

CHAPTER 1

INTRODUCTION, TERMS OF REFERENCE AND MEMBERSHIP OF THE GROUP

1.1 The increasing concern throughout the world about the future availability of fossil fuels and other finite resources has emphasised the need for appraising the balance of wood demand and supply into the next century, and in particular its implications for wood production and forest strategy in Great Britain. This led the Forestry Commissioners to invite a group of officials to consider the wood production outlook in Great Britain to the year 2050 and this report represents the views of the Group.

1.2 The Commissioners recognise that forestry is but one of the activities using land - the basic rural resource, and that consideration of forest strategy cannot proceed in isolation, or be divorced from other decisions about the countryside. This review - which is exploratory and does not bind Group members or their parent bodies - is therefore being made available as a consultative document, in the hope that it will encourage wider debate.

1.3 The Group received valuable help from British industry, international sources and not least from colleagues within the Forestry Commission, Princes Risborough Laboratory of the Building Research Establishment and other public services. It would be impossible in every case for the Group to acknowledge this help individually, but members are grateful to all those whose work and advice has contributed to the review.

1.4 The members of the Group are:-

E.G. Richards	Forestry Commission (Chairman)
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1.5 Comments on the review should be addressed to:-

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They should reach the Secretary not later than 1 July 1978.

CHAPTER 2

SUMMARY AND DISCUSSION

FACTORS FOR CONSIDERATION

2.1 The Group was asked to concentrate its attention on the provision of wood recognising, nevertheless, the relevance of social, environmental, economic, technical and political considerations. The general approach has been first to examine world demand and supply prospects and then to examine their implications for Great Britain, since it has been assumed throughout that Britain's forestry and forest products industries could not sensibly be looked at in isolation.

2.2 With a time span of three-quarters of a century to consider it would have been possible to advance some imaginative, yet technically plausible arguments to suggest that wood as a renewable resource should be accorded a very special place in a world depleted of many of its non-renewable sources of raw materials and energy. The Group do not, however, consider that such a future is a particularly likely one. Equally, a scenario based on the concept of a highly developed technology providing cheap energy could have been advanced, however unlikely such a prospect may appear at the moment. While aware of the great uncertainties that surround the future, the Group consider it realistic to assume that no major changes will occur in either a continuing aim of people for an improved material life or the capability of the world's economic systems to provide it. Thus, on the demand side, it is not considered that significant changes in tastes will occur. Although prices of commodities capable of replacing, or being replaced, by wood products, may display different trends from the past, there is no basis for forecasting such change. Accordingly, projections of future demand have been made on the basis of a range of specific assumptions, varied to take into account uncertainties about likely rates of change in population growth and spending power per head. Account has also been taken of uncertainty about the relationship between wood consumption and income.

2.3 In examining long-term world supplies it was not possible to establish the same sort of arithmetical basis for prediction as indicated above for demand. The forest management strategies of countries, their processing strategies and their trade policies in the long-term are described only in an indicative way in country and regional studies. However, there is evidence on the biological potential of the world's forests to provide and sustain greatly increased levels of output. In addition, the assumptions on population growth and increase in income per head adopted in projecting wood product demand necessarily carry with them the assumption that economic activity in general will increase and with it the ability to apply the human and other resources required to produce higher volumes of wood products.

2.4 In considering the relevance of world demand and supply prospects to a forestry programme in Great Britain, and in view of the successful performance of British forestry and British wood processing industries, possible alternative future afforestation programmes were translated into their corresponding wood production possibilities. These were examined in the light of the likely development of prices and Britain's demand for wood products.

2.5 The Group decided that any evaluation of the benefits and costs of alternative afforestation programmes for Great Britain should be made on the basis of a judgement of various factors, including reduced dependence on overseas suppliers, the provision of jobs in rural areas, the use of available resources and environmental factors.

WORLD DEMAND FOR WOOD

CURRENT SITUATION

Table 4.1 (Page 27)

Table 4.3 (Page 31)

2.6 Total world consumption of wood and wood products is currently equivalent to about 2450 million cubic metres (m^3) of roundwood per annum, of which sawlogs account for about 735 million m^3 (30 per cent); pulpwood 420 million m^3 (17 per cent); wood for panel products 155 million m^3 (6 per cent); and fuelwood about 1140 million m^3 (47 per cent).

FUTURE DEMAND PROSPECTS

Appendix A

Chapter 3

2.7 Critical factors which will affect future demand for wood and wood products include population growth; growth of incomes (GNP); substitution by and for other materials, which depends largely upon the relationship of wood prices to those of other materials; technological change; and social and political attitudes.

Appendix A

2.8 Population growth is a dominant factor. It is estimated that by the year 2000 the population of the developed regions will have increased from 1100 million to 1400 million, and that of the developing regions from 2700 million to at least 5200 million, amounting to an increase in world population from 3800 million in 1972 to about 6600 million by the year 2000. It is impossible to make a firm forecast of world population beyond the year 2000 but it seems more plausible to assume for the year 2025 an estimate of around 8000 million, resulting from a low rate of growth rather than a figure of 9700 million resulting from a high rate.

Chapter 4

2.9 It has been assumed that total demand for wood and wood products will outpace population growth. Incomes are expected to rise, and a proportion of the increase *per capita* will be spent on additional wood and wood products. Fuelwood has been regarded as an important exception. At a certain level of affluence there is likely to be a change to other fuels, and the demand for domestic fuelwood may decrease as *per capita* income rises. However, there may be local variations where, for example, fuelwood can be created cheaply in village fuel plantations with high rates of growth.

Chapter 3 2.10 Wood will continue to be replaced by other materials in a number of ways but, on current evidence, wood used in the solid is not likely to be replaced to a significant extent taking the world as a whole. Conversely it seems unlikely, even with a predicted 5 per cent to 10 per cent increase in the efficiency with which wood in the solid will be used, that wood will significantly replace other materials such as steel, aluminium, concrete or bricks which are energy intensive and therefore liable to become more expensive in the long run.

Chapter 3 2.11 In the long-term the prospects of technological change also make it difficult to predict with any degree of accuracy how much roundwood will be needed for a given quantity of end product, such as a page of newsprint or sheet of foolscap. Taking the world as a whole, over the next half century the major change is likely to be in pulp manufacture with the greater use of the thermo-mechanical pulping process. This gives a much higher yield than chemical pulping processes and thus has the prospect of substantially reducing the volume of wood needed to make a given quantity of pulp and therefore pulp product. Thermo-mechanical pulp mills are economic at a much smaller size than chemical mills and require less capital, so they are a more attractive investment in many situations. Thermo-mechanical pulp could eventually account for 20 per cent to 30 per cent of the pulp market by the year 2025.

Para 3.4 2.12 Branchwood and stumps will undoubtedly be used on a greater
scale than hitherto in board products or pulp but the use of roots
on a significant scale is not thought to be likely. Future use of
branchwood and stumpwood may increase the utilisation of the
standing tree by 5 per cent to 10 per cent by the year 2000 and
15 per cent by the year 2025. Allowances have also to be made for
re-cycling. Thus by the year 2000 waste paper might account for
Para 3.14 35 per cent of the fibre used in pulp, rising to 40 per cent by 2025.
Current use is about 25 per cent.

Para 3.12 2.13 There are possibilities - both technical and economic - for a greater use of non-wood fibre in making pulp and paper. Bagasse is already used extensively for a very wide range of papers; bamboo is used in a few countries and the use of straw, of which there are immense quantities grown annually, is still in its infancy. Other locally important fibres include reeds and papyrus. Currently all such fibres account for about 7 per cent of pulp and paper production; in the future they will make a progressively larger contribution to the increasing production of pulp and so reduce the wood demand for pulping. By the year 2025 these non-wood fibres might account for 8 per cent of the then greatly increased total world pulp production.

Paras 3.17- 2.14 Economic and technical considerations tend to suggest that
3.24 within the period of this review wood will not become a major raw material for making chemicals or food on a world scale. It has also to be borne in mind that there are still considerable possibilities of increasing food from conventional sources on a very large scale by, for example, plant breeding or the irrigation of semi-arid regions endowed with as yet untapped sources of water. The extent to which wood will one day be used either directly, or after processing, as a fuel, is also open to question, although some Governments are investigating the possibility of using, for example, fast growing coppice harvested like corn.

2.15 Assuming high rates of population increase and of income growth, then with known technologies and the present price relativities of wood and other materials, world requirements of industrial roundwood by 2000 could be as high as 3580 million m^3 rising to 8850 million m^3 by 2025. In addition, requirements of fuelwood by the year 2000 could be 1700 million m^3 giving a total demand of more than 5200 million m^3 by the year 2000. (1)

2.16 It is unlikely, however, that the high population growth and high rate of growth of incomes will go together. The Group has assumed medium rates of growth of population and GNP leading to a total consumption at constant prices of something of the order of 4500 million m^3, including fuelwood, by the year 2000. By the year 2025 the total demand is thought likely to be 7000 million m^3.

TABLE 2.1 *Millions cubic metres*

Year	*Industrial wood*	*Fuel wood*	*World total roundwood requirements*
1972	1310	1140	2450
2000	2900	1600	4500 (a)
2025	5200	1800	7000 (a)

(a) Actual wood requirement after adjustment for better utilisation of the standing tree (branches and stumps), and including allowances for better recovery of waste and increased use of other non-woody materials such as straw.

WORLD WOOD SUPPLY PROSPECTS

WORLD FOREST RESOURCE

2.17 FAO estimate that the total world forest area is around 3800 million hectares (2) of which 2800 million hectares (3) are closed forest. The greater part of the closed forest - probably 2500 million hectares - can be considered as exploitable (= FAO's term "operable").

VOLUME HARVESTED

Table 5.1 (Page 35) 2.18 The growing stock on the total forest area is estimated to be over 300000 million m^3. Annual removals of wood are only about 2500 million m^3. This is about one cubic metre per hectare of operable, closed forest.

Notes: (1) FAO have examined the world situation and predict a demand of something around 5500 million at constant prices by year 2000. Madas (1974) suggests a figure of between 4200 and 5000 million m^3.

(2) FAO World Forest Inventory (1966a).

(3) Persson (1974).

FUTURE SUPPLY PROSPECTS

2.19 As has already been noted, the demand for wood is rising and will continue to rise over the next half century. The production from and productive capacity of the world's forests could also be raised very substantially if they were managed systematically so that an annual cut of several times the present annual rate of removals could be sustained from a much smaller total area. This is likely to be the major source of increases in wood supplies over the next half century but, in addition, new plantations of fast growing species, particularly in tropical and sub-tropical regions, could in the longer term become a major source of supply on a sustained yield basis. It will be many decades before all the possibilities can be translated into reality and, in examining future potential supplies of wood, financial, technological, political and social, as well as purely physical factors, have to be considered. Price is obviously important but its importance like that of other factors will vary regionally. Thus, for example, there is a tendency for the USSR to sell wood to earn overseas currency as part of a long-term industrial and trade strategy. Huge investments having been made in harvesting and processing capacity, large quantities of wood will be produced even if prices do not increase. In some tropical countries large tracts of land are cleared of forest primarily for agriculture and the wood produced from this type of operation will, from time to time, tend to keep prices down.

Chapter 5
Appendix B
Appendix C
Para 5.7

HARVESTING COSTS

Paras. 5.11-5.28
Appendix D

2.20 The cost of harvesting wood in the quantities implied by the estimates of greatly increased future demand is one important factor.

2.21 Increased mechanisation can be expected to contain or reduce harvesting costs (in real terms) in many of the forest areas currently being exploited in developed countries, and eventually in developing countries. Technological progress in the processing industries and in timber engineering is making it possible to use an ever-widening range of tropical species and the increased yield of utilisable trees per unit area will tend to reduce logging costs. Increased use of branches and stumpwood will have a similar if smaller effect. Against these cost-reducing factors an increasing flow of wood to world markets on the scale envisaged means the exploitation of hitherto untapped forest resources in difficult terrain and often in unfavourable climatic conditions, implying increased logging and transport costs.

Paras. 5.11-5.28
Appendix D

2.22 It has not been found possible to quantify the overall effect of all these various trends and factors, but having examined the available evidence, for the purposes of this study it has been concluded that harvesting costs overall will tend to remain at present levels in real terms until year 2000; thereafter they may increase.

WOOD PROCESSING COSTS

Paras. 5.29-5.31

2.23 It was at one time thought that technical innovation in sawmilling (eg. by the use of laser beams and water jets) promised cheaper methods of producing deals, battens and boards, but this prospect is no longer considered realistic as these and other once promising new, theoretical, possibilities are tested in practice.

2.24 In the pulp and paper field where the most dramatic increases in demand are envisaged the industry is already under pressure to undertake relatively costly improvements in the disposal of effluent and generally to reduce what are seen by environmentalists to be bad practices. Moreover, much new plant will be needed often in difficult or remote terrain far from existing services.

2.25 Particle board manufacture is fairly new and process control mechanisms are relatively crude, so that there is room for technical innovation leading to reduced costs.

2.26 But over the forest industry as a whole the view has been taken that there is unlikely to be any substantial reduction in processing costs in real terms. What little evidence there is tends to point in the direction of increasing costs.

WORLD SUPPLY AND DEMAND - CONCLUSIONS

2.27 There are great uncertainties about the future - and about increases in wood supply in particular - so that it is always prudent to consider a range of possible relationships of supply to demand in the distant future.

Table 4.4 and 5.1 (pages 31 and 35)

2.28 Bearing in mind the problems inherent in long term forecasting the broad conclusions reached are that:

- world supplies might increase by the year 2000 broadly to match the projected demand of 4500 million m^3 of roundwood, at constant prices and "medium" assumptions for population growth, incomes and relationships between income and wood product consumption;

- by the year 2025 world supplies might fall short of the projected demand of 7000 million m^3 at constant prices. There will be a rise in the price of wood products in real terms.

2.29 The implications of these forecasts of trends in wood product prices for changes in the prices of roundwood and standing trees will differ from country to country, depending on movements in processing and harvesting costs.

2.30 The general picture which emerges from the review of possible future world and Great Britain demand for wood and wood products is:

- by the year 2000 world demand will have increased from a current level of 2500 million m^3 to 4500 million m^3; supply at constant prices may match this requirement, so that prices do not change in real terms;

- by the year 2025 a gap may emerge between projected demand of the order of 7000 million m^3 and possible supply at constant prices; a balance implies increased prices;

- current annual consumption of wood and wood products in Britain is equivalent to 44 million m^3 of roundwood;

- 92 per cent of Britain's current consumption of wood and wood products is imported;

Table 6.3 (Page 44) Para 6.15

- by the year 2000 demand in Britain is predicted to be between 55 and 60 million m^3;

Table 2.3 (Page 11)

- in the year 2000 production from the present forest area in Britain could meet only 14 per cent to 15 per cent of that demand;

Table 6.3 (Page 44) Para 6.15

- by the year 2025 demand in Britain is estimated to be between 70 and 90 million m^3.

2.31 Various options are open, bearing in mind the Group's assumptions that:

- the wood products industry based on home timber will be able to compete with imported sawn wood and wood products and has the possibility of improving its competitive position in relative terms;

- harvesting costs in Britain will remain in line with world trends;

- it is technically feasible to plant at least another 1.8 million hectares of low grade agricultural land, and it has been argued that much of it could be planted without making a great deal of difference to the quantity of food produced in Britain.

2.32 Three possible options have been examined, based on (1) no more planting, (2) the planting of a further 1 million hectares and (3) the planting of 1.8 million hectares.

TABLE 2.2

ALTERNATIVE PLANTING PROGRAMMES

Thousands hectares

	Total	*By the year 2000*	*Between years 2001 and 2025*
Alternative 1	NIL	NIL	NIL
Alternative 2	1,000	700	300
Alternative 3	1,800	1,000	800

2.33 Planting at these levels, together with existing woodlands, would give yields of the order of magnitude shown in Table 2.3 under what may be called a Traditional Cutting Regime. Under this regime it has been assumed that all Forestry Commission plantations will be managed on 55 year rotations for conifers and 100 year rotations for broadleaves. Moderately heavy thinning has been allowed for, with no thinning in areas particularly susceptible to windblow. Allowance has been made for special treatment of areas of environmental importance. In private woodlands extended rotations of 80 years for conifers and 150 years for broadleaves have been adopted but it has been assumed that thinning will follow the pattern in Forestry Commission woodlands. Other management regimes are discussed in Chapter 7 and Appendix F.

TABLE 2.3

POTENTIAL PRODUCTION FROM THREE ALTERNATIVE LEVELS OF PLANTING
TRADITIONAL CUTTING REGIME

Millions cubic metres per annum

	Year 2000	*2025*	*2050*	*Sustained yield*
BROADLEAVES				
Alternative 1	1.3	1.4	1.6	2.3
Alternative 2	1.3	1.5	1.7	2.6
Alternative 3	1.3	1.5	1.7	3.0
CONIFERS				
Alternative 1	7.0	9.2	10.3	12.0
Alternative 2	7.0	12.8	16.8	22.0
Alternative 3	7.0	14.1	20.4	27.0

2.34 Conifer production is shown in graphical form in Figure 2.1.

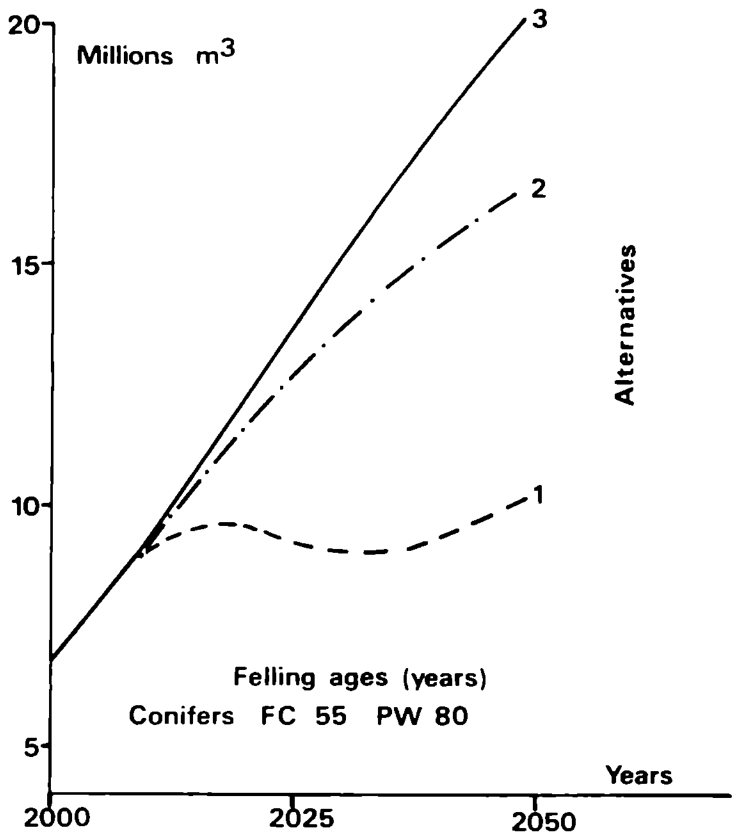

Figure 2.1 Forecast of production for the three planting rates.

2.35 For the discussion of labour and investment requirements in forestry and the wood processing industries for 1985, when new planting under the alternative programmes would not be in production, the published forecast of 4.1 million m^3 for conifers from Forestry Commission and private woodlands has been used. For broadleaves a figure of 1.3 million m^3 has been used. The Traditional Cutting Regime has been adopted for the year 2000 and beyond.

Chapter 7
Appendix F

2.36 With Alternative 1 - no more planting - production gradually increases to the year 2020, after which it drops markedly for about 15 years and then rises again.

2.37 The proportion of conifer sawlogs to smallwood also fluctuates markedly over relatively short periods of time with Alternative 1. This would pose problems for the wood processing industry.

2.38 The one million hectare programme (Alternative 2) would increase production of conifers by the year 2050 by over 50 per cent compared with Alternative 1.

2.39 The 1.8 million hectare programme (Alternative 3) would increase production of conifers to some 20 million m^3 by the year 2050, and give in that year a 20 per cent increase over Alternative 2.

2.40 Broadleaved production is relatively little affected by the alternative rates of new planting assumed.

2.41 Unless further substantial planting is undertaken, Britain will, with time, become more and more dependent on overseas countries for her requirements of wood and wood products. This has special implications for the balance of payments because, for political and economic reasons, the developing countries are more and more seeking to export manufactured wood products rather than wood as a raw material. The British wood processing industry may well find it increasingly difficult and expensive to secure raw material from overseas.

2.42 The question is - to what extent is it prudent to use resources now in creating new plantations as an insurance for the future ? It is not possible to justify such investment on any scale in strict financial terms if the required rate of return is more than about 5 per cent, according to the current knowledge of future trends presented in this review. On the other hand, Britain's oil revenues will enable her, over the next thirty years, to modernise her industry, and it seems entirely reasonable to use a very modest proportion of those revenues to create a renewable raw material resource on land that has a low potential as a source of food.

2.43 The long-term arguments as well as the more immediate considerations - such as employment - suggest that to stop all investment in new planting would be to leave Britain dependent to an unnecessary extent on imported timber.

2.44 Another factor which favours new planting is the fact that the money used to create new sources of wood in Britain is invested with the virtual certainty that wood will be forthcoming when it will be much needed, whereas to do nothing involves risk and uncertainty about the future procurement of wood and wood products.

2.45 If the expansion of the forest estate continues there will of course be a balance sheet of costs and benefits. At the levels envisaged in Alternatives 2 and 3, ie. targets of 1 million to 1.8 million hectares of new planting, the most important benefits are thought to be the creation and maintenance of employment in rural areas and in the forest industries; reduced dependence on imports; and diversification of the rural economy.

Paras 8.4 - 8.18

2.46 Any substantial planting programme implies planting on soils of little agricultural value - mainly in upland Scotland - in areas where rural depopulation is a continuing problem. If no new planting were undertaken the manual labour requirements in forestry would fall at once by more than 2000 . Because no additional land would be planted there would be no loss of jobs in agriculture. As the volume to be harvested from the woodlands increased, labour requirements would continue to fall if productivity of labour increased at 2.5 per cent per annum.

Table 2.4 (Page 14)

2.47 At an annual increase in labour productivity of 2.5 per cent, planting one million hectares (Alternative 2) at the rates assumed would give 1600 to 2000 more jobs than Alternative 1 during the next twenty five years, after allowing for the loss of jobs in agriculture. On the same basis the 1.8 million hectare programme would give an additional 2,700 jobs by the year 2000. Alternative 3 gives substantially more jobs than the other alternatives in the year 2025.

Table 8.1
(Page 54)
Appendix G

TABLE 2.4

FORECASTS OF LABOUR REQUIREMENTS IN FORESTRY
TRADITIONAL CUTTING REGIME

(At 2.5 per cent per annum increase in productivity and after deducting jobs lost in agriculture but including local supervision in rural areas)

Thousands man years

Years	*1985*	*2000*	*2025*
Alternative 1			
No more planting	14.8	13.7	9.7
Alternative 2			
Planting another 1 million hectares	17.4	16.3	13.9
(Jobs lost in agriculture)	(0.6)	(1.0)	(0.7)
Net number of jobs	16.8	15.3	13.2
Net additional jobs	2.0	1.6	3.5
Alternative 3			
Planting another 1.8 million hectares	18.5	17.8	16.3
(Jobs lost in agriculture)	(0.8)	(1.4)	(1.2)
Net number of jobs	17.7	16.4	15.1
Net additional jobs	2.9	2.7	5.4

2.48 Labour requirements for wood processing in rural areas are of the following order:-

TABLE 2.5

FORECASTS OF EMPLOYMENT IN WOOD PROCESSING IN RURAL AREAS
TRADITIONAL CUTTING REGIME

Thousands man years

Years	*1975*	*2000*	*2025*
Alternatives			
1. No more new planting	4.0	4.6	3.5
2. Plant another 1 million hectares	4.0	4.6	4.6
3. Plant another 1.8 million hectares	4.0	4.6	5.0

Paras 8.35 - 8.37

2.49 It proved difficult to assess the benefits of further upland afforestation on the landscape, particularly in terms of future public attitudes to landscape features, and no particular weight was accorded to this part of the equation. Rather similarly, it was thought that the recreational potential of the new plantations should not be given much value as the balance of advantage lies in developing recreational features near to population centres rather than in the remoter uplands. On nature conservation, the general opinion appears to be that forests improve the degraded soils found in much of the uplands. They add another, vertical, dimension to the wildlife habitat and add considerably to the variety of flora and fauna, especially when felling starts, and the cleared areas greatly increase the desirable "edge effect" between forest and open land.

2.50 Taken as a whole the effect of these environmental factors was thought to be positive but not to be a major argument for further upland afforestation.

Para 7.3

2.51 The Centre for Agricultural Strategy (Reading (1976)) considers that the loss of agricultural production consequent on the transfer to forestry of between 1.7 and 2.1 million hectares, implies a loss in total British agricultural production - in the absence of technical progress - of about 1.5 per cent to 2 per cent by the year 2000.

2.52 To enjoy the substantial benefits expected to accrue from the planting programmes suggested will involve the use of capital that might otherwise be used elsewhere. However, it must remain a matter of judgment how much the country should set aside from its current earnings to provide an essential raw material as a deliberate act of policy. A long-term goal of creating, on some of Britain's poorest land, up to a further 1.8 million hectares of plantations is technically feasible and appears to be a prudent investment.

FUTURE STUDIES

2.53 It has not been possible to study in any depth the implications for agriculture of the planting programmes discussed in this study, and the issues must be examined in conjunction with agricultural interests.

2.54 Clearly there is also an incentive to increase yields from existing woodlands, including those classified as unproductive, and to try to find and adopt better methods of establishing woodlands so that future yields per unit area are increased. Thus the existing work aimed at increasing the potential yield from existing and new plantations should be continued.

2.55 The structure of British wood processing costs should be examined together with the relationship between raw material costs, processing costs and the rates of return achieved in industry.

2.56 Much of the wood grown in Britain is technically suitable for a range of possible uses. Studies of the factors which influence its use in Britain should be continued and broadened.

2.57 Studies on the cost of achieving standards of performance of wood comparable with those of other materials should be extended.

2.58 Studies should be undertaken of the wood product export strategies of overseas countries and the effect of importing more highly processed products on, for example, the cost of the final product and jobs in Britain.

2.59 FAO and other appropriate agencies should be encouraged to intensify studies at the international level of prospects for future wood supplies, with the object of arriving at better forecasts based on a more precise understanding of the factors which determine wood supply levels in different regions and countries of the world.

TABLE 2.6

SELECTED STATISTICS - GREAT BRITAIN

		PROGRAMME OF NEW PLANTING								
		NO NEW PLANTING (Alternative 1)			*PLANT ANOTHER 1.0 Million hectares (Alternative 2)*			*PLANT ANOTHER 1.8 Million hectares (Alternative 3)*		
	Year	*2000*	*2025*	*2050*	*2000*	*2025*	*2050*	*2000*	*2025*	*2050*
Potential production broadleaves and conifers	Millions m^3	8.3	10.6	11.9	8.3	14.3	18.5	8.3	15.6	22.1
Numbers of jobs in forestry (net of any loss of jobs in agriculture) at 2.5% p.a. increase in productivity	Thousands	13.7	9.7	*	15.3	13.2	*	16.4	15.1	*
Net additional jobs in forestry	Thousands	-	-	*	+1.6	+3.5	*	+2.7	+5.4	*
Employment in wood processing in rural areas	Thousands	4.6	3.5	*	4.6	4.6	*	4.6	5.0	*

	Years	*1975-2000*	*2001-2025*	*1975-2000*	*2001-2025*	*1975-2000*	*2001-2025*
Extra forestry investment	£millions per annum	-	-	14.4	7.2	20.6	16.5
	(Thousands hectares/annum)	-	-	(28)	(14)	(40)	(32)

* Not calculated

Continued on page 18

TABLE 2.6 continued

	Year	*NO NEW PLANTING (Alternative 1)*	*PLANT ANOTHER 1.0 Million hectares (Alternative 2)*	*PLANT ANOTHER 1.8 Million hectares (Alternative 3)*
		£Millions p.a.	*£Millions p.a.*	*£Millions p.a.*
Investment in wood processing				
Strategies A, B (para 8.23 Table 8.5)	1975-1985	26	26	26
	1985-2000	66	66	66
	2001-2025	43	64	73
	2026-2050	64	93	111
Foreign exchange savings				
Strategies A, B (para 8.24 Table 8.6)	1975	176	176	176
	1985	254	254	254
	2000	416	416	416
	2025	478	660	728
	2050	576	880	1052

				1972-1985	1986-2000	2001-2025
Annual growth rates assumed for Britain -	Population	Percentage		0.16	0.16	0.12
-	GDP/Capita	Percentage	High	2.5	3.0	3.0
			Low	1.5	2.0	2.0
				1972	2000	2025
Consumption of wood and wood products (roundwood requirements) in Britain, actual and estimated		Millions m^3		44	55-60	70-90

CHAPTER 3

THE CHANGING WORLD

THE EFFECTS OF TECHNICAL CHANGE ON THE SUPPLY AND DEMAND FOR WOOD

3.1 In considering technical developments the Group has had regard not only to the likelihood of change but also to the rate at which changes are likely to be introduced.

FACTORS AFFECTING SUPPLY

3.2 The bulk of the current supply of wood comes from natural forests and a comparatively small proportion from plantation forests. One expected change is an increase in the volume and proportion obtained from managed plantations. It is predicted that in the long run in place of the current 1 m^3 per hectare per annum from all forests, a yield of 7 or 8 m^3 per hectare is possible. Substantial improvements are likely to occur in plantations through advances in tree breeding and forest management techniques. Furthermore, production from natural forest is likely to increase mainly through the wider utilisation of tree species. These developments will take a considerable time to have any marked effect, and particularly for plantations to become a major source of supply. A yield of 7 to 8 m^3 per hectare over the world's forests as a whole implies an output of 20 to 25 billion [(1)] cubic metres or eight to ten times today's cut and twice the highest projected demand in the year 2025.

3.3 At present only relatively few species in the natural tropical forests are economically marketable, and the need to increase the number of species which can profitably be marketed is clearly recognised. Developments in timber technology are expected to facilitate this process and indeed they have to some extent already started. Thus in the United Kingdom prior to 1938 the bulk of overseas supplies consisted of five temperate species and five tropical species of timber; in the 1950's an additional eight tropical species were being used in appreciable volume and a further four species were added during the 1960's. Within the last eight years of so some of the species introduced in the 1950's have become difficult to obtain and currently 12 or more additional species are available in the UK from South America and South East Asia; more are confidently expected in the next few years. In addition, the concept of grouping species with like properties as an aid to marketing and utilisation is being developed.

3.4 In addition, recent developments are clearly pointing the way to utilise smaller and lower quality trees and to obtain a greater volume of useful material from each tree. Technically it is possible to use all parts of the tree, including foliage and roots, but the problems of using the last two categories are such that it seems unlikely that they will be used to make wood-based products or pulp on any appreciable scale. It would appear to be more realistic to assume that tops, branches and stumps will fairly

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Note: (1) One billion equals one thousand million (10^9).

readily be put to use, ie. all that part of the tree above the ground with the exception of foliage. This material will find its way into panel products or pulp and can be expected to add between 20 per cent and 30 per cent to the yield currently being obtained from trees being cut. The extent to which this potential increase will be realised is difficult to assess because of economic uncertainties and because there will be advantages in leaving tops on the forest floor in some cases in order to maintain or improve quality of the soil. Overall it appears reasonable to assume that an increase of between 5 per cent and 10 per cent in utilisation of the standing tree may be achieved by the year 2000 and an increase of 15 per cent by 2025.

3.5 Although it is recognised that coppice techniques may be developed and combined with complete harvesting for the production of pulp or chip-board, it is not thought that this will make a major impact on world production and no account has been taken of this possibility in the Group's calculations.

FACTORS AFFECTING DEMAND

The use of wood for timber products

3.6 Recent developments in technology have made it possible to build structural and semi-structural elements that use rather less timber than before, and although additional advances of this kind may not produce very significant further reductions, the wider application of the recent developments could result in an overall increase in the efficiency of wood utilisation. It can be expected that new wood products, primarily sheet materials, will continue to be developed and that these will increasingly find a use in construction, particularly for semi-structural purposes. Although the demand for wood-based sheet materials has been rising very rapidly in the last ten years, it still represents less than 20 per cent of total industrial wood use excluding pulp. The rapid growth has been in products for which a high proportion (eg. 55%) of the raw material is in the form of chips or residues which previously would probably have been largely wasted. The recent increase in the use of residues is slowing and may be reaching the limit of what is practicable in the light of the quantity currently available. However, as sawmill production increases more residues will become available to sustain increased manufacture of sheet materials with a high residue content.

The use of wood for pulping

3.7 A current development is the introduction of thermo-mechanical processes (TMP). This development is motivated by the combination of high yield and the good pulp quality obtainable; reduced pollution problems; the fact that a comparatively small plant can be viable; and the low capital investment required compared with that needed for chemical processes. The pulp is expected to be suitable for the range of products currently produced from mechanical pulps and also for some purposes for which chemical or semi-chemical pulps are now used.

3.8 The power requirements for these processes are a little higher than for other mechanical processes and substantially higher than for chemical processing. The resulting difference in costs is not thought to be high enough to inhibit developments in application and there are expectations that in the longer term it will be possible to reduce power consumption by the pre-treatment of wood with enzymes.

3.9 Thermo-mechanical pulp could become a major development and should enable the increased demands for pulp to be met with less than an equivalent growth in wood requirements, and without a significant increase in cost. Existing capital intensive pulping plants will last for many years and will be updated in parts before the complete replacement is built. It is not therefore expected that TMP will have a very significant effect on wood demand before 2000. It is estimated, however, that TMP may account for up to one-third of the total pulp market by 2025. Overall it is assumed that the introduction of thermo-mechanical pulp processes will reduce what would otherwise have been the wood fibre requirements for pulping by 4 per cent by the year 2000 and 10 per cent by 2025.

3.10 The present situation in the UK is illustrated by figures for 1976:

Mechanical pulp	home produced	200,000 tons air-dry
	imported	260,000 tons air-dry
Chemical/semi-chemical	home produced	200,000 tons air-dry
	imported	1,600,000 tons air-dry

From calculations of potential yield it is clear that within the period being considered it would be possible to produce all the mechanical pulp required in the UK using home sources.

3.11 The possibilities of biological pulping require further comment. In this process the lignin bonding the fibres together is broken down by enzymes and is lost as carbon dioxide and water. Although technically feasible, it seems unlikely that such a process would be used to remove all the lignin as it would be desirable to use part of it for the production of energy or chemicals. It seems more likely that the process will be used as a pre-treatment, prior, for example, to thermo-mechanical or some other form of wood processing.

3.12 It is also necessary to comment on the production of pulp from agricultural crops. Currently between 6 per cent and 8 per cent of the world's pulp is obtained from materials such as grasses, straw, bamboo, hemp and bagasse. The quantity thus produced has been growing, particularly in certain countries, but informed opinion suggests that the proportion of the growing pulp demands which will be produced from these materials will not exceed 8 per cent.

Re-cycling waste material

3.13 Although "waste" - mostly the by-product of various forms of wood processing - is now extensively used for products such as chipboard, the re-cycling of once-used materials seems to be important to this study only in respect of paper.

3.14 Waste paper forms 46 per cent of the furnish[(1)] for paper produced in the UK and about half the total requirement is produced at home. Thus about one quarter of UK needs is based on re-cycled material, a figure comparable to that for several other industrialised countries. Technical factors are expected to limit an increase in the amount of waste paper re-cycled to 70 per cent of the furnish, ie. about a 50 per cent increase on present figures, and considerable research is now in progress to make this feasible. Such an advance would mean that the same quantity of paper could be produced using only 60 per cent of the present volume of wood. On a world basis it is assumed that the 25 per cent waste paper in the total fibre requirement will increase to perhaps 35 per cent by the year 2000, rising to 40 per cent by 2025.

Use of other materials as alternatives to timber

3.15 There has been a long term trend whereby newly developed materials displace traditional ones from some of their established uses when their combination of properties is particularly appropriate and costs are lower; recently, as an example, various plastics have been substituted for timber in a number of uses. Some research has been carried out on the implications of substituting other materials for timber in parts of buildings, but these do not reveal any great incentive in the UK for the replacement of timber by other currently known materials. This is because, over a period of years, the costs of different materials tend to keep broadly in step and, in any case, the cost of materials is not always the major component of the total cost of the end product. So far as major end uses of timber are concerned, it seems more likely that substitution will come about because of an absolute shortage of certain materials, or through changes in design and human or functional requirements.

3.16 It has been assumed therefore that there will not be a substitution of other materials for timber, or *vice versa*, on any appreciable scale in the industrialised countries.

WOOD AS A SOURCE OF ENERGY, CHEMICALS AND FOOD

WOOD AS A FUEL

3.17 Fuelwood accounts for about half the total wood used in the world. This is mainly in the developing countries and the use of wood for this purpose seems likely to increase with the population, until the growth of incomes and the development of cash economies make it feasible for other fuels and sources of energy to be used to an increasing extent. Any further rise in the price of fossil fuels would of course slow down such changes. The Group has considered the possibility that trees will be harvested specifically as a fuel in the industrial sense, but on the whole consider that

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Note: (1) The furnish includes fibre, clay, chemicals etc.
Waste paper forms 50% of the fibre content.

this is an unlikely development except where there are reasonably high concentrations of trees which are of no value for other purposes, for example Mesquite in Texas. It has been calculated for example that, in the UK in 1977, wood would need to be prepared and delivered to the combustion plant at around £7.50 per ton (about a third of ruling pulpwood prices) to compete with fossil fuels, and that the continuous yield from some 650,000 hectares of softwood would be needed to supply a 1000 megawatt power plant.

3.18 It has not been possible to assess the likelihood of trees being grown on very short rotations (coppice) for fuel in semi-tropical areas, but the production from such crops would reduce only to a modest extent the assumed contribution from man-made plantations and non-forest crops.

WOOD AS A SOURCE OF CHEMICALS

3.19 Because of concern about the projected shortage of petroleum and derived products, possible developments in the use of wood for the production of chemicals have been considered.

3.20 Wood is basically composed of carbohydrates and therefore the most obvious possibility is hydrolysis, using either chemicals or biological agents, with the production of simple sugars or alcohols; and a further conversion of the alcohols into either higher chemicals and plastics or, using biological systems, to simple protein materials. There must however be serious doubts as to whether processes of this kind will be developed and become effective in the time scale being considered. Generally speaking, existing technology for these products is based upon oil as a raw material and it will be much easier to convert to processes which use coal than to change to wood or other agricultural materials. Moreover there is a vast amount of coal and shale available and it is often concentrated in small areas, putting it at an advantage in terms of transport costs to the consumer. In addition, if the demand for alternative raw materials becomes large enough, there are other crops which could compete with wood in the economic production of carbohydrates. Examples are sugar cane and other plants containing high concentrations of starches. In the less developed parts of the world in particular, it would be logical to consider these materials as feedstock for chemical processing rather than the more complicated carbohydrate obtained from trees.

3.21 In situations where the very high cost of capital, or the large-scale of investment necessary for economically viable plants, militates against the development of plants for the conversion of coal to chemicals, greater possibilities exist for small scale chemical processing plants based upon carbohydrate material. Oil is more likely to be used as a chemical feedstock than as a fuel, as there are alternative ways of producing energy, particularly for use in buildings and industrial processing; this should further delay the time when chemicals from wood become important.

3.22 There is one other factor. Whereas chemical processing based upon largely hydrocarbon products does not involve the handling of a great deal of water, the processing of carbohydrate materials inevitably involves the production of a large volume of water, which is extremely costly and energy consuming to handle. This means that the economics of producing chemicals from carbohydrates are not likely to become really attractive.

3.23 Overall, the production of chemicals from carbohydrates in the period under review is not regarded as likely to have a major impact, and the best judgement obtainable suggests that the proportions in which fossil materials and cellulose materials will be used for polymer products and structural products is likely to remain much the same for the foreseeable future.

WOOD AS A SOURCE OF FOOD

3.24 Some progress has been made in the partial degradation of wood so as to make it suitable for feeding to cattle, but such processes are likely to be more attractive when based upon agricultural crops. Such developments are not thought likely to have a significant effect on the demand for wood within the period under review.

CHANGES IN SOCIAL AND POLITICAL ATTITUDES

3.25 There is evidence that in some developing countries forest land is being lost through shifting cultivation or failure to replant or regenerate felled areas, but there are other places where plantations are successfully established and are producing high yields. There are social and political advantages in such developments, particularly as they encourage the construction of industrial processing plants to use the forest crop, and there is evidence that both industry and development agencies in the wealthier countries are prepared to assist with development capital and expertise. This enables developing countries to obtain higher added-value from raw materials they produce, and there is evidence that this is already a policy objective in some places.

3.26 The political uncertainties accompanying investment in some parts of the world will encourage consideration of investment in forestry in more stable areas, even though plantation growth rates may be much lower, and the return on investment less. There is a trend for industrial countries to become more dependent on imports of wood products and a growing interest in encouraging plantation forestry, both as a step towards reducing dependence on overseas supplies with its attendant uncertainties, and from the point of view of import saving. Although the financial return on such investment may not be very high, there is no doubt about the saleability of the product and the risk is therefore low.

3.27 It is clear that the environmental implications - in the widest sense - of afforestation will be an important factor. While such considerations may not in the end affect the quantity of wood which can be produced, they may provide constraints within which wood production has to proceed, leading to higher costs and a reduced return on investment.

3.28 Much has been said in recent years about the influence of overseas suppliers' commercial strategy [(1)] on the cost of Britain's imports of wood products. The point has been made that, quite apart from any changes in the real price of particular wood products (which, as noted in Chapter 6, have occurred since the low levels of 1972 but not on the scale which many observers have claimed), there has been a growing trend for the export of more highly processed goods. The extent of this trend in terms of its effects on British imports is measurable. For example, the average value of wood product imports in £'s of 1970 value fell from £21.01 per m^3 of wood material equivalent in 1955 to £17.01 in 1972, but if the commodity composition of wood and wood product imports had remained the same, the average value would have fallen to £15.00. In other words, on a constant volume basis the prices of the individual products fell by 29 per cent on average but, because of the effect of a changing composition towards more highly processed goods, the average value overall fell only 19 per cent.

3.29 It has been argued that if this trend towards importing more highly processed materials continues, Britain will have to pay more for imports, even if the quantity and real prices of particular sorts of product remain stable, with a resulting increased drain on foreign exchange. There are two aspects to this argument which have to be noted. If more value is added by exporters this may be done because it is advantageous for the firm concerned, or because it is a policy determined by governments. To the extent that the extra processing is economically efficient or may be beneficial to the UK, it is arguable that the overall economic effect is neutral. Equally, if export earnings in the Third World rise, not only is there increasing income in such countries but the ability to buy British goods is enhanced.

3.30 Despite these considerations, it is recognised that the extra pressure on the UK balance of payments is liable to create greater problems for this country. It is for consideration whether a measure of the desirability of increased import substitution on the basis of this concern should be obtained by attaching a foreign exchange premium to future wood product imports. This subject is more fully discussed in Chapter 8.

Note: (1) Possible strategies for processing home-grown wood are discussed in the sections of Chapter 8 dealing with employment and other implications of alternative planting and wood processing programmes.

CHAPTER 4

WORLD DEMAND FOR WOOD

PROJECTION OF FUTURE WORLD REQUIREMENTS

INTRODUCTION

4.1 The projections set out in this section and described in detail in Appendix A, are conditional on the relationships assumed between wood products (1) consumption and the various measures selected as influencing their consumption. The projections are accordingly heavily influenced by past trends and it is assumed that there will be no change, at constant prices, in the way in which consumption changes in the future with changes in population and income *per capita* (which are the relevant measures underlying our forecasts) compared with the past. Thus no explicit allowance has been made for changes in taste. To the extent that such changes have occurred in the past, their effect is subsumed in the assumptions on the percentage change in consumption of particular products with a 1 per cent change in income *per capita*. In practice, no evidence has been discovered for any marked change in taste in the medium term which can be separated from income effects, and it is not considered appropriate to incorporate any specific change in tastes in the forecasting procedure.

4.2 It should be emphasised that all the projections assume no change in the prices of wood products in real terms. The effect on actual consumption of any price changes foreseen in the light of the supply projections noted in Chapter 5, is considered in Chapter 6.

PROCEDURE

4.3 Four groups of wood products are considered. Three are derived from industrial wood, namely sawn wood, paper and paperboard, and panel products. Other industrial wood products which are small in volume, such as pit props and poles, are not separately distinguished. The fourth product, fuelwood, is dealt with separately.

4.4 Table 4.1 shows the starting values for consumption of industrial wood products, distinguishing developed countries (DCs) from developing or less developed countries (LDCs).

Note: (1) No independent work has been carried out on the relevant measures for which projections are necessary. Instead, the views expressed in various UN and other international organisations' publications have been distilled to produce "high" and "low" rates of change in the underlying factors used.

TABLE 4.1

WORLD CONSUMPTION OF INDUSTRIAL WOOD PRODUCTS, AVERAGE 1970-74

World Consumption (= production)

Commodity	*(i) in product units* DCs	LDCs	Total	*(ii) in terms of roundwood Millions cubic metres UB (c)*	*Inferred conversion factor from roundwood*
Sawnwood	328	102	430 m m^3(s)	735	1.71 m^3 UB/m^3(s) (a)
Paper and paperboard	108	31	139 m tonnes	418	3.01 m^3 UB/tonne (b)
Panel products	70	15	85 m m^3(s)	155	1.82 m UB/m^3(s)
				1308	

Notes: (a) m^3(s) is the abbreviation for sawn, or otherwise processed, material measured in cubic metres of mill product.

(b) includes effect of recovered waste paper plus residues from saw and plywood mills.

(c) UB = Under Bark.

4.5 Appendix A details the method of projecting consumption of each industrial wood product. These projections yield results expressed in terms of the roundwood requirement, using 1970-74 factors and assume no change in recovery of wood product per unit of standing timber volume measured according to the conventions of 1970-74. Figures for adjusted roundwood requirement have then been calculated for changes in one or other of the four factors of: improved utilisation of the tree; changed conversion efficiency in primary processing; enhanced recovery of material available from later stages of processing and from final consumption; and use of non-wood fibre.

4.6 The purpose of this adjustment is to indicate the total demand on the growing stock after allowance for changes in roundwood recovery in the forest, as well as in processing and residue recovery from mills and subsequent consumption.

4.7 Finally, allowance has to be made for the consumption of fuelwood. FAO (1976a), as in earlier FAO publications, assumed that fuelwood use rises in proportion to population. Other workers have suggested, plausibly in the Group's view, that above a certain level of income the *per capita* consumption of fuelwood may actually decline, and account is taken of this effect in the projections for fuelwood noted in Table 4.3. No adjustment has been made for changing fuelwood recovery from standing trees. In addition, no explicit allowance has been made for increased demand for wood used in providing forms of energy other than raw wood used for fuel or charcoal. It is accepted that some such uses may develop but their volume may be expected to be small in relation to the uncertainties, both of current fuelwood consumption in the world and projected changes in that total.

RESULTS

4.8 Table 4.2 shows the final results in terms of roundwood requirement for industrial wood products, first unadjusted for future changes in conversion efficiency, residue recovery, etc. ie. using 1970-74 factors, and secondly with the changes mentioned in paragraph 4.5 and listed in paragraph A7 of Appendix A. The forecasts for industrial roundwood and past consumption are shown in Figure 4.1.

TABLE 4.2

PROJECTIONS OF ROUNDWOOD REQUIREMENT FOR INDUSTRIAL WOOD PRODUCTS

Millions cubic metres per annum

Rate of increase in		*Roundwood requirement*					
		Unadjusted			*Adjusted*		
Population	*Income per capita*	*1972*	*2000*	*2025*	*1972*	*2000*	*2025*
		A: high income elasticity assumption					
H	H	1310	4140	11690	1310	3580	8850
H	L	1310	3140	6630	1310	2690	4970
L	H	1310	4040	10190	1310	3500	7710
L	L	1310	3060	5860	1310	2620	4390
		B: low income elasticity assumption					
H	H	1310	3570	9070	1310	3080	6780
H	L	1310	2820	5590	1310	2410	4140
L	H	1310	3480	7870	1310	3010	5890
L	L	1310	2760	4910	1310	2350	3630

4.9 It is interesting to observe the relationship between these forecasts, after adjustment for changed recovery, and total world income. Paragraph A8 of Appendix A gives the comparison. This indicates that with 1970-74 as the base period, adjusted roundwood requirement for production of industrial wood products is projected to rise on average only 70 per cent as fast as the world output of all goods and services to the year 2000 and 55 per cent as fast to 2025.

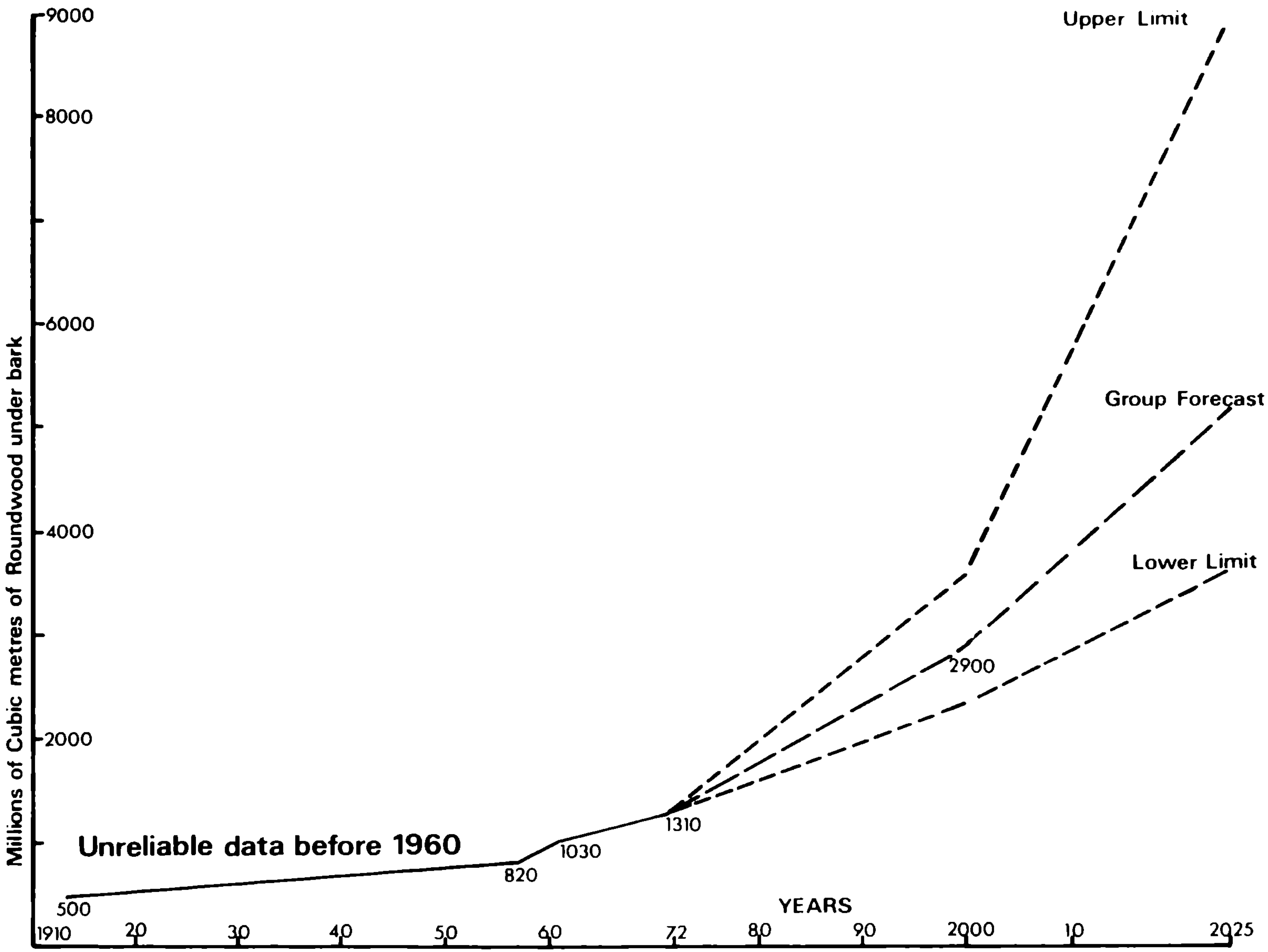

Figure 4.1 Past world consumption of industrial roundwood and projected roundwood requirements.

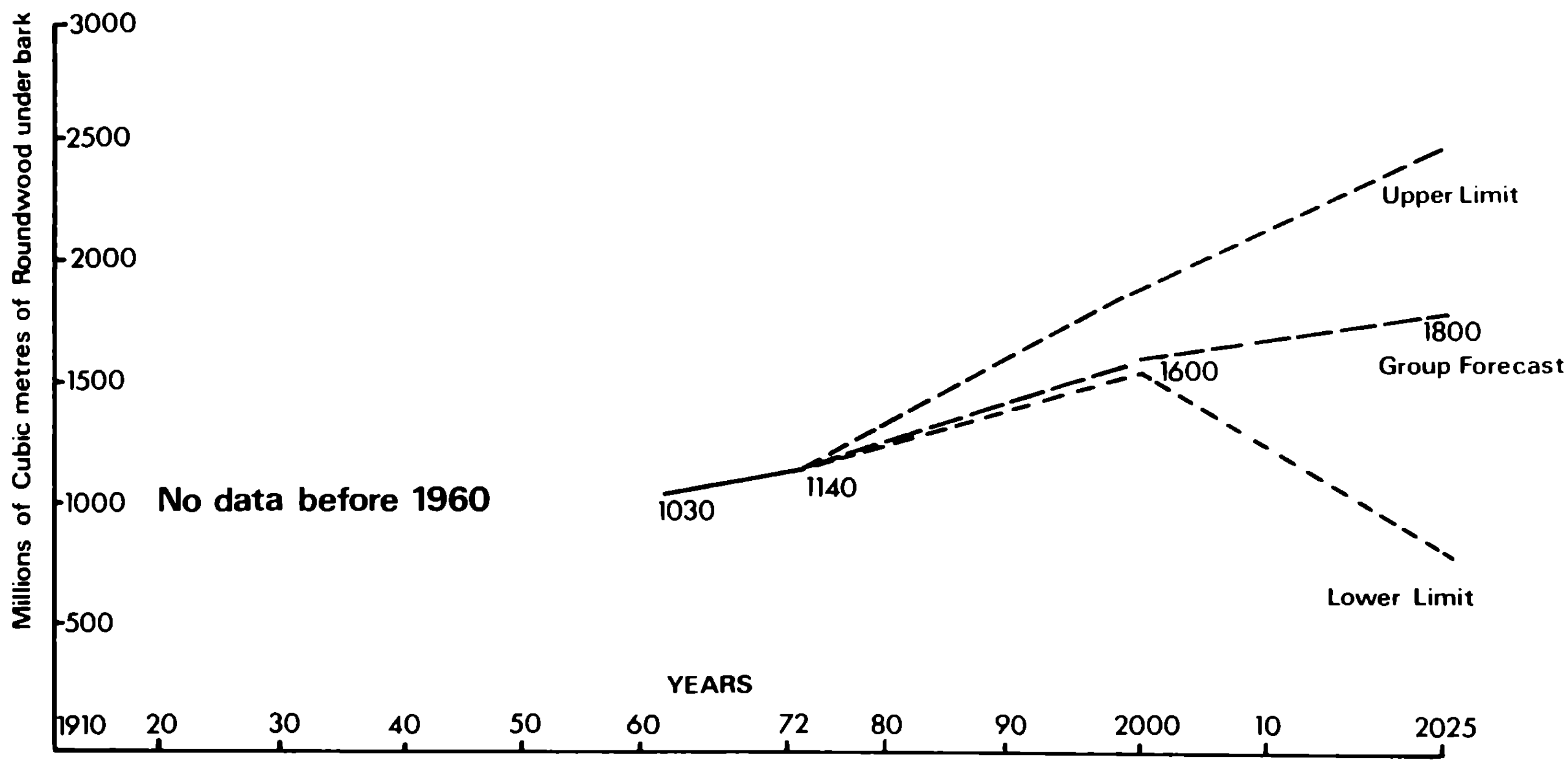

Figure 4.2 Past world consumption of fuelwood and projected roundwood requirements.

4.10 Table 4.3 and Figure 4.2 show the projections for roundwood used as fuel.

TABLE 4.3

PROJECTIONS OF FUELWOOD REQUIREMENTS

Rate of increase		1972	2000		2025	
		Millions cubic metres per annum				
		Income elasticity assumption				
Population	*Income per capita*		*H*	*L*	*H*	*L*
H	H	1140	1800	1590	2040	1150
H	L	1140	1890	1780	2500	2080
L	H	1140	1750	1550	1630	810
L	L	1140	1840	1730	2050	1640

4.11 The implied total wood requirements in 2000 and 2025 are set out in Table 4.4.

TABLE 4.4

TOTAL WOOD REQUIREMENTS

Rate of increase		2000		2025	
		Millions cubic metres (adjusted) per annum			
		Income elasticity assumption			
Population	*Income per capita*	*H*	*L*	*H*	*L*
H	H	5380	4670	10890	7930
H	L	4580	4190	7470	6220
L	H	5250	4560	9340	6700
L	L	4460	4080	6440	5270
Most likely assumptions:		4500		7000	

4.12 The most likely outcome is judged to be a total roundwood requirement of some 4500 million m^3 in 2000 and, bearing in mind the possibility of the low rate of population increase being more plausible in the next century, of the order of 7000 million cubic metres in 2025. The projection for 2000 may be compared with the figures produced by FAO in the timber trends study for Asia and the Far East (FAO, 1976b): this suggests, by extrapolation, a total roundwood demand for the world, including fuelwood, of the order of 5,600 million m^3. Madas (1974) suggests a total consumption of between 4,200 million m^3 and 5,000 million m^3. It is considered that one of the reasons for the higher FAO (implied) estimate for 2000 may be in the fact that relatively little allowance has been made for improved utilisation of the tree in that study, although allowance has been made in most international studies for enhanced use of waste from mills and recovery from final consumers in, for example, the form of waste paper.

CHAPTER 5

WORLD FOREST RESOURCE

PROJECTIONS OF FUTURE WORLD SUPPLY OF ROUNDWOOD

5.1 There is no very clear understanding of what determines the volume of wood cut. It is not even clear how much the price offered for standing timber affects the amount that a forest owner offers for sale. For some products and many forest ownerships, the cut appears to be quite independent of price. Nevertheless, in aggregate the volume cut must depend to some extent on price, for if this falls and remains low for a number of years owners do, in fact, cut less. It is also clear that if the price offered rises then, other things being equal, the volume cut eventually increases in response.

5.2 Over time, the volume of wood cut has increased although the price has remained constant. This is probably because more intensive cutting regimes have been adopted and new tracts of forest opened up. Looking to the future, there may also be an increased yield through changes in the number of species and sizes of tree that can be utilised or, as with plantations, through the recruitment of stands capable of yielding marketable wood. This would result in a satisfactory level of income even if prices were constant or falling.

5.3 The first section of this Chapter reviews possible increases in supply, assuming constant prices of standing wood. Subsequent sections consider the implications of changes in the costs of harvesting, transporting and processing timber.

EVIDENCE ON PAST RATES OF CUT

5.4 A principal aim of this review is to indicate the likely development of wood product prices in the world as a whole and in Britain in particular. Unfortunately it is impossible to say how far changes in the world supply of roundwood are to be attributed to political, social, or technical factors as opposed to price change factors. In certain developed countries it appears that prices have remained broadly stable in real terms over long periods. In other countries which have been more recently opened up, trees which were regarded as free goods in early frontier days have become progressively more valuable. It is therefore likely that for the world as a whole, and in the long-term, the increased level of removals observed has occurred partly as a response to price. While it is difficult to avoid this conclusion over periods of, say, a half century or more, it is noteworthy that in the post-war period major increases in cut have taken place in certain countries with no obvious trend in the prices paid for standing wood (Streyffert 1960, Eden 1976, USDA 1974).

5.5 Data on past fuelwood production in the world are notoriously poor and price information almost non-existent, partly because fuelwood does not enter the market system. Accordingly, attention is confined to changes in removals of industrial roundwood.

Indicative data from FAO sources on the long-term development of world cut are given in Johnston *et al.* (1967). These figures, together with those for more recent years, are graphed in Figure 4.1.

5.6 The annual average rate of increase in industrial wood removals over the period 1913-1951 was 1.2 per cent, being affected by the depression of the 1930's and the Second World War. From 1951 (mean of 1950-1952) to 1961, the rate was 2.3 per cent and from 1961-1972 2.2 per cent. Table B1 of Appendix B indicates the trends for the world and for different regions over the most recent decades, for which data are available. This shows that the rate of increase for the world has averaged 2.2 per cent ± 0.2 per cent for the decades 1954-1964 and 1964-1974. Rates of increase have been higher than the world average in developing regions of the world and in Canada. It should be remembered that these changes have occurred during an era of unprecedented economic growth for the world as a whole.

PROSPECTS FOR INCREASING REMOVALS

5.7 Two bases can be used for estimating future volumes of world removals. One is to aggregate the references, so far as these are available, to future supply in official country and regional timber trends studies. However, it is believed that there are good grounds for considering such projections to be generally conservative. The alternative is to indicate plausible higher rates of removal in the light of the pressure arising from increasing demand and of changed concepts of allowable cut. Some downward adjustment to estimates of sustained wood production must be made for the effects of destructive logging, with or without change in land use, and some upward adjustment for increases in yield resulting from more intensive management and utilisation, especially in view of the contribution of fast growing plantations.

5.8 Table 5.1 sets out the results for the year 2000 of adopting these two approaches, and gives an indication of possible removals in the year 2025. The bases of the projections are described in Appendix C.

TABLE 5.1

CURRENT AND PROJECTED SUPPLY OF WOOD AT CONSTANT PRICES

Region	*Growing stock*[(a)] *Billions cubic metres (b) (at stated year)*	*Annual cut of all roundwood* *Millions cubic metres*			
		1970-74 Average	*2000 "Official"*	*2000 Projected*[(c)]	*2025 Projected*[(c)]
Europe	15(1970)	320	430	500	550
USSR	75(1973)	380	520	620	750
USA	22(1973)	330	535	600	700
Canada	25(1973)	130	225	330	500
Latin America	95(ca 1970)	270		900	1600
Africa	40(ca 1970)	310		600	900
Asia, Far East inc. Oceania	45(ca 1973)	710		1130	1400
World Total	317(ca 1970)	2450		4680	6400
Absolute annual increase in cut in millions of cubic metres per annum:				80	69

Notes: (a) One billion = one thousand million (10^9)

(b) Country/regional figures adjusted, where appropriate, to overbark basis by addition of 10 per cent.

(c) ie. possible and probable.

5.9 Two further observations about the projected levels of cut in Table 5.1 may be noted at this stage. One is the increase in wood output compared with the increase in total world output of all goods and services. The rise in cut suggested over the next half century of over two and a half times, may be compared with an increase in total world production of all commodities of between eight and ten times on the assumptions for increase in population and GDP *per capita* adopted in Chapter 4.

5.10 The second consideration is the plausibility of the implied cut in the year 2025 in terms of the potential productivity of the world's forest area as it may be 50 years hence. Roberts (1977) indicates that the pressure on forest land from extension of agriculture will not be very large, even though future food supply appears to be the field in which physical resource constraints will become apparent sooner than in any other sector of activity. The prospect therefore is that the productive forest area will not drop below 2000 million hectares in the first quarter of the next century. Studies on the potential dry matter production of the same broad geographical distribution of the world's forests as occurs today, suggest potential outputs of 19 billion m^3 (Paterson) with no change in species and no fertilisation or other soil improving inputs, and of 40 billion tonnes of dry matter (Lieth, 1977) or, say, 18 billion m^3, assuming one-third of the total dry matter production is in the form of utilisable wood and that the average density of dry wood is 750 kg per m^3. Taking the lower figure, this implies that the physical yield, with no intensive techniques being applied in forestry apart from methods which ensure regeneration, could rise still further to a level over two and a half times that of the projected cut in 2025. The contribution of plantations is in itself very large and its potential in the longer term most significant. If , as is expected, the total area of some 100 million hectares in the 1970s increases to 200 million hectares by the year 2000, then plantations on about 10 per cent of the forest lands of the world may alone be expected to contribute the order of an additional 2000 million m^3 to total wood supply.

TRENDS IN HARVESTING AND TRANSPORT COSTS

5.11 During the first half of this century there was relatively little change in the methods of harvesting and transporting timber. Felling and trimming were labour intensive and the movement of timber from forest to mill depended on animal power or floating.

5.12 There were some exceptions. In North America, for example, the crawler tractor had begun to be used for extraction, and on the West Coast large logs were hauled from stump to forest roadside by steel wire ropeways erected on tall mast-trees or on steel towers; the power source was often a steam engine. In central Europe simple cableways were used in steeply mountainous terrain.

5.13 In the post-war years there was a general acceptance of the need for change in the whole approach to the harvesting and transporting of timber. The future lay in providing the worker with machinery to enable him to increase his output and earnings under better and safer working conditions.

5.14 Throughout the world most of the felling and trimming of trees is still done by forest workers equipped with power saws. Extraction on suitable ground is by specially designed forest tractor and virtually all lifting and handling is by mechanical crane or grab. In the most advanced systems, operating in a few situations, felling and trimming is by tractor mounted saws and delimbers, so that the operator never leaves his cab. In terrain too steep for tractors, extraction is by cable-crane of one sort or another.

5.15 Further mechanisation can be envisaged with the greatest developments occurring on relatively easy terrain, the opportunities for mechanisation being limited in steep mountainous conditions.

PAST TRENDS IN HARVESTING AND TRANSPORT COSTS

5.16 Despite a background of international co-operation it is difficult to find data to show over any length of time how harvesting and transport costs have moved in real terms, comparing like with like. The amount of data available on historic cost trends in developed countries is limited and no information has been found for developing countries.

5.17 Logging costs from sources in Sweden and Canada indicate an increase, in real terms, of between 1.5 per cent and 2.5 per cent per annum (see Appendix D). Transport costs in Sweden and Canada have not shown any clear change with time. The suggestion is that technological changes in transportation may have been faster than in harvesting and this has tended to keep real costs more stable.

5.18 On the basis of the limited information available, the indications are that from the early part of this century the main trends have been for:

(a) harvesting costs to rise in real terms by 1.5 per cent to 2.5 per cent per annum;

(b) transportation costs to remain relatively stable.

FUTURE COSTS

5.19 Future costs in harvesting will depend on a number of factors and it is worth mentioning one or two of the main considerations.

5.20 The frequency of technological change is increasing so that in the logging field major technological change is occurring once every 20-30 years. The rate at which changes are introduced into commercial practice has also increased as a result of developments in communication, training and management, and there is potential for further improvement in these directions. Changes in cost may not be so dramatic, however. For example, new methods tend to be more capital intensive so that the costs associated with the introduction of new technology may well not be in proportion to the increase in labour productivity.

5.21 The possibilities for introducing major technological change vary between tractorable terrain and mountainous terrain. On the world scale they will vary with the degree of sophistication of individual countries and with physical and other constraints peculiar to individual situations. Thus there are especial difficulties in introducing technological change in the far North of Canada and in Siberia, where, apart from the extremely rigorous climate, there may be the added problem of permafrost. Again the scope for the use of large machines may be limited in plantation forestry if there is a preponderance of early thinnings, and some scattered operations will also militate against the introduction of certain logging systems. Product specification will also have an influence on output and cost.

5.22 Bearing in mind these general factors, consideration of the various harvesting systems that may be used in Britain indicates the following trends; similar patterns can be expected in developed countries with broadly parallel conditions.

TABLE 5.2

Year	1975	1980	1985	1990	2000	2010	2020	2030
Index of harvesting cost	100	98	66	68	72	80	106	127

5.23 This (hypothetical) index of costs expressed in real terms is based on what is considered to be a likely rate of introduction of new harvesting methods, taking into account invention and innovation and the extent to which they will be introduced in practice. Machinery costs are assumed to decrease in real terms by 2 per cent per annum, whilst labour costs increase at 4 per cent.

5.24 It is assumed that management practices will not change significantly during the period under review, but of course a substantial change in the ratio of thinning to clear felling could alter the situation, since outputs are higher and costs lower in clear felling than in thinning.

5.25 It is difficult to predict any significant technological innovation after the turn of the century. Therefore it is assumed, perhaps pessimistically, that there will be little opportunity for further technological change dramatic enough to overcome the effect of wage increases - so costs may rise.

CONCLUSIONS

5.26 While historic trends in harvesting costs have shown an increase of about 2 per cent in real terms it is predicted that they may fall somewhat during the next decade or so before gradually rising beyond present levels into the next century. It is worth noting that the historic cost trends have occurred with harvesting systems which remained comparatively labour intensive throughout. The prediction of future harvesting cost trends rests on the assumption that harvesting systems will become much less labour intensive, especially in felling and processing. It has also been assumed that there will be no major technological changes in methods of hauling from stump to road.

5.27 Transportation costs, the limited evidence suggests, have been fairly constant. There is of course the prospect that the exploitation of more distant forests in other countries will cause these costs to rise in real terms. However, the exploitation of increasingly remote forests has been a feature of forestry from 1900 to the present, when costs have been fairly constant. Therefore it would be reasonable to assume that future changes in technology would allow a similar achievement in the future.

5.28 Although most of the evidence available is from developed countries, trends in harvesting and transport costs in developing countries have also been assumed to remain fairly constant with time.

TRENDS IN WOOD PROCESSING COSTS

SAWMILLING

5.29 Information has been obtained from Scandinavia, from the UK and from various other countries and the general picture that emerges over the last 20 years is that unit processing costs have shown very little change in real terms. A reduction has been achieved in the manpower required per cubic metre, but this in turn has been offset by higher costs per manhour. It is noteworthy that labour accounts for only about 10 per cent of the total cost of producing sawn timber, while the logs account for 70 per cent of the cost, and the drive to increase yields of useful material from the tree is limiting the fall in unit processing costs while substantially increasing the revenue obtained from residues. There has been significant technological change within the period examined and one can expect continued improvements in the efficiency of sawing operations and handling. The data available suggest however that unless there is a radical and unforeseen change in technology, little significant change in the costs of sawmilling is likely within the period under review. Information and discussion relating to sawing operations in the United States and Africa substantially confirm this view.

PARTICLE BOARD PRODUCTION

5.30 It has not been possible to find data giving a clear view of trends in the cost of making chipboard but considering the comparative newness of the techniques being used, the Group think that some cost reducing refinements will be introduced as time goes on and that some reductions in cost will be achieved. However, board production is a fairly energy intensive process and such reductions may be small. It is noteworthy that likely developments in board production will be aimed at improving quality and this is not expected to help in reducing costs.

PULPING

5.31 The cost reductions which result from an increasing scale of operation have probably almost reached the limit with the present size of plant, but some future reductions in cost will result from systematic improvements in efficiency.. It is to be expected that new processes will concentrate on increasing the yields rather than decreasing costs, especially in the short-term, although in the longer-term reductions are to be expected through the learning process. If our expectations about the introduction of thermo-mechanical pulping processes are realised, then the lower capital investment is likely to be offset by the high energy costs. The Group has assumed that overall there will be no substantial change in the (real) costs of producing pulp from wood.

PAPER MAKING

5.32 Further advances in paper-making technology can be expected, especially in the direction of more efficient use of pulp to give a bigger area of paper per unit weight of pulp and other furnish, but no major technological breakthrough, leading to major cost reductions, can be envisaged. It is therefore assumed that paper-making costs will not change significantly in real terms.

CHAPTER 6

WORLD PRICES AND GREAT BRITAIN DEMAND

PRICES

6.1 In the light of the assessment of future harvesting, transport and processing costs in Chapter 5, the question to be determined is the likely development of wood product prices. It must be said at the outset that because all the elements that go to determine the market price of wood products can only be forecast in very vague terms, any conclusions drawn on the basis of forecasts of the future positions of demand and supply curves can only be indicative. In particular, the supply side is very imperfectly understood and forecasting future supply of products at various prices is extremely difficult, owing to the lack of any clear evidence on the way in which technology will develop and with it requirements of capital, labour and non-wood materials per unit of output of the various kinds of product.

6.2 The marked rise in prices of many wood products since 1973 has occurred over a period during which prices in the economy as a whole rose rapidly. The indices set out in Table 6.1 show how prices have moved since 1958 in real terms, ie. relative to the general level of prices.

TABLE 6.1

INDICES OF WOOD AND WOOD PRODUCT VALUES IN BRITAIN EXPRESSED IN REAL TERMS (a)

1958 = 100

Commodity	*1958*	*1960*	*1965*	*1970*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977* (b)
FC standing sales of conifers										
(i) all tree sizes	100	89	70	75	72	89	171	97	87	93
(ii) trees of 0.07 to 0.12 m^3	100	92	71	65	69	70	131	89	73	75
Imported sawn softwood	100	99	97	96	89	142	163	117	134	149
Imported woodpulp	100	93	84	90	77	85	115	131	135	127
Paper and board produced in the UK	100	95	86	86	78	78	96	96	94	99
Home grown hardwood logs	100	83	100	103	93	130	138	101	94	101
Home grown sawn hardwood	100	91	87	80	77	99	116	91	86	90
Imported hardwood (logs + sawn wood)	100	102	92	99	100	148	158	116	129	140

Notes: (a) Prices received from Forestry Commission standing sales converted to indices and Department of Industry indices, both deflated using GDP implicit price deflator.

(b) To September for Forestry Commission standing sales (conifers); otherwise for the first half of the calendar year.

6.3 After the commodity price boom of 1973-74 prices [1] of most wood products fell sharply to low levels in 1975 and 1976 with the general economic recession. In the first half of 1977 (and up to September in the case of conifer standing sales) prices rose again largely as a result of the continued fall in the value of sterling. It is difficult to judge the trend in prices in the aftermath of the major disturbances in commodity markets since 1973 but the following points may be noted. Real values of standing conifers in Britain, as in several other countries, have not regained the price levels of the late 1950s, and the same is true of hardwood logs at mill. Imported hardwood and sawn softwood have continued to show substantially higher prices than over the years 1958 to 1972. The picture for sawn softwood is thus in line with the very long-term trend of rising real price, but the rise in imported hardwood price is a new departure. Paper product prices on the other hand remained stable in real terms, continuing the long-term trend.

6.4 The explanation of much of the difference in the price histories of different products must lie in the differing rates of technical development in the various branches of forest industry. Sawmilling techniques changed little after the introduction of framesaws until the advent of a large market for chips and the change in sawing pattern this made possible. In particle board manufacture, large advances have been made in technology and skill. In paper manufacture and the pulping processes serving it, scale economies have in the past been the main source of cost reduction.

6.5 In view of the evidence set out in the preceding Chapter, it seems that there is no obvious reason to consider that, for wood products taken as a whole, costs of harvesting and processing will increase. It is on the side of wood supply that more doubt must arise. If forest owners were not willing to cut the increased quantities shown in Chapter 5 at unchanged prices, the effect would be to raise the cost of final products, for market prices to rise somewhat and for the quantity of products marketed and consumed, and hence the total roundwood requirement noted in Chapter 4, to be reduced. The argument is not, however, all in one direction. Changes in harvesting technology will make more areas accessible at unchanged cost. Equally, developments in processing and marketing the products of a wider range of species and log sizes will alter the economics of wood supply to mills. Both factors may tend to make it possible to offer larger quantities of wood at constant prices than might otherwise be the case.

6.6 On balance, the Group see no obvious reason for wood product prices, taken by and large, to vary very much from the levels observed over the past quarter century. However, to the extent that there must be doubt about the adequacy of the future supply of wood relative to demand, we consider the further possibility that prices will increase. If, in the early decades of the 21st Century, supply were to fall short of demand at constant prices by, say, 20 per cent, the effect would be to raise the market price of products by between 10 per cent and 20 per cent assuming plausible ranges of price elasticities of demand and supply. (It is considered that the marked changes in wood product prices of recent years are evidence of

Note: (1) Prices and costs referred to in this Chapter are expressed throughout in real terms.

speculative effects as well as low elasticities of supply in the short-run; these are not features relevant to long-term judgements about price elasticities of demand and supply).

6.7 These possible price assumptions must next be considered in the light of trends in processing and harvesting costs in Britain in order that a judgement may be formed about the possible development of standing tree prices.

6.8 Taking into account known technology, it is estimated that harvesting costs in Britain will fall (in real terms) before beginning to rise again after the turn of the century. However, although the direction of change in the 21st century cannot now be predicted, it is not unreasonable to expect that harvesting technology will continue to improve so that harvesting costs in Britain may not in fact rise significantly in real terms in the future.

6.9 British wood processing industries, which are small by world standards, will have increasing supplies of wood available. This should enable them to benefit from economies of scale and to improve their competitiveness. There will also be opportunities for rationalising the location of sawmills vis-a-vis other wood-processing industries using sawmill residues.

6.10 With unchanged harvesting and processing costs, constant product prices imply constant stumpage. With a change in product price and unchanged costs, the proportional change in stumpage is magnified and the degree of magnification is substantial. The effect of a 10 per cent price rise to product prices over 50 years (the average rotation for conifers in Britain) would be to raise stumpage values on average 1 per cent per annum.

6.11 For working purposes, the profitability calculations set out in Chapter 8 make two assumptions, the first being that stumpage price will remain constant and the second that there will be a yearly change of plus 1 per cent.

BRITISH DEMAND

6.12 The same method of projecting demand for industrial wood products has been used in forecasting for Britain as that described in Appendix A. The range of assumptions is slightly narrowed by adopting only one set of growth rates for population. These and the income *per capita* growth assumptions are set out in Table 6.2.

TABLE 6.2

ANNUAL GROWTH RATES (PERCENTAGE)

		1972–1985	*1985–2000*	*2000–2025*
Population	H	0.16	0.16	0.12
GDP/Capita	H	2.5	3.0	3.0
	L	1.5	2.0	2.0

6.13 Adjustments as before, for technological change, include the amount of roundwood recovered from the standing tree (remembering that the greater proportion of UK demand will, for the foreseeable future, continue to be met from overseas sources so the "world" assumptions apply).

6.14 Results are shown in Table 6.3 for the single assumption adopted for population growth rate in Table 6.2. Details are given in Appendix E, and future predictions of Great Britain supply in Appendix F.

TABLE 6.3

ROUNDWOOD REQUIREMENTS FOR PROJECTED UK INDUSTRIAL WOOD PRODUCTS CONSUMPTION

Millions cubic metres per annum

Rates of increase in Income/capita	*Adjusted roundwood requirement* 1972	2000	2025
	A: High income elasticity assumption		
H	44.3	69.6	110.7
L	44.3	54.6	68.8
	B: Low income elasticity assumption		
H		60.6	85.4
L		50.0	57.7
"Most likely" assumptions:		55–60 million m^3	70–90 million m^3

6.15 For working purposes, and deducting a small proportion (2 per cent) for Northern Ireland's consumption, the projected demand at constant prices is put in the range of 55 to 60 million m^3 roundwood requirement in the year 2000, and 70 to 90 million m^3 roundwood requirement in the year 2025.

6.16 It is interesting to note how the material requirement changes over time. In 1970-74, the roundwood needed to meet total UK consumption was 45 per cent in the form of sawlogs and veneer logs and 55 per cent in the form of roundwood, chips and waste, used in manufacture of chipboard, paper, paperboard and fibreboard. By the year 2025, the balance is expected to alter to 25:75 owing to an increase in the demand for products of sawlogs and veneer logs of only about one-half, compared with a trebling or quadrupling of that for material used in manufacture of chipboard and paper and board products. Accordingly, the importance of sawn softwood will decline relative to that for pulp and board material.

CHAPTER 7

GREAT BRITAIN : WOOD SUPPLY POTENTIAL

LAND

7.1 There are physical limitations on the extent to which forestry can be practised in the uplands - mainly topography, soil and climate. In the lowlands there are economic rather than physical limitations, since the lowlands of Britain are primarily agricultural land, mostly of good quality. Excluding areas where climatic conditions, including exposure, are unfavourable to tree growth, thin soils, arable and permanent grassland, it is estimated that more than 3 million hectares of land in Britain could be planted with trees to produce economic crops of timber. Just over half (1.7 million hectares) is in Scotland. In England and Wales there are constraints on the amount of new planting in National Parks and Areas of Outstanding Natural Beauty. Thus it is perhaps more realistic to think in terms of one third the 1.3 million hectares of technically plantable land in England and Wales actually being planted over the next 50 years.

7.2 In addition to bare land technically suitable for afforestation there are some 0.3 million hectares of unproductive woodland - mainly areas of scrub but including some felled woodlands - which must be regarded as having some potential for conversion to productive woodland by planting.

7.3 If 2 million hectares of bare land were in fact planted, the overall effect on pastoral farming would be substantial but the overall effect on agricultural production would be less than the area might initially lead one to suppose. For example, in the Centre for Agricultural Strategy Report No.1. it is stated that:

> "The impact on potential agricultural production of transferring between 1 and 2 million hectares of land from agriculture to forestry (in Great Britain) is almost certainly overstated by considering areas alone. Taking the ratio of average rents paid for upland and lowland areas in Scotland as indicative of the relative agricultural productivity of potential forest land it appears that such land is only about a sixth as productive as the average. According to the Scottish Agricultural Economics (DAFS, 1976b) the average rental value for upland rearing and hill sheep farms is about £2.50 per ha in 1974-75; the comparable figure for lowland areas is about £15 to £18 per ha. Hence a potential transfer of about 1.7 to 2.1 million ha, representing between 9 and 11 per cent of the total agricultural area (including rough grazing) in 1974, implies a loss in agricultural production - in the absence of technical progress - of 1.5 to 2.0 per cent by the year 2000. Given the scale of proposed new planting in hill areas and the interdependence between upland and

lowland farming in the UK (especially in livestock farming) the rental ratio may underestimate the impact that substantial afforestation will have on farm output. Nonetheless, even if it is assumed that the loss of hill land means a loss in overall farm output of double that inferred by rental comparisons (ie. effectively, hill land is about one-quarter to a third as productive as the national average) forestry could be a strong economic rival to farming in the upland areas of Britain. Certainly, if a low discount rate is employed, a case can be made for replacing sheep by timber. The adoption of a 10 per cent discount rate in a study by HM Treasury (1972) appears rather high .... the return on all capital assets for sheep farms in 1974/5 was little more than 3 to 4 per cent; if account is taken of the production subsidies paid to farmers, the figure is nearer 1 to 2 per cent".

7.4 For the purposes of this review it has been assumed that by year 2025 the transfer to forestry of up to 200,000 hectares of bare land in England and Wales is a reasonable proposition; that the corresponding figure for Scotland is up to 1.5 million hectares; and that about 100,000 hectares of land classified as unproductive woodland could be brought into production by planting by year 2025. The planting of unproductive woodland areas is included in "new planting" rather than "restocking". This gives a total of 1.8 million hectares.

7.5 The harvesting of substantial quantities of existing hedgerow trees has been allowed for in the predictions of potential production of timber; the question of future levels of planting of trees (as opposed to woods) has not been examined. The planting of trees in hedgerows, parks, small copses and spinneys can make a major contribution to the landscape and can also be important for nature conservation. Such plantings may yield utilisable timber, but their contribution to the overall supply of wood for industry has not been taken into account in this study.

7.6 Three alternative rates of planting and planting targets are assumed:-

<u>Alternative 1</u> assumes no new planting.

<u>Alternative 2</u> assumes expansion at the historic rate to give 0.7 million hectares of new planting by the year 2000; thereafter the rate of new planting is substantially reduced to give a total of 0.3 million hectares for the period year 2001 to year 2025.

Within these assumed targets broadleaved planting is set at 1,200 hectares per annum for the whole period, ie. twice the average rate achieved during the five years to 1976.

<u>Alternative 3</u> assumes 1.8 million hectares of new planting by the year 2025, with broadleaved planting at 2000 hectares per annum falling to 1,200 hectares per annum.

TABLE 7.1

NEW PLANTING BY PERIODS - ALTERNATIVE 2

Thousands hectares

	Up to 2000		*2001-2025*		*Total to 2025*	
	Bl	*Cf*	*Bl*	*Cf*	*Bl*	*Cf*
England and Wales	20	80	20	30	40	110
Scotland	10	590	10	240	20	830
GB	30	670	30	270	60	940
GB Grand Total BL and CF	700		300		1,000	

TABLE 7.2

NEW PLANTING BY PERIODS - ALTERNATIVE 3

Thousands hectares

	Up to 2000		*2001-2025*		*Total to 2025*	
	Bl	*Cf*	*Bl*	*Cf*	*Bl*	*Cf*
England and Wales	30	145	20	135	50	280
Scotland	20	805	10	635	30	1440
GB	50	950	30	770	80	1720
GB Grand Total Bl and Cf	1,000		800		1,800	

7.7 The potential production of roundwood arising from existing woodlands and the new plantations (Alternatives 2 and 3) has been calculated. Details are given in Appendix F.

7.8 Four different management regimes are compared. In all four regimes it is assumed that Forestry Commission woodlands will be managed on rotations of 55 years for conifers and about 100 years for broadleaves, and that thinning will be moderately heavy with no thinning in areas susceptible to windblow. Allowances are made for areas of environmental importance. In all four regimes it is assumed that thinning in private woodlands will follow the pattern set for the Forestry Commission's woodlands. The differences between the four regimes lie in the different assumptions made on rotation lengths in private woodlands, ie.:-

(a) Conifers 55 years and broadleaves 100 years
(b) Conifers 70 years and broadleaves 150 years
(c) Conifers 80 years and broadleaves 150 years
(d) Conifers 90 years and broadleaves 150 years

Figure 7.1 shows the differences in potential production of conifers for three planting options, assuming a rotation age of 55 years in Forestry Commission woodlands and rotation ages of 70, 80 and 90 years respectively in private woodlands.

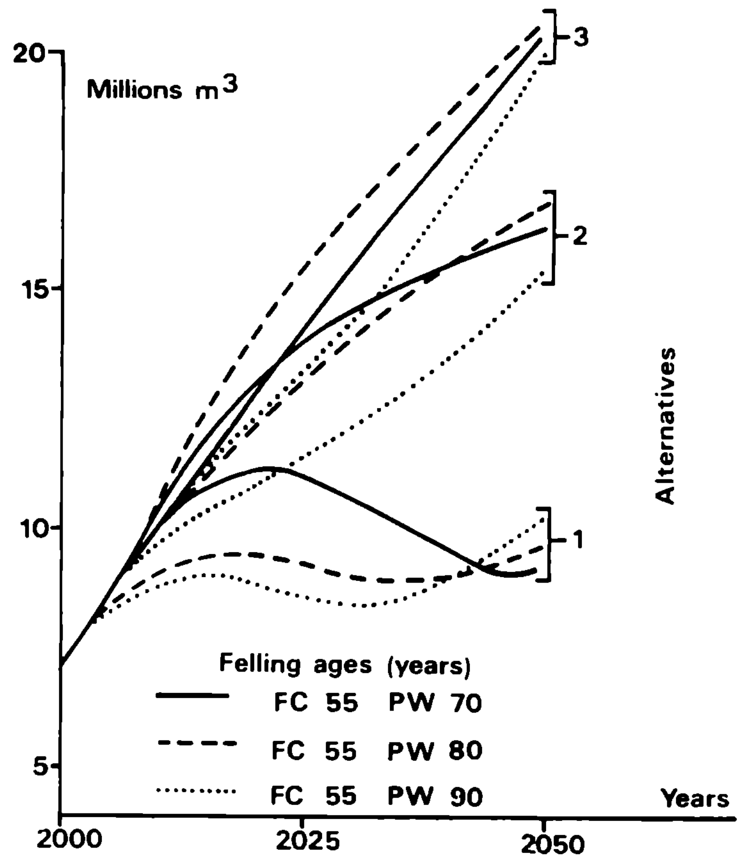

Figure 7.1 Forecasts of production from three management regimes and three planting programmes: Conifers.

7.9 The strict application of any particular regime gives rise to fluctuations from decade to decade and it is necessary to smooth the production forecasts in order to present a rational picture for the period under review. However, no crop is assumed to be felled more than 15 years before maturity, and any other adjustment is achieved by postponing the age of felling as necessary.

7.10 Owing to the age class distribution in existing woodlands, conifer production drops dramatically after the year 2020 if there is no more new planting (Alternative 1).

7.11 The effect on conifer production of planting an additional 1 million hectares (Alternative 2) and 1.8 million hectares (Alternative 3) becomes more pronounced after about the year 2020.

7.12 Differences in conifer production due to rotation age are relatively less important for the larger planting programmes (see Appendix F).

7.13 Within the period of this review the different levels of broadleaved planting have little effect on broadleaved production. Varying the rotation age in broadleaves from 100 to 150 years for private woodlands, with the Forestry Commission rotation constant at 100 years, decreases production by 0.2 to 0.4 million m^3 per annum during the period to the year 2050 (see Appendix F, Tables F6 and F7).

7.14 In order to demonstrate the labour requirements and the investment implications for the three planting options the management regime which is closest to current practice has been chosen. This has been called the Traditional Cutting Regime. Production under this regime is shown in Table 7.3

TABLE 7.3

POTENTIAL ANNUAL PRODUCTION
TRADITIONAL CUTTING REGIME

Rotation ages *Broadleaves* *FC 100 years : PW 150 years*
Conifers *FC 55 years : PW 80 years*

Millions cubic metres

	Year 2000	*2025*	*2050*	*Sustained Yield*
BROADLEAVES				
Alternative 1	1.3	1.4	1.6	2.3
Alternative 2	1.3	1.5	1.7	2.6
Alternative 3	1.3	1.5	1.7	3.0
CONIFERS				
Alternative 1	7.0	9.2	10.3	12.0
Alternative 2	7.0	12.8	16.8	22.0
Alternative 3	7.0	14.1	20.4	27.0

7.15 Although the total wood production forecast for conifers in Alternative 1 shows a reasonable progression towards sustained yield, the total obscures the fluctuations in the proportion of sawlogs to smallwood over relatively short periods. This can be seen in Table 7.4.

TABLE 7.4

POTENTIAL ANNUAL PRODUCTION BY ASSORTMENTS - CONIFERS
TRADITIONAL CUTTING REGIME

			Millions cubic metres
	Year 2000	*2025*	*2050*
ALTERNATIVE 1			
Sawlogs	3.2	7.3	6.1
Smallwood	3.8	1.9	4.2
Total	7.0	9.2	10.3
ALTERNATIVE 2			
Sawlogs	3.2	9.2	10.6
Smallwood	3.8	3.6	6.2
Total	7.0	12.8	16.8
ALTERNATIVE 3			
Sawlogs	3.2	9.7	12.8
Smallwood	3.8	4.4	7.6
Total	7.0	14.1	20.4

7.16 For the discussion of labour and investment requirements in the wood processing industries for 1985, when new plantings under the alternative programmes would not be in production, the published forecasts of 4.1 million m^3 for conifers from Forestry Commission and private woodlands has been used. (Sawlogs 2.0 million m^3, smallwood 2.1 million m^3). For broadleaves a figure of 1.3 million m^3 has been used.

CHAPTER 8

APPRAISAL OF PLANTING OPTIONS

INTRODUCTION

8.1 There are two approaches to the appraisal of alternative investments. One is to quantify and evaluate the various costs and benefits in money terms, to calculate the net social benefit and to add a few rounded phrases to qualify the result for the quantifiables. While the concept appears both elegant and satisfying, it suffers from some operational disadvantages if left to stand on its own.

8.2 It is important to recognise the reasons for this. Three examples of difficulties will suffice. The first is that implicit in the normal investment appraisal or cost-benefit analysis (which differs from a financial appraisal in that attempts to measure the costs and benefits to society - or the social costs and benefits - rather than to the entrepreneur) is the summation of a variety of measures not all of which can be assessed at all precisely. Sensitivity analysis is desirable but laborious to undertake for all possible combinations of plausible levels of costs and benefits. The second difficulty is the pervasive one of valuation: it is not easy to see in principle how a benefit such as provision of jobs in rural areas can be evaluated. It is equally true that in some cases where the methodology is clear, the values of certain inputs are not known: examples are the resource costs of land and labour. The third, long standing problem concerns the choice of discount rate.

8.3 In order to avoid the pitfalls of a cost-benefit analysis that only goes part of the way towards a comprehensive assessment, the Group has decided that the various elements which are considered important should be set out separately and as precisely as possible, leaving the selection of the preferred option as a judgment to be made by the reader. Obviously an important element is the assessment of quantifiable net benefits and this aspect is considered under the heading of profitability in terms of rates of return on all inputs.

REDUCED DEPENDENCE ON OVERSEAS SUPPLIES

8.4 Increased home production of wood reduces the import bill for wood products and therefore Britain's dependence on overseas supplies. However, it is by no means clear that import saving for its own sake has any special merit. Participation in international trade gives the opportunity for a country to achieve an overall higher level of economic welfare by allowing productive resources to be concentrated in activities to which the country is best suited. The resulting output can then be traded for goods which can be produced more cheaply in other countries. It is therefore necessary to be clear about the arguments in favour of deliberately shifting the traditional pattern of trade.

8.5 In the context of this study the following arguments for substituting wood imports by home production may be advanced.

8.6 If the price of wood products is expected to rise in real terms, all other things being equal, then home production becomes relatively more attractive than importing because it would be necessary otherwise to devote an increased volume of home resources to cover the increased cost of importing wood and wood products. The possibility of cartels in world timber and wood products markets was considered but it was concluded that they were unlikely and price rises need not be expected from that source. Another argument is that raw materials prices may be expected to fluctuate more than the prices of manufactured goods. Therefore for countries which tend to import raw materials and export manufactured goods, such as Britain, the balance of payments may be subject to rather sharp movements. Short term movements may be dealt with by foreign exchange reserve adjustments or short-term international loans - with no necessary repercussions on domestic demand. But if there are serious and long lasting balance of payments deficits it becomes necessary to reduce domestic demand and this tends to create unemployment. If this becomes a possibility there is a case for reducing our dependence on imports. Society may in fact be willing to pay a premium to insure against such effects. For the country as a whole, the cost of insurance is then the output foregone in switching from international trade to domestic production. The benefit lies in the avoidance of periodic falls in employment.

8.7 A similar case can be made for import substitution as an insurance against major interruptions in world trade. However there is no evidence that Britain will come to depend on a narrow base of politically risky sources of wood supply. It has to be remembered that the producers of primary products or semi-processed goods based on home produced materials vary widely in their political orientation and, most important, are dependent on foreign exchange earnings from such exports to finance imports of certain manufactures and technology. It is not thought therefore that the argument about insurance against interruptions in trade is particularly significant.

8.8 On the other hand it is reasonable to assume that even if there will be no difficulty in importing the quantities of wood and wood products which Britain requires, there will be a tendency on the part of exporting countries to export more highly processed goods - for example, paper and paperboard rather than pulp. It is also argued that although it may be temporarily more economic to import some processed wood products than to grow trees in Britain, the gradual erosion of this option in the future may mean that it is better to increase home wood production rather than to have to import finished wood products. The question hinges on whether or not resources employed in forestry and forest industries could be more profitably employed in other activities. The issue is considered in paragraphs 8.25 - 8.33.

8.9 A foreign exchange premium may be used to quantify the value of import substitution. The effect of using an FEP is to cost imports higher than their market price and this in turn makes forestry investment relatively more attractive, its output substituting directly for more highly priced imports. For illustrative purposes, the effects of assuming an FEP of 10 per cent are discussed in paragraphs 8.29 - 8.33.

EMPLOYMENT

8.10 The value of forestry in providing jobs depends upon the higher level of employment in forestry than in pastoral farming, rather than in the creation of jobs *per se*. This is because it is assumed that Governments will continue to value the creation of jobs and economic development in the areas of rural depopulation. Forestry jobs occur predominantly if not necessarily in the areas of rural depopulation, although this is not always true of the processing industries. There are however some mills in rural areas and more may be created. Assumptions on this point are incorporated in the forecasts of industrial employment in such areas.

EMPLOYMENT IN FORESTRY

8.11 The total labour input in forestry, including logging (but excluding supervisory and managerial staff), in 1975 was some 15,500 man years - based on Forestry Commission records for employment generated in State forests and on estimates for private woodlands (University of Aberdeen 1976).

8.12 The volume of work in forests in future years can be forecast on the basis of the programmes of new planting set out in Chapter 7, the areas of restocking that result from the application of the cutting regime described and the volume yields forecast. It is assumed that the specifications of work carried out in areas of new planting in future are the same for both Forestry Commission forests and private woodlands and that the labour productivities in each sector are as set out in Appendix G. Finally, various rates of increase in labour productivity are examined - ranging from zero to 4 per cent, with 2.5 per cent assumed to be most plausible (Appendix G). The resulting forecasts of labour input required in forestry are shown in Table 8.1 for a 2.5 per cent productivity increase per annum.

8.13 The substantial planting programmes of Alternatives 2 and 3 would result in a loss of jobs in agriculture and this effect has been estimated in Table 8.1.

TABLE 8.1

FORECASTS OF LABOUR REQUIREMENTS IN FORESTRY
TRADITIONAL CUTTING REGIME

(At 2.5 per cent per annum increase in productivity and after deducting jobs lost in agriculture but including local supervision in rural areas)

Thousands man years

Years	*1985*	*2000*	*2025*
Alternative 1			
No more planting	14.8	13.7	9.7
Alternative 2			
Planting another 1 million hectares	17.4	16.3	13.9
(Jobs lost in agriculture)	(0.6)	(1.0)	(0.7)
Net number of jobs	16.8	15.3	13.2
Net additional jobs	2.0	1.6	3.5
Alternative 3			
Planting another 1.8 million hectares	18.5	17.8	16.3
(Jobs lost in agriculture)	(0.8)	(1.4)	(1.2)
Net number of jobs	17.7	16.4	15.1
Net additional jobs	2.9	2.7	5.4

8.14 The numbers employed in forestry may be compared with total civil employment in the areas of rural depopulation demarcated in the Treasury Report on that subject (HM Treasury,(1976)). In 1974 forestry employees accounted for 1.05 per cent of the total civil employment in areas of rural depopulation in Wales (and were 2,160 out of the 2,890 forestry workers in Wales as a whole); the corresponding proportion in Scotland was 1.37 per cent, or 5,940 forestry workers out of a total of 7,250 in the whole of Scotland.

EMPLOYMENT IN WOOD PROCESSING INDUSTRY IN RURAL AREAS

8.15 It is estimated that the equivalent of 14,300 full-time jobs existed in 1974 in the transport of home grown wood and processing in sawmills and mills using small roundwood based partly or wholly on home grown wood. *Pro rata* the number directly attributable to home grown wood was 12,100. In rural areas where population has declined over the long term and which are characterised by high unemployment and high levels of under-employment (HM Treasury, (1976)), the distribution of employment in 1974 is assessed at England 500, Wales 500, Scotland 3,000, giving a total of 4,000 or one-third of the total employment attributable to home grown wood.

8.16 Employment generated in rural areas in transport and processing of future yields of wood has been estimated on the basis of forecasts of production, that one-third of the wood will be handled by people working in rural areas, and that productivity in those activities will rise annually at 2.5 per cent. The resulting forecasts are shown in Table 8.2.

TABLE 8.2

FORECASTS OF EMPLOYMENT IN WOOD PROCESSING IN RURAL AREAS
TRADITIONAL CUTTING REGIME

Programme of new planting	*Year*	*Thousands man years* 1975	1985	2000	2025
Alternative 1		4.0	4.6	4.6	3.5
Alternative 2		4.0	4.6	4.6	4.6
Alternative 3		4.0	4.6	4.6	5.0

MULTIPLIER EFFECTS

8.17 In addition to the direct effects on employment noted in the above tables, it is relevant to take account of multiplier effects on employment in the regions of interest. It is assumed that if the structure of the local economy in activities unrelated to forestry does not alter, extra employment of 100 generated in forestry and forest industry will lead to up to a further 20 jobs as a result of local spending by the enterprises concerned. Similarly, if forestry and forest industry employment falls by 100, there will be a further loss of up to 20 through the multiplier working in reverse.

DIVERSIFICATION OF THE RURAL ECONOMY

8.18 The activities associated with the creation of new plantations and later the harvesting of the wood, often bring to rural areas dominated by extensive pastoral farming a welcome diversification of the local economy. A number of families become dependent on an industry altogether different from agriculture. Local craftsmen are not tied to work associated with agriculture and to the rhythmn of the agricultural year but can find a wider variety of work with a different seasonal pattern. Thus, for example, the preparation of ground for planting, forest road building and harvesting and transport of wood go on all the year round. These operations are highly mechanised and there is a regular year round demand for the maintenance and repair of machines. As forests become established, opportunities arise for creating small businesses: the manufacture of wooden fencing and estate timbers is a case in point. Although the effects are difficult to quantify, freedom from sole or major dependence on the prosperity of hill farming can bring real benefits to remote rural areas.

FINANCIAL IMPLICATIONS

8.19 Before considering the rate of return on wood production, it is useful to note the cash outlays by way of investments in forestry and forest industry associated with different planting and wood processing options.

INVESTMENT IN FORESTRY

8.20 Forestry investment embraces the purchase of land and equipment, plus working capital for payment of labour and purchases of materials and tools required to establish and maintain plantations up to the stage when wood production starts. The assumptions listed in Appendix H indicate averages of £190 per hectare for land and £405 for establishment in England and Wales, and of £185 for land and £315 for establishment in Scotland. The implied annual sums for investment in new planting on alternative planting programmes 2 and 3 are shown in Table 8.3

TABLE 8.3

EXTRA FORESTRY INVESTMENT IMPLIED BY PLANTING PROGRAMMES ALTERNATIVES 2 and 3

	1975 - 2000		*2001 - 2025*	
Programme of new planting	*ha/annum thousands*	*Cost £M per annum*	*ha/annum thousands*	*Cost £M per annum*
Alternative 2	28	14.4	14	7.2
Alternative 3	40	20.6	32	16.5

INVESTMENT IN INDUSTRY

8.21 The production forecasts in Tables 7.3 & 7.4 provide the basis for setting out possible future developments in wood processing industry. Three industrial strategies are considered. The first, a purely commercial one, assumes that industries would be established of the kind and scale and in the locations that market forces determine. The second assumes that emphasis in investment would be placed on certain regions characterised by low economic activity and depopulation, and that Government transfers of one kind or another would ensure that mill owners would not be at a disadvantage. The third emphasises the foreign exchange saved through the production of high valued products by encouraging investment in mills making those commodities which per unit of roundwood cost most to import.

8.22 Figure 8.1 sets out UK wood flows in volume and value terms in 1975. The chart indicates the contribution of home grown wood to the total consumption of wood fibre in the United Kingdom over 59 per cent of which is accounted for by pulp products. Table 8.4 analyses the current utilisation of wood in terms of different product groups.

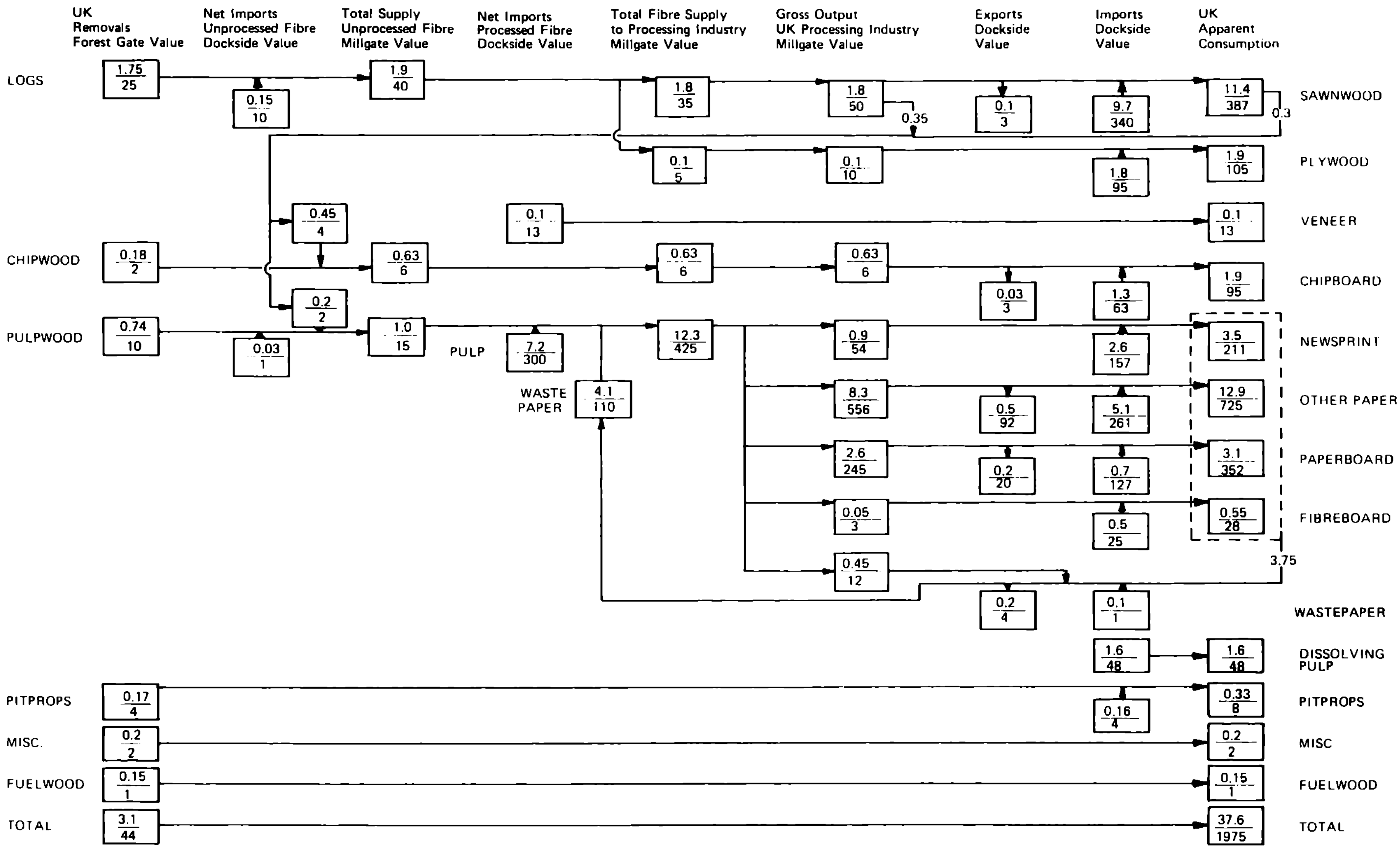

Figure 8.1 UNITED KINGDOM WOOD FLOW 1975
expressed as $\frac{\text{millions cubic metres}}{\text{£ millions}}$

TABLE 8.4

RECENT UTILISATION OF HOME GROWN WOOD

Commodity	*1975 supply*	*1976 supply*	*% Mean 75/76*	*Rounded % Mean*
	thousands m^3 UB			
Pitwood and other small roundwood	293	292	9	10
Wood for pulp and paper	736	893	24	25
Wood for chipboard	179	210	6	5
Sawlogs and woodwool	1,825	1,951	57)	60
Fuelwood	140	136	4)	
	3,173	3,482	100	100

8.23 For the three strategies on industrial investment, the investment requirements (capital required per yearly cubic metre of intake) are assumed to differ only in respect of the diameter assortments, namely between 7 cm diameter UB and 18 cm and over 18 cm, and are taken to be £250 and £50 per m^3 OB respectively. The annual investment requirements are assumed to differ negligibly between strategy A (straight commercial) and strategy B (regional emphasis). For strategy C (maximum import saving potential) it is assumed that the greatest foreign exchange saving would accrue from converting all wood to pulp and paper. The effects of the different investment strategies associated with the forecasts of production in Chapter 7 are shown in Table 8.5. Replacement of worn-out plant is allowed for on a 25 year cycle.

TABLE 8.5

INVESTMENT (NEW AND REPLACEMENT) IN WOOD PROCESSING
TRADITIONAL CUTTING REGIME

Programme of new planting	*Investment strategies*	*£ Millions per annum at 1976 prices* 1975-85	1986-2000	2001-2025	2026-2050
Alternative 1	A, B	26	66	43	64
	C	103	70	106	119
Alternative 2	A, B	26	66	64	93
	C	103	70	143	185
Alternative 3	A, B	26	66	73	111
	C	103	70	156	221

8.24 Table 8.6 shows, for each of the investment strategies, the foreign exchange saved on wood products as a result of wood production implied by the Traditional Cutting Regime associated with each of the three planting programmes.

TABLE 8.6

FOREIGN EXCHANGE SAVINGS ASSOCIATED WITH DIFFERENT PLANTING PROGRAMMES AND INVESTMENT STRATEGIES TRADITIONAL CUTTING REGIME

Programme of new planting	*Investment strategies*	*£Millions per annum at 1976 prices*				
		1975	*1985*	*2000*	*2025*	*2050*
Alternative 1	A, B	176	254	416	478	576
	C	216	324	498	636	714
Alternative 2	A, B	176	254	416	660	880
	C	216	324	498	858	1110
Alternative 3	A, B	176	254	416	728	1052
	C	216	324	498	936	1326

PROFITABILITY OF WOOD GROWING

8.25 The profitability of wood growing can never be known with precision and all assessments of it must include some subjective judgements. Nevertheless, there is good evidence that in a country like Britain, the rates of return in forestry vary from negligible to around 5 per cent. Under the best conditions found in West and North Europe, 3 per cent is regarded as a good return.

8.26 The internal rate of return may be looked upon as the interest rate which forestry could bear by way of compound interest if all purchases of land, machinery, labour and materials were financed by way of loan.

8.27 Figure 8.2 shows the distribution of rates of return, assuming October 1976 costs and prices, calculated for the Forestry Commission's programme of new planting over the 5 years starting in 1977/78, after adjustment for the effect of including overheads on forest operations at a marginal cost equal to 30 per cent of the full overheads adopted in calculations of planting subsidies. It is considered that the distribution shown is broadly representative of the types of site which might be planted by private investors or the Forestry Commission under the Alternative 2 planting programme. Alternative 3 entails a faster rate of planting than Alternative 2 during the next 25 years and thus implies greater pressure on land prices. Rates of return on Alternative 3 might therefore be marginally lower than on Alternative 2 because of higher land prices.

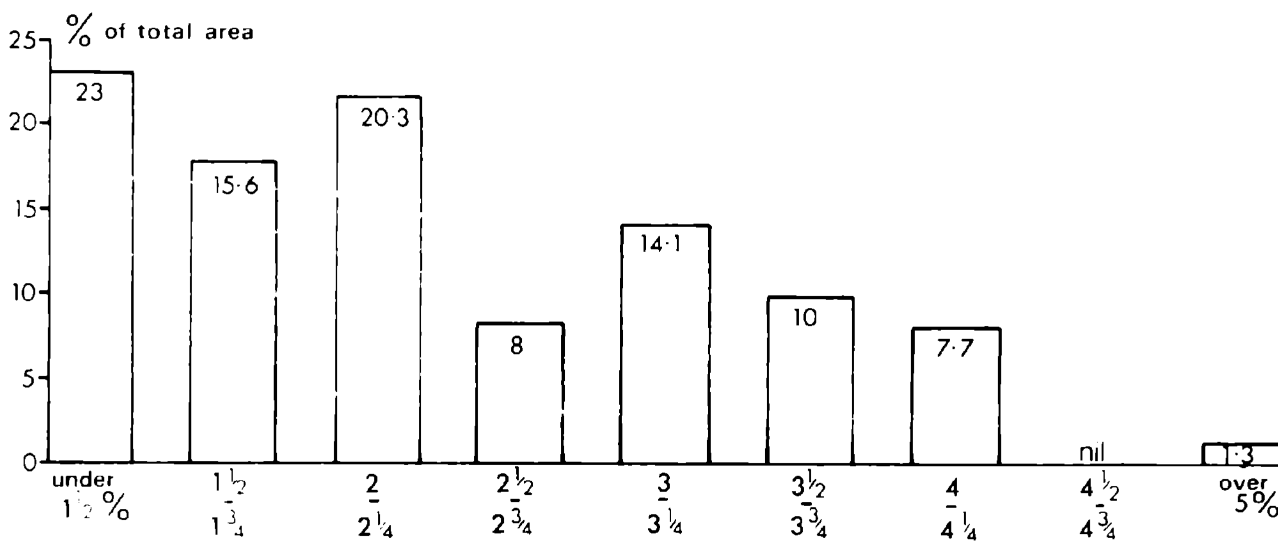

Figure 8.2 *Distribution of rates of return on new planting by the Forestry Commission in the quinquenium 1977 to 1981, assuming marginal overhead costs.*

8.28 The rates shown in Figure 8.2 are expressed in real terms, ie. excluding the effects of inflation. It should be noted that the internal rates of return calculated for plantation investment are not directly comparable with the measure of current rate of return, net of depreciation, conventionally used in business accounting, even when this has been corrected to refer to the current replacement cost of assets employed. Thus it can be shown that a net rate of return of 12 per cent post-tax is equivalent to an internal rate of about 9 per cent when the life of the investment is of the order of 20 to 25 years.

8.29 The sensitivity of the results to changes in various elements can be generalised for the locations and crops covered and the results of the sensitivity analysis are shown in Table 8.7. As noted in paragraph 6.11, the effect of a rise in the real price of standing timber of 1 per cent per annum is shown. The assumption on land price is introduced to indicate the effect of assessing land at a value nearer its real resource cost, ie. excluding agricultural support and taking account of the opportunity cost of farmers' and shepherds' labour. The adoption of a 50 per cent reduction in the labour cost of establishment operations is intended to represent the case where the resource cost of forest labour is estimated to be only one half of the market wage. Finally, the effect of attaching a foreign exchange premium of 10 per cent to wood product prices is introduced in order to give weight to the arguments set out in paragraphs 8.6 to 8.9.

TABLE 8.7

SENSITIVITY OF INTERNAL RATES OF RETURN ON NEW PLANTING TO CHANGES IN COST AND PRICE ASSUMPTION

	Per cent
Price of standing timber rising 1% per annum	+ 1.0
Land value at one half of 1976 market price	+ 0.2 to + 0.4
Labour element of establishment cost at 50% of market wage	+ 0.2 to + 0.4
Foreign exchange premium of 10% on wood product prices	+ 2.0 to + 2.2

8.30 The average rate of return implied by the distribution of returns shown in Figure 8.2 is 2.3 per cent. A price rise of 1 per cent per annum would raise this average rate to 3.3 per cent. The effect of attaching a 10 per cent foreign exchange premium would be to give a rate of 4.4 per cent. The two in combination would yield an average rate of 5.4 per cent.

8.31 It is sometimes argued that the return on growing (or growing and harvesting) wood should be viewed not in isolation but in combination with the return on wood processing. This course may be justified on either of two grounds. One is that the market for roundwood is imperfect, ie. the price established is not a competitive one. The other is that the only feasible alternative to export of such wood from Britain is integration of primary processing with home grown wood production. To follow through the calculation of an overall return on growing and processing it is necessary to make a number of assumptions, central to which is the assumed rate of return (after tax) in industry. If this is set at 8 per cent, Table 8.8 shows that two internal rates of return on forestry alone (4.5 per cent and 1.7 per cent) are raised on average 2 per cent for forestry and industry combined.

8.32 As table 8.8 indicates, a weight of approximately two-thirds attached to the rate of return from growing and harvesting investment and a weight of one-third attached to processing gives the overall rate of return from both combined. The reason for forestry having such a heavy weight lies partly in the level of costs incurred in plantation establishment and management costs and partly in the long interval which elapses between planting and the supply of material on which industry makes its return.

TABLE 8.8

INTERNAL RATES OF RETURN IN FORESTRY
AND FORESTRY AND FOREST INDUSTRY COMBINED

	Percentage return			
	Alternative A		*Alternative B*[(a)]	
Assumed gross profit rate in industry (b)	12		16	
Net profit rate in industry	8		12	
Species	*Sitka spruce*	*Lodgepole pine* (c)	*Sitka spruce*	*Lodgepole pine* (c)
Yield class	*14*	*8*	*14*	*8*
Rotation (years)	*50*	*45*	*50*	*45*
	Percentage return			
IRR, forestry	4.5	1.7	4.5	1.7
Average IRR overall, ie. forestry plus industry	6.0	4.3	7.4	5.3
IRR, forestry with 10% FEP	6.5	3.9	6.7	4.1
Average IRR overall with 10% FEP	7.0	5.1	8.4	6.0

Notes: (a) Assuming higher product prices associated with higher profits in processing industry but unchanged roadside prices.

(b) These rates are illustrative of the plausible range of gross profit rates but, as noted in paragraph 8.28 reflect internal rates of return which are substantially lower than the figures shown.

(c) Unthinned.

8.33 One can conclude that the rate of return overall from growing, harvesting and processing is significantly higher than from wood production to roadside alone. Whether the achieved overall rate is high enough to justify investment in growing is another matter. As already noted, it is likely that the primary processing stage of manufacturing industry would not exist if a supply of home grown timber were not available.

INCREASED PLANTING AND THE ENVIRONMENT

8.34 Under what may loosely be termed environmental factors and in the context of a substantial programme of new planting, considera- tion has to be given to recreation, amenity and nature conservation.

RECREATION

8.35 Although forests can and do play a major role in providing recreational facilities and especially in providing opportunities for fresh air and exercise, by far the greater part of the new planting programmes discussed in this review implies planting in the uplands away from major population centres. To that extent therefore, the opportunities for providing cost-effective recreational facilities will be less than the size of the programmes might at first suggest. Again, very young woodlands are usually less attractive than older woodlands from the recreational point of view, and therefore an expansion of recreational facilities in existing woodlands seems likely to enjoy a higher priority over the next few decades. Thus, although the recreational potential of woodlands in general is recognised, it is not considered that any weight should be attached to recreational potential in arguing the merits of large-scale new planting programmes discussed in this review.

VISUAL AMENITY

8.36 The Countryside Commission has argued powerfully for a major increase in the planting of trees, copses, spinneys, and what may broadly be described as small woodlands in England and Wales, and the Countryside Commission for Scotland has fully supported the re-introduction of a planting grant for small-scale planting. From this and other similar evidence it can be assumed that the creation of a large number of relatively small woodlands - and in the lowlands of broadleaved woodlands in particular - would be seen as a positive contribution to the landscape. On the other hand, the planting of conifers on a large-scale does not have the same universal appeal and a preference for the retention of bare moorland is often stated.

8.37 Work is now being initiated to develop ways of assessing numerically the emotional and personal judgements that people make on particular landscapes. But in the absence of any such definite evidence to date, the conventional view has been adopted, namely, that large-scale upland conifer afforestation is not everywhere seen as positively beneficial in terms of visual amenity and is sometimes positively disliked.

NATURE CONSERVATION

8.38 Those who work in the field of nature conservation see woodlands as having a positive, beneficial effect on the conservation of flora and fauna. Long established woodlands are more valuable than those of more recent origin; and generally woodlands of broadleaved native species support a much greater variety of wildlife than those of exotic conifers. However, the point remains that even very young woodlands contribute to wildlife conservation and in the uplands large-scale coniferous woodlands have a quite dramatic, beneficial effect on wildlife. For example, where periodically there may be prolonged spells of snow lasting several weeks with sub-zero temperatures, dense, coniferous woodlands can provide shelter otherwise lacking over a very wide area. At other seasons, the "edge effect" of woodlands is also very important, whether this be round the perimeter of the woodland or alongside rides, roads and clearings. The ability to move freely into and out of the woodland canopy is beneficial to various species of birds and mammals and essential to others, and some earlier ideas that large scale upland plantations were largely devoid of all wildlife must now be revised in the light of recent studies. Even after allowing for older woodlands usually being much richer in wildlife than young plantations, a large-scale programme of planting is judged to confer positive benefit on nature conservation.

8.39 From time to time questions have been asked as to how far the continued grazing of certain upland areas is likely, in the long-term, to lead to further soil erosion and depletion of the soil resources; and it has been argued that extensive planting of trees would check the impoverishment of certain upland soils. Whilst soil erosion has not been a matter of major concern in Britain, it is is of interest to note that there is some evidence in favour of planting as a means of ensuring the long-term conservation of soil resources in parts of the uplands.

CONCLUSIONS

8.40 With the very varied kinds of implications discussed, it is clearly impossible to make any other than a subjective assessment of the overall impact of the different planting programmes considered. It must remain a matter of judgement how much weight should be given to the various factors listed. Those such as reduced dependence on imports, although considered important by some today, may not be held so vital by others, especially when looking ahead 50 years, but the relative profitability of wood growing, environmental aspects and the provision of rural jobs seem likely to remain important issues.

8.41 On balance the Group believe that as long as the cost of land taken from agriculture (which is a reflection of the disturbance to existing farming) does not rise markedly, the reasonable and prudent course,satisfying the jobs and foreign exchange criteria as well, is to maintain and indeed increase the rate of planting.

APPENDICES

APPENDIX A

FORECASTS OF WORLD DEMAND FOR WOOD PRODUCTS

A1. The steps in the arithmetic used to project consumption of the three groups of industrial wood products at constant prices are:

a. to distinguish two groups of countries (developed, or DCs and developing, or LDCs) and three groups of wood products (sawnwood, paper and paperboard, wood panel products);

b. to establish the consumption for each of the six country/product sets in the base year which has been taken to be the mean of 1970-1974;

c. to assume a range of plausible figures for growth in population, growth in *per capita* GDP and change in income elasticity (the percentage change in *per capita* consumption per 1 per cent change in *per capita* income) with income or time. Income elasticity has been assumed to change with level of income for sawnwood and paper but with time for wood-based panels;

d. to calculate the implied consumption levels expressed in terms of roundwood requirement with 1970-1974 conversion and recovery techniques;

e. to adjust the results for change in recovery of wood product per unit of roundwood.

A2. For fuelwood, a global projection is based on increase in population and GDP *per capita* and two levels of negative income elasticity.

A3. Table A1 sets out the assumptions made on changes in population and GDP *per capita*, the range of assumed growth rates being covered in each case by a low and a high rate. A variety of national and international sources has been used to assess these rates including: FAO(1967), IBRD (1972), Manning and Grinnell (1972), OECD (1976), UN (1973), USDA (1973).

TABLE A1

ASSUMPTIONS ON RATE OF INCREASE IN POPULATION AND *PER CAPITA* INCOME

Country group	*1972 population millions*	*1972 per capita income dollars (1972)*	*Period*	*Percentage* — *Population growth per year* — *high*	*low*	*Per capita income growth per year* — *high*	*low*
Developed	1100	2200	1972-1985	1.0	1.0	3.4	2.5
			1985-2000	1.0	0.9	3.4	2.5
			2000-2025	0.8	0.6	3.4	2.5
Developing	2700	200	1972-1985	2.5	2.5	3.0	1.8
			1985-2000	2.3	2.1	3.0	1.8
			2000-2025	1.7	1.0	3.0	1.8

A4. Table A2 shows the implied projections of population and income.

TABLE A2

PROJECTED WORLD POPULATION AND INCOME

	Rate of increase		*1972*	*2000*	*2025*
Population, millions	high		3800	6680	9740
	low		3800	6510	8170
	Population	*GDP/capita*			
Income 1972 = 100	H	H	100	355	1032
	H	L	100	273	625
	L	H	100	350	937
	L	L	100	269	570

A5. The assumptions made about the links between consumption of wood products and income are of course crucial. Assuming that real income is used as the determinant of consumption at constant prices, it has to be recognised that there are three difficulties in quantifying the relationship. The first is that even if past experience indicates a particular pattern of change in consumption with change in income, differentiated as necessary by income level, there is no good basis available for judging whether, and, if so, how, the relationship may change in the future. All the assumptions about income elasticity recorded in Tables A3a-c incorporate a decline in elasticity with rising *per capita* income. The second difficulty lies in establishing the nature of the relationship and the determination of the relevant parameters. In this connection, reference has been made to FAO work prior to 1975 (since when a rather different methodology for assessing the relationship between wood product consumption and income has been used by that organisation) and work by a small number of individuals. The third source of difficulty centres on the fact that the current assessment, like that of all others working in the field of forest products consumption, attempts to relate consumption of the actual goods consumed, rather than the services provided by consumption, to various economic measures. If the services provided by a unit of the particular goods do not alter over time, the two approaches are equivalent, only the units being different. In the recent past, however, there have been more newspaper pages, for example, produced from a given tonnage of newsprint through the adoption of thinner paper which has, nevertheless, satisfactory strength and opacity properties. This sort of progress in technology affecting demand for units of product may be expected to continue and, to the extent that the period studied for purposes of estimating elasticities has not incorporated change in this factor, it appears reasonable to give rather more weight to consumption projections based on the lower of the pair of elasticity assumptions noted in Tables A3a-c. Sources used in determining the two sets of elasticity assumptions for industrial wood products include ECE/FAO (1976), FAO (1960, 1966, 1967a, 1967b), FAO/ECE (1964), Grayson (1969, 1974), Gregory (1966), Mckillop (1967), Manning and Grinnell (1971), Ray (1965), USDA (1974). For fuelwood income elasticities of – 0.1 (high) and – 0.2 (low) are assumed.

A6. Tables A3a-c show the projection consumption of industrial wood products in conventional product measurement units.

A7. A separate set of considerations concerns the effect of various technical developments on the volume of roundwood required to yield a unit of each of the industrial wood product groups. These developments and their likely proportional impacts are as follows:-

a. There will be generally improved utilisation of the tree, leading to a larger supply of usable fibre from a given forest stand through fuller use of the tree (e.g. top, stump and branches) and reduced losses in harvesting. This subject is a complicated one to assess because of doubt about the technical feasibilities, the economic attractiveness of fuller utilisation and the possible application of some of the additional material harvested to uses not covered by the three product groups considered here. Among such applications are food, probably in the form of animal feed, and feedstock for chemical processes. Overall it appears reasonable to assume that a 7.5 per cent increase in utilisation of the standing tree may be achieved by the year 2000 and a 15 per cent increase by 2025.

b. There will be an improved conversion efficiency in mills, i.e. a rise in product volume from a given quantity (mass) of fibre of whatever kind. Trends towards fuller utilisation and the exploitation of smaller trees will have some impact on the conversion factors applicable to sawnwood. In addition an increasing proportion of the sawlog may be chipped rather than sawn. Such trends will tend to raise the volume of sawlogs required to produce a cubic metre of sawnwood. There are however some countervailing effects through better marketing, improved sawmill design and improved saws and kilning techniques which will limit the extent of any fall in conversion efficiency. On the other hand yields on conversion may improve in the manufacture of plywood, fibre board and particle board. Accordingly no allowance has been made for changes in conversion efficiency for sawnwood and panel products, but allowance has been made for increasing use of thermo-mechanical pulp in future pulp furnishes for paper manufacture. The assumed penetration of the total market for chemical pulp is assumed to be 8 per cent from this source by the year 2000 and 22 per cent by 2025. The introduction of thermo-mechanical pulp carries with it an increased conversion efficiency roughly equal in material terms to that of mechanical pulp. The overall effect is to reduce wood fibre requirement for pulp by 4 per cent in 2000 and 10 per cent in 2025.

c. Arising from changes in recovery of waste material and in availability of such material, it is assumed that residues from sawmills and plywood mills used in pulping will rise from 30 per cent in 1972 to 40 per cent in 2000 and 50 per cent in 2025.

d. An important factor concerns improved recovery from consumption, which is only significant in the field of wastepaper. Here it is assumed that an increase from 25 per cent of total fibre furnish for paper and board manufacture to 35 per cent will occur by the year 2000 rising to 40 per cent by 2025.

e. Increased use of non-wood fibre may be expected. There are severe practical limitations to the use of a very high proportion of agricultural wastes however. The present pulping capacity based on this source is 7 per cent (FAO, 1977) representing well under 1 per cent of the total amount of straw, bagasse, cotton linters, etc produced in the world. For working purposes increases in supply from 6 per cent in 1970-74 to 8 per cent by 2000 and also by 2025 are assumed.

f. A final consideration concerns competition for woody material from uses other than those listed as industrial wood products in this review. Any demand from other processes such as liquid fuel manufacture, solid fuel, feedstock for various chemical plants or feed for animals would obviously place direct pressure on roundwood requirements or indirect pressure through the use of material, notably chips, otherwise of value for paper and panel products manufacture. It is not, however, considered that chemical conversion of wood to products other than those covered here will be significant, fossil fuels and other plant residues being more likely sources. In the energy field, any increased demand for material in a processed form is covered under the heading of fuelwood.

A8. Considering the field of industrial wood products alone, the average of the two income elasticity assumptions indicate that the proportional increase in adjusted roundwood requirements relative to the proportional increase in world income (which equals the total output of all goods and services) will be between 0.71 and 0.72 in the year 2000 and between 0.54 and 0.58 in 2025.

TABLES A3a, b and c

NOTE OF EXPLANATION

1. Income elasticity is the percentage change in *per capita* consumption per 1 per cent change in *per capita* income. A positive income elasticity implies that as income per head of population rises so does wood product consumption per head of population. When income elasticity equals 1, wood product consumption per head of population rises at the same rate as income per head of population i.e, a 1 per cent rise in income per head of population results in a 1 per cent rise in wood product consumption per head of population. A negative income elasticity implies that as income per head of population rises consumption per head of population actually falls. This is most readily observed in the case of fuel wood when, as standards of living rise, gas, electricity and coal are substituted for wood as a means of heating.

2. For the purposes of the calculations in Tables A3a and A3b income per head of population in the developed world in 1972 is set at an index value (Y) of 100 (corresponding to an actual income per head of population of 2,200 dollars, as shown in Table A1.) It follows that the index value Y for the developing world in 1972 is about 9 (corresponding to an actual income per head of population of 200 dollars as shown in Table A1).

3. A, B and C in Tables A3a and A3b are levels of income elasticity corresponding to different ranges of income index (Y) per head of population.

An income elasticity A is assumed for levels of Y less than Y1

An income elasticity B is assumed for levels of Y greater than Y1 but less than Y2

An income elasticity C is assumed for levels of Y greater than Y2.

Thus in the upper part of Table A3a for an index value of income per head of population less than 40 the assumed income elasticity is 1, and so on.

4. In Table A3c income elasticities are assumed to vary with *time* rather than income per head of population. As can be seen in the table -

Income elasticity A is assumed for the period 1972-1985

Income elasticity B is assumed for the period 1985-2000

Income elasticity C is assumed for the period 2000-2025.

TABLE A3a WORLD WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: SAWNWOOD & SLEEPERS (MILLIONS CUBIC METRES)

	Developed World				*Developing World*				*Total*							
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*		*(2)*		*(3)*		*(4)*	
A = 1.00 B = 0.30 Y1 = 40.00 C = 0.00 Y2 = 95.00																
1972	328	328	328	328	102	102	102	102	430		430		430		430	735 [a]
1985	373	373	372	372	206	176	205	176	579		549		577		548	
2000	432	432	425	425	448	323	432	311	880		755		857		736	
2025	527	527	493	493	1240	769	1006	624	1767		1296		1499		1117	
							Year 2000 [a]			1505		1291		1465		1259
							Year 2025 (a)			3022		2216		2563		1910
A = 1.00 B = 0.20 Y1 = 40.00 C = -0.20 Y2 = 95.00																
1972	328	328	328	328	102	102	102	102	430		430		430		430	
1985	341	349	341	349	208	176	205	176	547		525		546		525	
2000	357	375	351	369	448	323	432	311	805		698		783		680	
2025	367	404	344	378	1214	769	985	624	1581		1173		1329		1002	
							Year 2000 [a]			1377		1194		1339		1163
							Year 2025 (a)			2704		2006		2273		1713

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors i.e. unadjusted roundwood removals in millions of cubic metres.

TABLE A3b

WORLD WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: PAPER & PAPERBOARD (MILLIONS METRIC TONNES)

A = 1.60
B = 1.05 Y1 = 70.00
C = 0.90 Y2 = 140.00

	Developed World				*Developing World*				*Total*				
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	
1972	108	108	108	108	31	31	31	31	139	139	139	139	418 [a]
1985	191	172	190	171	78	61	78	61	269	233	268	232	
2000	347	278	342	273	221	132	213	127	568	410	555	400	
2025	902	592	844	554	1090	409	884	332	1992	1001	1728	886	
Year 2000 [a]									1710	1234	1671	1204	
Year 2025 (a)									5996	3013	5201	2667	

A = 1.40
B = 0.95 Y1 = 70.00
C = 0.80 Y2 = 140.00

	Developed World				*Developing World*				*Total*			
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*
1972	108	108	108	108	31	31	31	31	139	139	139	139
1985	183	166	182	166	72	58	72	58	255	224	254	224
2000	317	260	311	255	188	119	181	115	505	379	492	370
2025	757	520	708	487	804	339	652	275	1561	859	1360	762
Year 2000 [a]									1520	1141	1481	1114
Year 2025 (a)									4699	2586	4094	2294

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors i.e. unadjusted roundwood removals in millions of cubic metres.

TABLE A3c

WORLD WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: WOOD BASED PANELS (MILLIONS CUBIC METRES)

	Developed World				*Developing World*				*Total*				
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	
A = 1.80 1972-1985 B = 1.40 1985-2000 C = 1.00 2000-2025													
1972	70	70	70	70	15	15	15	15	85	85	85	85	155[a]
1985	172	141	172	141	40	31	40	31	212	172	212	172	
2000	401	274	394	269	105	63	102	61	506	337	496	330	
2025	1129	620	1057	580	338	151	274	122	1467	771	1331	702	
Year 2000[a]									921	613	903	601	
Year 2025 (a)									2670	1403	2422	1278	
A = 1.50 1972-1985 B = 1.00 1985-2000 C = 0.80 2000-2025													
1972	70	70	70	70	15	15	15	15	85	85	85	85	
1985	152	128	151	128	36	29	36	29	188	157	187	157	
2000	290	215	286	212	79	53	76	51	369	268	362	263	
2025	694	431	649	404	219	116	178	94	913	547	827	498	
Year 2000[a]									672	488	659	479	
Year 2025 (a)									1662	996	1505	906	

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors i.e. unadjusted roundwood removals in millions of cubic metres.

TABLE A4

TOTAL WORLD CONSUMPTION

Unadjusted RR billions m^3 (UB)		(1)	(2)	(3)	(4)
1972		1.31	1.31	1.31	1.31
2000	HIGH	4.14	3.14	4.04	3.06
	LOW	3.57	2.82	3.48	2.76
2025	HIGH	11.69	6.63	10.19	5.86
	LOW	9.07	5.59	7.87	4.91

APPENDIX B

EVIDENCE ON PAST RATES OF INCREASE IN WOOD PRODUCTION BY REGION

B1. Statistics for industrial wood production have been extracted from FAO Year Books. Fuelwood has not been covered owing to the very marked uncertainties about reliability of the recorded figures. Some of the same difficulties arise with industrial wood, and discontinuities in the data arising from statistical improvements rather than real changes in physical output are frequent.

B2. The graph in Figure B1 shows trends in removals plotted every 3 years. The reason for the apparent conformity of the dates at which discontinuities arise is that 10-year summary data have been used.

B3. Table B1 shows the annual compound rates of growth by region for the decades 1954-64 and 1964-74 and the whole 20 years. Considering the latter first, it will be seen that the regions which show above average rates of increase are the developing ones plus Canada, while the lower than average ones are the more developed. The same broad picture emerges from the figures for the decade 1964-74. The interesting features that appear to emerge are that

a. the rate of increase in world cut was slightly higher in 1964-74 than in 1954-64;

b. apart from the USSR and Latin America with their very different performances over the two decades, most regions or countries tend to show convergence of rates of growth towards the world average rate of increase, the range (excluding USSR and Latin America) being 1.1 per cent to 5.35 per cent per year in the first decade and 1.4 per cent to 3.7 per cent in the second.

B4. The projections of industrial roundwood requirement show a range of from 2.35 billion m^3 to 3.58 billion m^3 for the world in 2000, representing annual rates of increase from 1972's volume of 1,310 million m^3 of 2.1 per cent and 3.7 per cent respectively. /The Group's central forecast implies a 3 per cent per annum rate of increase/. In considering the feasibility of attaining these rates of increase it has to be remembered that increasing population implies a larger labour supply and increasing income means increased investment. Thus, even if the required rate of increase in roundwood supply were, say, more than double the past rate of increase, there would be no justification for concluding that such increases were impossible simply on the basis of past performance. The projected rate of increase in Britain's cut from now to the end of the century is a case in point.

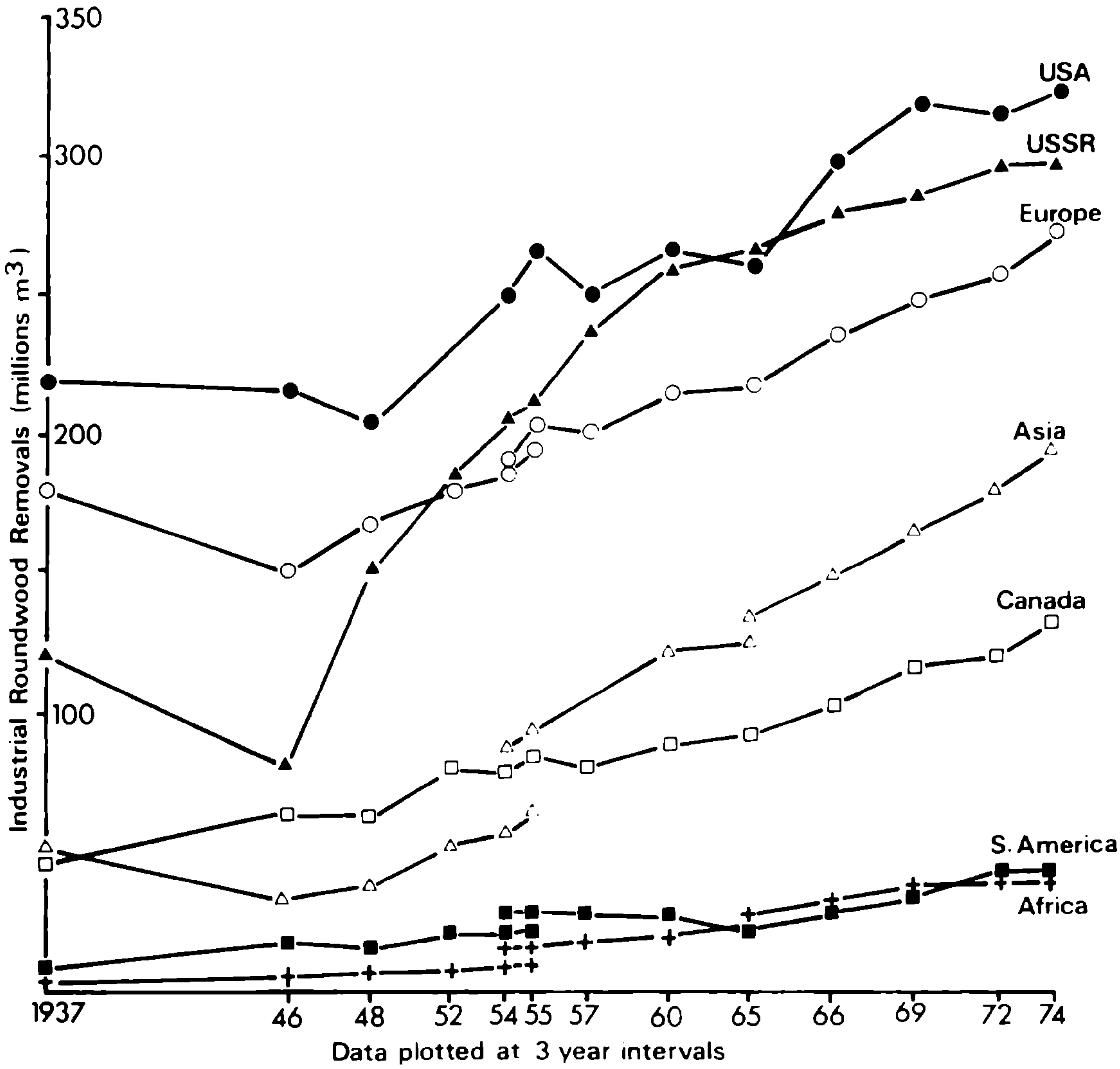

Figure B1. Industrial roundwood removals.

TABLE B1

AVERAGE ANNUAL COMPOUND PERCENTAGE RATES OF INCREASE IN CUT OF INDUSTRIAL ROUNDWOOD

	Decade 1954-64		*Decade 1964-74*		*Overall 1954-74*
Africa	5.35	L Amer.	4.1	Africa	4.9
Asia	4.5	Africa	3.7	Asia	4.0
USSR	3.0	Canada	3.3	Canada	2.7
Oceania	2.6	Asia	3.2	L Amer.	2.4
				Oceania	2.2
World	2.15	World	2.4	World	2.2
Canada	2.0	Europe	1.7	USSR	1.9
Europe	1.8	Oceania	1.6	Europe	1.9
USA	1.1	USA	1.4	USA	1.3
L Amer.	0.2[(a)]	USSR	0.7		

Note: (a) As indicated by the data available, but the result appears to be unreliable.

APPENDIX C

PROJECTIONS OF WOOD SUPPLY

EUROPE

C1. The latest European timber trends study (ECE/FAO, 1976) indicates a range of possible levels of cut in the year 2000. So far as is known all the figures for removals which are quoted assume constant real prices of standing wood. The differences in volume arise from consideration of the effects of changing attitudes towards management.

		Millions cubic metres UB
a.	Aggregate of country forecasts	408
b.	Secretariat "realistic low"	386
c.	Secretariat "realistic high"	453

The study considers that a central forecast of 430 million m^3 is reasonable for the year 2000. This represents a removal rate on growing stock measured over-bark of 2.7 per cent on an estimated growing stock of 16 billion m^3 OB. Recent analyses by Kuusela (1977) indicate that there is no reason why sustained yield at a level equivalent to over 3 per cent of the over-bark growing stock should not be possible with the growth rates found and management techniques that may be practised in Europe. This would imply an annual cut of 500 million m^3. Some further increase, arising particularly from use of more productive species, is probable in the 21st century.

USSR

C2. Persson (1974) indicates a growing stock volume of 79 billion m^3 (73 of which occur on the area of closed forest which amounts to something of the order of 700 million hectares). Vasiljev (1963) on the other hand gives a figure of 75 billion m^3 which is related to a forest area of 784 million hectares (a subsequent reference to Vasiljev by Sutton (1975) refers to 80 billion m^3 but the 75 billion figure is quoted in ECE/FAO 1976). Figures for annual increment in the USSR forests are, as Sutton explains, open to serious doubt, but current growth is unlikely, net of natural losses, to be higher than 600 million m^3. The volume cut in the longer term, which is taken here to imply the year 2000, is put in the range 520-620 million m^3 by Sutton. Such a rate of production represents a removal percentage of only 0.8 per cent at the maximum. Under the difficult growing conditions found in much of the USSR, the possible removal rate for sustained yield is seriously limited by the low increment and accordingly a rise to no higher than 1.0 per cent by the year 2025 is assumed.

UNITED STATES

C3. The growing stock of timber in the US is estimated at some

20 billion m^3 in the year 2000 (USDA, 1974). The 1974 study of the timber outlook in the US indicates a likely cut in the year 2000 at 1970 levels of management of 535 million m^3. The growing stock of approximately 22 billion m^3 OB in that year could provide a yield of 600 million m^3 if the removals percentage rose as seems possible to 2.7 per cent. In the long term it is estimated by Spurr and Vaux (1976) that the yield of the future forest area assuming no major change in species composition could be 820 million m^3. With more intensive management a physically possible yield of 980 million m^3 is predicated. The authors conclude that an economically realistic level of management would lead in time to a yield of 830 million m^3 and accordingly an intermediate value of 700 million m^3 is proposed as the cut in the year 2025.

CANADA

C4. Information on the extent of operable forest, its growing stock and potential yield is still very imperfect for many Canadian forests. The economic level of cut at unchanged 1972 prices is estimated (British Columbia Council, 1972, Manning and Grinell, 1971) at 225 million m^3 for the year 2000 from an area of forest suitable for regular harvest of 240 million hectares. This implies a yield of less than 1 m^3 per hectare or, in terms of removal percentage, a cut on a growing stock volume of 25 billion m^3 OB of 0.9 per cent. A rise in the level of cut to 1.3 per cent by the year 2000 would imply 330 million m^3 per year and to one of 2 per cent by 2025 would imply 500 million m^3.

LATIN AMERICA

C5. The closed forest area of 590 million hectares (Persson,1974) or 725 million hectares (ECE/FAO, 1976) currently supports a total cut of 270 million m^3, all but 40 million m^3 of which is fuelwood. The total growing stock is estimated at 91 billion m^3 by the Latin America Forestry Commission (1976) while Persson notes a figure of 96 billion m^3 with uncertainty over the volume of bark included. Thus the current level of cut represents a removal rate of 0.3 per cent of the growing stock. It is assumed that this level could be raised by 0.7 per cent to 1.0 per cent by the year 2000 and by a further 0.6 per cent to 1.6 per cent by 2025. The cut implied by the latter of 1500 million m^3 is raised by 100 million m^3 to account for increasing plantation yield: the total of 1600 million m^3 represents a yield of under 3 m^3 per hectare.

AFRICA

C6. A similar approach to that adopted above is used to estimate possible future cut in Africa. The closed forest area of 190 million hectares (Persson, 1974) carries a growing stock of 25 billion m^3. The far larger area of open woodland supports a total volume of 14 billion m^3 thus producing a total growing stock of 39 billion m^3. The recent level of cut has been 310 million m^3 (FAO 1976 a) (ECE/FAO 1976 page 175 notes 280 million m^3 in 1973). The removal rate on a volume of over 40 billion m^3 OB is thus approximately 0.7 per cent and it is assumed that this will rise to 1.5 per cent by the year 2000 and to 2.2 per cent by 2025.

ASIA AND FAR EAST

C7. This region, among regions with many developing countries, is the one most liable to suffer permanent losses of forest land. At the same time it includes China, Oceania, Japan and a number of other countries with very active plantation programmes. The FAO study (FAO 1976 b) indicates "sustainable supply" levels of 980 million m^3 in 1981 and 1055 million m^3 in 1991. The growing stock in closed forests is estimated at 40 billion m^3 with a further 5 billion m^3 in open forest. The volume in operable closed forest is 29 billion m^3. Total cut of 710 million m^3 (of which only 220 million m^3 is in the form of industrial wood) thus represents a substantial rate of removal (2.3 per cent on an operable growing stock of, say, 35 billion m^3 OB) With further extension of the operable zone, the annual removal can be expected to rise to 2.8 per cent on 40 billion m^3 OB implying 1120 million m^3 in the year 2000 (a marginal rise on the FAO projection for 1991) By 2025 the yield from plantations may be expected to be greatly increased and accordingly a further rise in cut is assumed to a level of 1400 million m^3, or 3 per cent on a future growing stock of at least 45 billion m^3.

APPENDIX D

TRENDS IN HARVESTING COSTS AND METHODS

INTRODUCTION

D1. Trends in harvesting methods are dependent on the progress of technological change and this question is considered in this Appendix.

D2. The amount of data available in historic cost trends in harvesting and transportation is sparse so far as the developed countries are concerned and no information is available from developing countries. As well as published information a number of personal communications have contributed to the review of historic cost trends which follows.

D3. A brief review of current harvesting systems is presented followed by an appraisal of possible changes in harvesting systems and an assessment of future trends in harvesting costs arising from these changes. This section of the paper is confined to circumstances and expectations in Britain because of a lack of information available for other regions of the world.

PROGRESS OF TECHNOLOGICAL CHANGE

D4. Silversides (1966) has analysed the process of technological change into three broad stages:-

a. Invention: the development of a new idea for a product or process and its introduction to practice. This depends upon the scientist and inventor.

b. Innovation: the process of bringing the invention into commercial use: governed by production sales and profitability.

c. Diffusion: the spread of innovation through the industry.

D5. The result is that the process of technological change is typically a slow beginning as the first experiments are followed by the evolution of an efficient system, followed by a more rapid spread of the system once proved, with a slowing down when the system reaches saturation point. At this stage the system is in operation as far as it is possible to introduce it. The productivity changes associated with the system will follow a similar curve, but even when the system reaches its peak there will be some further gains in productivity although they will be very small.

D6. The final stage in the use of a system is a period of decline when a new technological change supersedes it.

D7. Cost changes may not be so dramatic, especially as the new methods become more capital intensive and thus the decrease in cost may not be in proportion to the increase in labour productivity.

D8. These stages are illustrated in Figure D1.

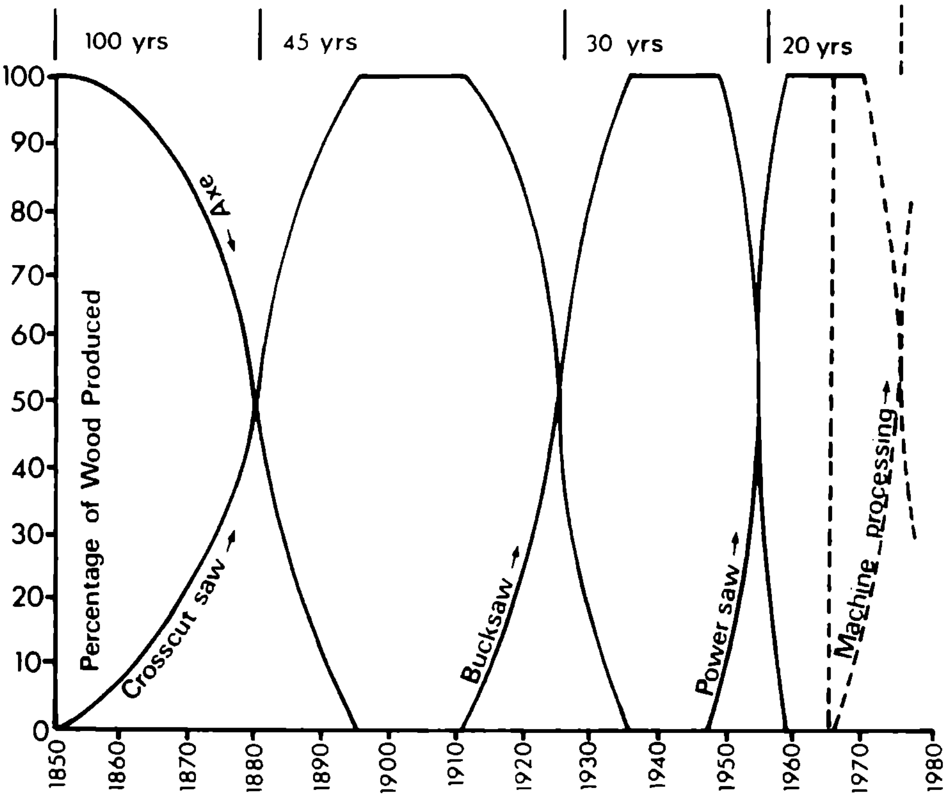

Figure D1. *Innovation acceleration in technology of cutting in the logging industry in eastern Canada. (Silversides 1966).*

D9. A direct comparison of trends in Figure D1 with those in Britain is not easy to make but the impression is that introduction into commercial use in this country is five to ten years behind the dates given, while the rate of acceleration of innovation is very similar.

D10. The rate at which changes are introduced into commercial practice has also increased as a result of improved communications, training and management. There is potential for further improvements in this direction.

D11. In considering the future pattern of technological change it is necessary to consider the following factors which are likely to affect the potential for change:-

a. Currently felling and debranching are two of the most labour intensive tasks in harvesting and both are susceptible to technological change.

b. Expectations are often based on progress towards bigger, more expensive, higher capacity, more sophisticated machines, and at some stage there must be a limit to progress in this direction.

c. In countries such as Britain, the required scale of operations in a locality to justify the use of the biggest machines on economic grounds may obtain only in a proportion of the volume to be harvested.

d. The scope for the use of larger machines may be limited by a preponderance of early thinnings.

e. Environmental constraints may slow down the introduction of the largest machines even where their use is practicable on other grounds.

HARVESTING COSTS - HISTORIC TRENDS ON A WORLD BASIS

D12. Figure D2 gives logging costs from sources in Sweden (Streyffert) 1960), (Embertsen 1975) and Canada (Payandeh 1972). The data has been converted to constant costs and expressed as an index using 1960 as the base year. The figures suggest an increase of between 1.5 per cent and 2.5 per cent per annum from a fairly uniform trend. Figure D3 gives transport costs, also in constant terms, from the same sources. Two examples for floating are included and they follow the same trend. Payandeh's transportation figures refer to an amalgam of rail, trucks, water, horse and tractor while Embertsen's data for Kramfors relates to lorry transport. There seems to be no significant overall tendency for these costs to change which suggests that technology changes are faster in the transportation field and this tends to keep real costs more stable.

D13. On the basis of this limited information the indications are that from the early part of this century the main trends have been:-

a. Harvesting costs have risen in real terms by 1.5 per cent to 2.5 per cent per annum.

b. For transportation costs the limited information available indicates that costs have remained relatively stable.

PRESENT HARVESTING SYSTEMS IN BRITAIN

D14. In order to assess the prospects of change in harvesting systems and costs the present systems must be defined. Four main systems can be distinguished:-

a. Treelength skidding - chainsaw felling and delimbing at stump and (after extraction by skidding tractor) chainsaw cross-cutting - manual piling.

This system accounts for approximately 70 per cent of harvesting.

b. Shortwood forwarder - chainsaw felling, delimbing and cross-cutting at stump - manual piling - extraction by forwarder.

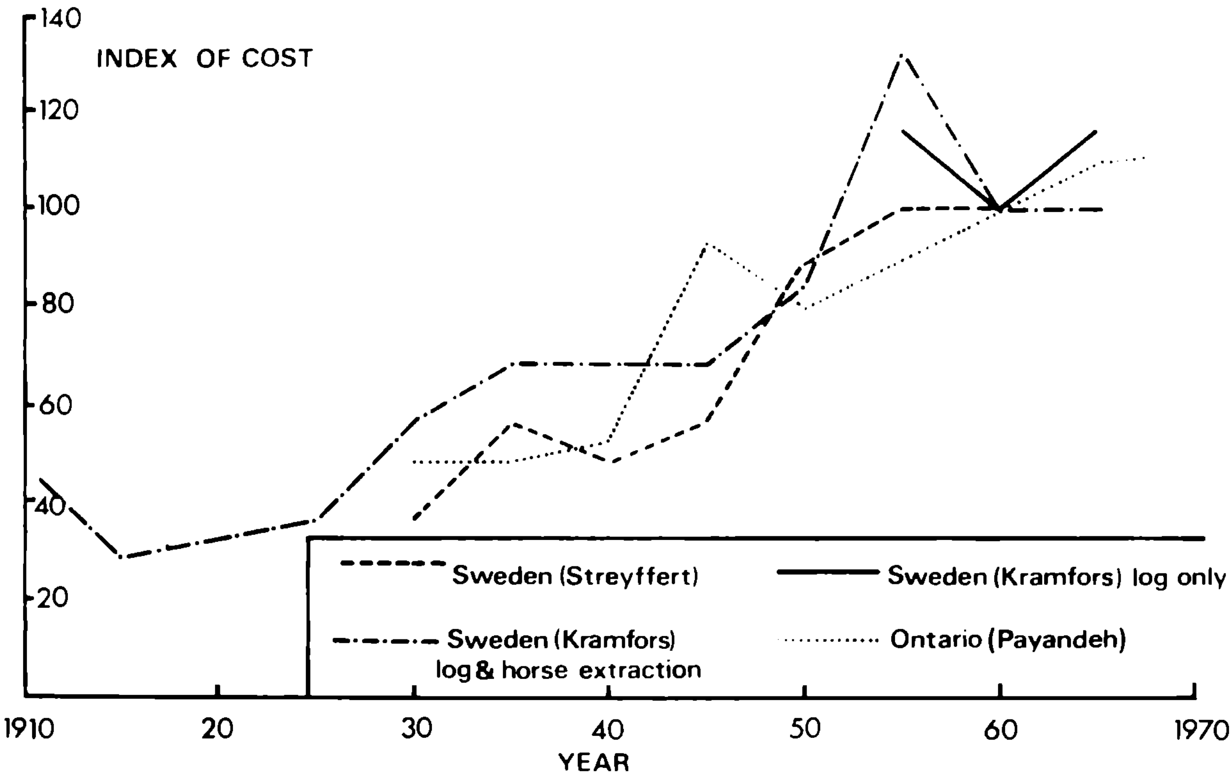

Figure D2. Indices of logging costs (1960 = 100) in real terms.

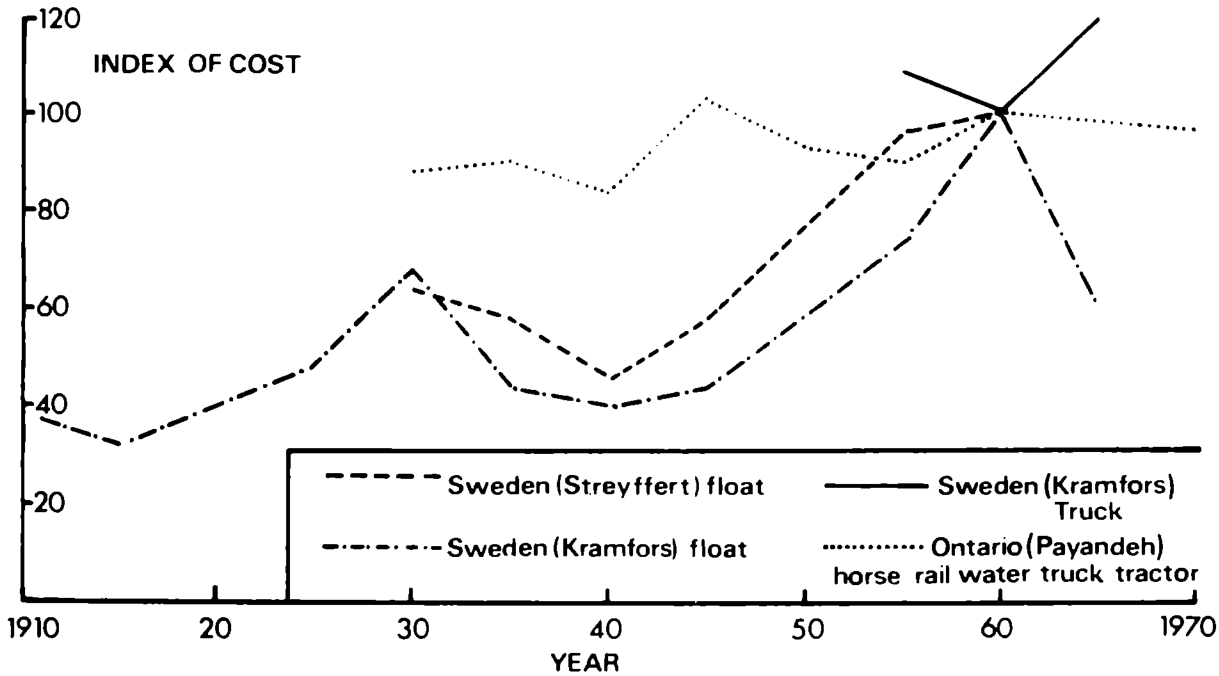

Figure D3. Indices of transport costs (1960 = 100) in real terms.

This system accounts for about 6 per cent of harvesting.

c. Treelength cable crane: as for a. but with cable crane extraction.

This system accounts for about 4 per cent of harvesting.

d. Shortwood cable crane: as for b. but with cable crane extraction.

This system accounts for about 20 per cent of harvesting.

D15. All four systems are of the "motor manual" type; i.e. they require considerable physical effort as well as the application of machinery in some phases of the work. The output per man-year is about 700-1,000 m^3 and the capital investment per man at 1977 prices lies in the range £2,000-£5,000.

FUTURE HARVESTING SYSTEMS IN BRITAIN

OPPORTUNITIES FOR MECHANISATION

D16. Mechanisation could be applied to some or all of the following stages of work:-

a. *Felling* - In motor manual systems this is a speedy operation and the advantages of full mechanisation would come only from:-

   i. greater outputs from delimbing machines and, when the felled stems are bunched, from extraction machinery

   or

   ii. the ability to work in adverse weather.

b. *Delimbing* - In motor manual systems this is a major part of the work involved; it is labour intensive and there are good opportunities for full mechanisation.

c. *Extraction* - More progress has been made in mechanisation in this phase than in any other. The use of systems which favour grapple skidders over winch skidders could make the operation less dependent upon the weather.

d. *Cross-cutting, Loading etc* - Further mechanisation of these operations is desirable on ergonomic grounds. Output per man-year would be increased but costs might also increase slightly.

FUTURE TRENDS IN HARVESTING SYSTEMS

D17. The following harvesting systems could be envisaged:-

a. *Large Processor System* - Felling mechanically or by hand: delimbing and cross-cutting done by large processor; extraction by forwarder and/or grapple skidder.

i. Output is dramatically higher than any other system: up to 7,000 to 8,000 m^3 per man-year. Capital investment is also very high but costs are much lower than with current motor manual systems. Two such systems are in operation in Britain.

ii. This system is best suited to clear felling (though it could operate in some forms in thinnings) and this, coupled with its very high output (minimum of 32,000 m^3 per year) restricts the opportunities for its use.

b. *Mini Processor System* - In principle this is a similar system to the large processor, but based on lower cost, lower capacity machines.

i. Output per man could be two to three times that of motor manual systems. Capital cost *per machine* and *per man* is less than for large processor systems but capital cost *per 1,000 m^3/year* is higher. Cost per m^3 is lower than for motor manual systems but higher than for large processor systems.

ii. These systems are under active development at the present time and represent the best possibility of improving productivity on the scale of working likely to be achieved in the foreseeable future in Britain, where three systems of this kind are already operational.

c. *Flail Delimber System* - Felling mechanically or by hand: extraction by clambank forwarder to depot: delimbing by a machine which "flails" the stems with revolving chains: mechanical cross-cutting with grabsaws.

i. The equipment is expensive but output per man is 3 to 4 times that of motor manual systems, and costs are lower than for any of the other systems so far mentioned.

ii. At present the standard of delimbing is lower than that required to meet current product specification but pressure on harvesting costs could change the position in the long term.

d. *Chipping Systems* - Felling mechanically or by hand: extraction by clambank skidder: chipping at depot into load transfer vehicles.

i. It is possible to get widely differing results depending on the assumptions made. It is clear that where high capacity of chippers can be utilised in a balanced harvesting system costs can be reduced and outputs increased significantly.

e. *Cable Crane Systems* - Output per man could be increased by confining the work done in the wood to felling only, with delimbing and cross-cutting done at roadside by mini processors. However, because of the significantly higher investment, total costs would be similar to the present system.

The pattern that emerges is:-

a. In cable crane harvesting labour output can be increased but costs are unlikely to be reduced.

b. In skidder/forwarder harvesting the high output/high capital cost systems based on processors, flails and chippers could give very high output per man and low cost. However, owing to the very large volumes required to work these systems efficiently their place in Britain will be restricted.

c. There will be many areas where the scale of operation and widely dispersed work sites will limit output improvements to systems based on mini processors.

COMPARISON OF HARVESTING SYSTEMS

D19. Table D1 illustrates a comparison of the harvesting systems considered by indices of output per man-year, cost per cubic metre, capital per man and by an estimate of the minimum annual programme required for efficient working in each system at which full utilisation of equipment is likely to be achieved.

TABLE D1

Harvesting System (1)	*Index of Output per man-year* (2)	*Index of Cost*[a] *per* m^3 (3)	*Index of Capital per man* (4)	*Minimum Programme* m^3*/year* (5)
Treelength skidder (Base)[b]	100	100	100	1,750
Shortwood cable crane	80	90	50	3,000
Large processor	1,000	50	1,250	32,000
Mini processor	300	70	750	21,000
Flail delimber	400	40	540	80,000
Chipping system	1,200	40	830	40,000
Mechanised cable crane	150	85	200	10,000[c]

Notes: (a) This table does not allow for road costs and investment. In most comparisons the road costs will not make significant differences but there will be a much higher road cost for cable crane systems in comparison with the others.

(b) A base index value of 100 is allocated to motor manual tree length skidding.

(c) Full utilisation of all the machines is not possible in this system and allowance has been made in the costs.

HARVESTING COSTS - FUTURE TRENDS IN BRITAIN

D20. The effect of most new systems considered is to increase the proportion of machine cost and decrease the proportion of labour cost.

D21. The following possible lines of future cost development were considered:-

a. Machinery costs increase in real terms by 2 per cent per annum.
   Labour remains the same in real terms.

b. Machinery costs increase by 2 per cent per annum.
   Labour costs increase by 4 per cent per annum.

c. Machinery costs decrease by 2 per cent per annum.
   Labour unchanged.

d. Machinery costs decrease by 2 per cent per annum.
   Labour costs increase by 4 per cent per annum.

D22. The most likely pattern for future cost development was considered to be d.

D23. A detailed analysis has been made of the likely rate of introduction of new harvesting methods and the extent to which they can be introduced. Costs are considered in 1977 terms and it is assumed that machinery costs decrease by 2 per cent per annum while labour costs increase at 4 per cent per annum in real terms.

D24. The harvesting costs derived are expressed as an index in Table D2 and in Figure D4.

TABLE D2

Year:	*1975*	*1980*	*1985*	*1990*	*2000*	*2010*	*2020*	*2030*
Index of harvesting cost	100	89	66	68	72	80	106	127

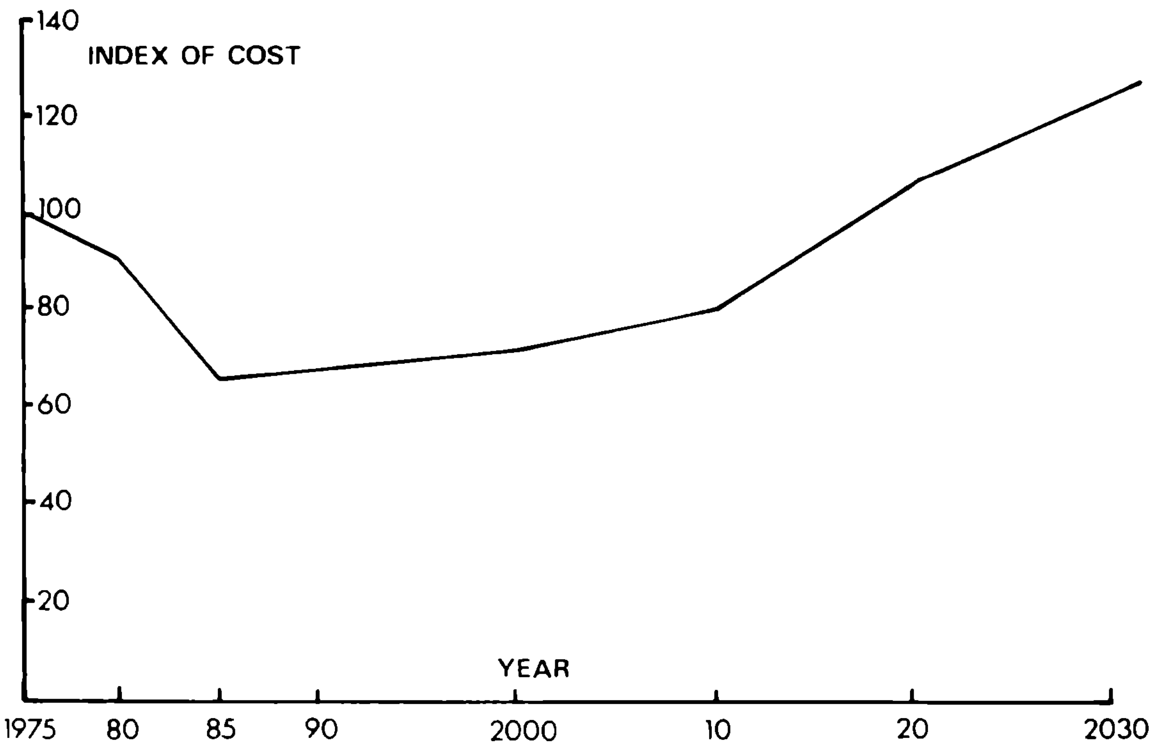

Figure D4. Index of harvesting cost.

D25. The effect is that as the more efficient methods are introduced there is a drop in costs in real terms. After that there is a gradual rise as the influence of the increase in labour costs asserts itself in the absence of technological change.

D26. Further technological innovations of a significant nature, but as yet undefined, at the turn of the century may allow costs to be contained in real terms. Here both the evidence of Silversides referred to earlier and a reasonable optimism suggests that it could be realised. Therefore it seems reasonable to assume that harvesting costs will not increase in real terms.

D27. Changes in product specification can influence output and cost. In general the larger the specification, the lower the cost and the higher the output. These changes could be considerable where local operations are concerned but are unlikely to affect significantly the long term conclusions of this report.

D28. Output is higher and costs lower in clearfelling as opposed to thinning, and a large change in the proportion of one to the other could influence matters considerably. However, the latest forecasts suggest that no significant change in the proportions of thinning to clearfelling is expected up to the end of this century.

CONCLUSIONS

D29. While historic trends in harvesting costs from 1910 to 1970 based on data from a number of countries have shown an increase of about 2 per cent in real terms, it is predicted that costs may fall somewhat during the next decade or so before gradually rising beyond present levels into the next century. It is worth noting that the historic trends have occurred under harvesting systems which remained comparatively labour intensive throughout. The prediction of future harvesting cost trends rests on the assumption that harvesting systems will become much less labour intensive especially in felling and processing. It has also been assumed that there will be no major technological changes in methods of hauling from stump to road.

D30. Transportation costs, the limited evidence suggests, have been fairly constant. There is of course the prospect that the exploitation of more distant forests in other countries will cause these costs to rise in real terms. However, the exploitation of increasingly remote forests has been a feature of forestry from 1900 to the present time when costs have been fairly constant. Therefore it would be reasonable to assume that future changes in technology would allow a similar achievement in the future.

APPENDIX E

UNITED KINGDOM WOOD CONSUMPTION PROJECTIONS

TABLE E1

UNITED KINGDOM WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: SAWNWOOD & SLEEPERS (THOUSANDS CUBIC METRES)

A = 1.00
B = 0.30 Y1 = 40.00
C = 0.00 Y2 = 95.00

	United Kingdom								*United Kingdom Total*				
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	
1972	10027	10027	10027	10027	0	0	0	0	10027	10027	10027	10027	17146 (a)
1985	10237	10237	10237	10237	0	0	0	0	10237	10237	10237	10237	
2000	10481	10481	10481	10481	0	0	0	0	10481	10481	10481	10481	
2025	10800	10800	10800	10800	0	0	0	0	10800	10800	10800	10800	
							Year 2000 (a)		17923	17923	17923	17923	
							Year 2025 (a)		18468	18468	18468	18468	

A = 1.00
B = 0.20 Y1 = 40.00
C = −0.20 Y2 = 95.00

	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*
1972	10027	10027	10027	10027	0	0	0	0	10027	10027	10027	10027
1985	9591	9845	9591	9845	0	0	0	0	9591	9845	9591	9845
2000	8972	9492	8972	9492	0	0	0	0	8972	9492	8972	9492
2025	7954	8848	7954	8848	0	0	0	0	7954	8848	7954	8848
							Year 2000 (a)		15342	16231	15342	16231
							Year 2025 (a)		13601	15130	13601	15130

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors, i.e. unadjusted roundwood removals in thousands of cubic metres.

TABLE E2 UNITED KINGDOM WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: PAPER & PAPERBOARD (THOUSANDS METRIC TONNES)

	United Kingdom (1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	*United Kingdom Total* (1)	(2)	(3)	(4)	
A = 1.60													
B = 1.05	Y1 = 70.00												
C = 0.90	Y2 = 140.00												
1972	7311	7311	7311	7311	0	0	0	0	7311	7311	7311	7311	22006 [a]
1985	10189	9085	10189	9085	0	0	0	0	10189	9085	10189	9085	
2000	15558	12156	15558	12156	0	0	0	0	15558	12156	15558	12156	
2025	31206	19566	31206	19566	0	0	0	0	31206	19566	31206	19566	
							Year 2000 [a]		46830	36590	46830	36590	
							Year 2025 (a)		93930	58894	93930	58894	
A = 1.40													
B = 0.95	Y1 = 70.00												
C = 0.80	Y2 = 140.00												
1972	7311	7311	7311	7311	0	0	0	0	7311	7311	7311	7311	
1985	9871	8912	9871	8912	0	0	0	0	9871	8912	9871	8912	
2000	14424	11578	14424	11578	0	0	0	0	14424	11578	14424	11578	
2025	26892	17742	26892	17742	0	0	0	0	26892	17742	26892	17742	
							Year 2000 [a]		43416	34850	43416	34850	
							Year 2025 (a)		80945	53403	80945	53403	

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors, i.e. unadjusted roundwood removals in thousands of cubic metres.

TABLE E3 UNITED KINGDOM WOOD CONSUMPTION PROJECTIONS

COMBINATIONS: (1) POP.-HIGH GDP-HIGH (2) POP.-HIGH GDP-LOW (3) POP.-LOW GDP-HIGH (4) POP.-LOW GDP-LOW

PRODUCT: WOOD BASED PANELS (THOUSANDS CUBIC METRES)

	United Kingdom								*United Kingdom Total*				
	(1)	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	*(1)*	*(2)*	*(3)*	*(4)*	
A = 1.80 1972-1985													
B = 1.40 1985-2000													
C = 1.00 2000-2025													
1972	2858	2858	2858	2858	0	0	0	0	2858	2858	2858	2858	5144 (a)
1985	5171	4125	5171	4125	0	0	0	0	5171	4125	5171	4125	
2000	9814	6392	9814	6392	0	0	0	0	9814	6392	9814	6392	
2025	21174	10806	21174	10806	0	0	0	0	21174	10806	21174	10806	
						Year 2000 (a)			17861	11633	17861	11633	
						Year 2025 (a)			38537	19667	38537	19667	
A = 1.50 1972-1985													
B = 1.00 1985-2000													
C = 0.80 2000-2025													
1972	2858	2858	2858	2858	0	0	0	0	2858	2858	2858	2858	
1985	4709	3896	4709	3896	0	0	0	0	4709	3896	4709	3896	
2000	7511	5369	7511	5369	0	0	0	0	7511	5369	7511	5369	
2025	14004	8228	14004	8228	0	0	0	0	14004	8228	14004	8228	
						Year 2000 (a)			13670	9772	13670	9772	
						Year 2025 (a)			25487	14975	25487	14975	

Note: (a) Wood raw material equivalent at unchanged 1970-74 conversion factors, i.e. unadjusted roundwood removals in thousands of cubic metres.

TABLE E4

TOTAL UNITED KINGDOM CONSUMPTION

Unadjusted RR millions cubic metres (UB)		*(1)*	*(2)*	*(3)*	*(4)*
1972		**44.30**	**44.30**	**44.30**	**44.30**
2000	**HIGH**	**82.61**	**66.15**	**82.61**	**66.15**
	LOW	**72.43**	**60.85**	**72.43**	**60.85**
2025	**HIGH**	**150.94**	**97.03**	**150.94**	**97.03**
	LOW	**120.03**	**83.51**	**120.03**	**83.51**

APPENDIX F

GREAT BRITAIN: WOOD SUPPLY POTENTIAL

FORECASTS OF PRODUCTION FROM BRITISH WOODLANDS

F1. The alternative rates of expansion are as follows:

(a) To do no further new planting. (Alternative 1).

(b) To plant at approximately the historic rate which will result in 700 thousand hectares between 1975 and 2000 and a further 300 thousand hectares between 2001 and 2025. No further new planting is assumed after 2025. (Alternative 2).

(c) To plant one million hectares between 1975 and 2000 and a further 800 thousand hectares between 2001 and 2025. No further new planting is assumed after 2025. (Alternative 3).

AREA STATEMENTS

F2. Alternative 1 represents the growing stock as estimated for the end of 1975 and shown in Table F1.

TABLE F1 — Thousands hectares

Country	*Ownership*	*Broadleaves*	*Conifers*	*Total*	
England and Wales	PW	311	230	541	918
	FC	46	331	377	
Scotland	PW	35	262	297	729
	FC	4	428	432	
G.B.	PW	346	492	838	1647
	FC	50	759	809	

PW = Private ownership

FC = Forestry Commission

F3. Alternative 2 is represented by Table F2 which shows the areas which would be planted in addition to the existing (1975) growing stock.

TABLE F2 Thousands hectares

Country	*Species Group*	*25 year periods*		*Totals*
		1976-2000	*2001-2025*	
England and Wales	B1	20	20	40
	Cf	80	30	110
Total		100	50	150
Scotland	B1	10	10	20
	Cf	590	240	830
Total		600	250	850
G.B.	B1	30	30	60
	Cf	670	270	940
Total		700	300	1000

F4. Alternative 3 is represented by Table F3 which shows the areas which would be planted in addition to the existing (1975) growing stock.

TABLE F3 Thousands hectares

Country	*Species Group*	*25 year periods*		*Totals*
		1976-2000	*2001-2025*	
England and Wales	B1	30	20	50
	Cf	145	135	280
Total		175	155	330
Scotland	B1	20	10	30
	Cf	805	635	1440
Total		825	645	1470
G.B.	B1	50	30	80
	Cf	950	770	1720
Total		1000	800	1800

F5. In order to test the sensitivity of the forecasts to the management assumptions applied to the crop data, a range of management regimes is used to prepare four forecasts for comparison. In all four regimes it is assumed that Forestry Commission woodlands will be managed on rotations of 55 years for conifers and about 100 years for broadleaves, and that thinning will be moderately heavy with no thinning in areas susceptible to windblow. In all four regimes it is assumed that thinning in private woodlands will follow the pattern set for the Forestry Commission's woodlands. The differences between the four regimes lie in the different assumptions made on rotation lengths in private woodlands i.e.

(a) Conifers 55 years and broadleaves 100 years

(b) Conifers 70 years and broadleaves 150 years

(c) Conifers 80 years and broadleaves 150 years

(d) Conifers 90 years and broadleaves 150 years.

It will be seen that the production forecasts are relatively little affected by the different rotations compared with the consequences of altering the rates of planting.

F6. For the purpose of calculating yields under the traditional regime, the private sector and Commission growing stocks at 1975 (Table F1) are dealt with on the basis of the actual distribution of broadleaves and conifers at 1975. It is assumed however, that in future, each sector will plant the same area and the same proportion of broadleaves and conifers.

INDEX OF GROWTH POTENTIAL

F7. The Forestry Commission yield class system, as described in FC Booklet No 34 pp 2-7, has been used to calculate yields. The yield classes selected for conifers and for broadleaves were the mean values for each country derived from crop inventory surveys conducted by the Forestry Commission. No upgrading of yield classes have been made to allow for crop improvements which might be derived from fertiliser treatments or genetic selection.

F8. For conifers, in order to give a more reliable estimate of assortment between sawlogs and smallwood, a distribution of yield classes around the mean is used, instead of the mean value itself. This is shown in Table F4.

TABLE F4

Country	*Species Group*	*Mean YC*	*Distribution of YCs* 8	10	12
England	Broadleaves	6	-	-	-
	Conifers	10	25	50	25
Wales	Broadleaves	6	-	-	-
	Conifers	11	-	50	50
Scotland	Broadleaves	4	-	-	-
	Conifers	9	50	50	-

PATTERN OF GROWTH

F9. To facilitate computing it is assumed that all conifers have the same pattern of growth as Sitka spruce and all broadleaves the same pattern of growth as beech.

CROPS IN CHECK

F10. A proportion of nearly all conifer plantations suffers a period of checked growth. Since much of the proposed planting would be on some of the more difficult upland sites, the allowances shown in Table F5 have been made.

TABLE F5

Planting Period	*Country*	*Percentage check allowed by species groups*
1948 and earlier	All	No check
After 1948	England and Wales	Broadleaves - None Conifers 10
	Scotland	Broadleaves - None Conifers 30

Notes: a. These proportions are the means for all Forestry Commission plantations as assessed in the course of Forest Inventory Surveys since 1960.

b. Checked crops have been placed in Yield Class 6 with a delay in first thinning of 20 years, and a 10 year delay in final felling.

NO THINNING

F11. A proportion of all conifer plantations is unlikely to be thinned during the rotation due either to poor access, expensive roading requiring the postponement of road construction or to the threat of windthrow on some site types.

The proportions used in the forecast are as follows:-

England	5%	
Wales	10%	
Scotland	planted 1976-2000,	20%
	planted 2001-2025,	30%

F12. These proportions are based upon Site Survey data collected by Field Surveys Branch for the Commission's 1977 Forecast of Production and an estimate of the areas of different site types likely to be planted in the 21st century.

OVERMATURE VOLUMES

F13. For all four regimes it is assumed that about half of the area of crops overmature at 1976 will be retained for environmental reasons and about half will be felled and replanted in equal annual coupes over a period of 50 years.

F14. In addition to this overmature stock, there are the volumes which will be available from hedgerow and park timber. The present stock from this source is estimated to be 30 million m^3. It is assumed that half of this stock, taken to be all broadleaved, will also be felled over the 75 years of the forecast period, yielding 200 thousand m^3 of sawlogs a year.

F15. Tables F6 to F9 include an allowance for overmature hedgerow and park timber.

SAWLOGS AND SMALLWOOD

F16. Sawlogs have been defined as follows:-

Conifers - material with a top diameter of 18 cm (OB) or more.

Broadleaves - material with a top diameter of 24 cm (OB) or more.

F17. Smallwood is other round material down to 7 cm (OB).

TABLE F6

FORECAST OF ANNUAL PRODUCTION - FORESTS, WOODLANDS AND HEDGEROWS

Rotations - Conifers PW 55 years FC 55 years
Broadleaves PW 100 years FC 100 years

Millions cubic metres

Planting Alternative	*Assortments*	*Broadleaves*			*Conifers*		
		2000	*2025*	*2050*	*2000*	*2025*	*2050*
1	Sawlogs	1.0	0.7	1.1	3.2	7.0	4.9
	Small wood	0.5	0.9	0.8	3.8	3.1	4.5
	Total	1.5	1.6	1.9	7.0	10.1	9.4
2	Sawlogs	1.0	0.8	1.2	3.2	9.3	9.1
	Small wood	0.5	0.9	0.8	3.8	4.7	6.6
	Total	1.5	1.7	2.0	7.0	14.0	15.7
3	Sawlogs	1.0	0.8	1.2	3.2	10.1	11.6
	Small wood	0.5	1.0	0.9	3.8	5.5	9.1
	Total	1.5	1.8	2.1	7.0	15.6	20.7

TABLE F7

FORECAST OF ANNUAL PRODUCTION - FORESTS, WOODLANDS AND HEDGEROWS

Rotations - Conifers PW 70 years FC 55 years
Broadleaves PW 150 years FC 100 years

Millions cubic metres

Planting Alternative	*Assortments*	*Broadleaves*			*Conifers*		
		2000	*2025*	*2050*	*2000*	*2025*	*2050*
1	Sawlogs	0.9	0.6	0.8	3.2	8.9	5.4
	Small wood	0.4	0.8	0.8	3.8	2.3	3.7
	Total	1.3	1.4	1.6	7.0	11.2	9.1
2	Sawlogs	0.9	0.7	0.9	3.2	10.0	10.2
	Small wood	0.4	0.8	0.8	3.8	3.9	6.0
	Total	1.3	1.5	1.7	7.0	13.9	16.2
3	Sawlogs	0.9	0.7	0.9	3.2	10.2	12.9
	Small wood	0.4	0.8	0.8	3.8	4.7	7.6
	Total	1.3	1.5	1.7	7.0	14.9	20.5

TABLE F8

FORECAST OF ANNUAL PRODUCTION - FORESTS, WOODLANDS AND HEDGEROWS

Rotations - Conifers PW 80 years FC 55 years[(a)]
Broadleaves PW 150 years FC 100 years

Millions cubic metres

Planting Alternative	*Assortments*	*Broadleaves*			*Conifers*		
		2000	*2025*	*2050*	*2000*	*2025*	*2050*
1	Sawlogs	0.9	0.6	0.8	3.2	7.3	6.1
	Small wood	0.4	0.8	0.8	3.8	1.9	4.2
	Total	1.3	1.4	1.6	7.0	9.2	10.3
2	Sawlogs	0.9	0.7	0.9	3.2	9.2	10.6
	Small wood	0.4	0.8	0.8	3.8	3.6	6.2
	Total	1.3	1.5	1.7	7.0	12.8	16.8
3	Sawlogs	0.9	0.7	0.9	3.2	9.7	12.8
	Small wood	0.4	0.8	0.8	3.8	4.4	7.6
	Total	1.3	1.5	1.7	7.0	14.1	20.4

Note: (a) Adopted as the Traditional Cutting Regime.

TABLE F9

FORECAST OF ANNUAL PRODUCTION - FORESTS, WOODLANDS AND HEDGEROWS

Rotations - Conifers PW 90 years FC 55 years
Broadleaves PW 150 years FC 100 years

Millions cubic metres

Planting Alternative	*Assortments*	*Broadleaves*			*Conifers*		
		2000	*2025*	*2050*	*2000*	*2025*	*2050*
1	Sawlogs	0.9	0.6	0.8	3.2	6.7	6.1
	Small wood	0.4	0.8	0.8	3.8	1.8	4.2
	Total	1.3	1.4	1.6	7.0	8.5	10.3
2	Sawlogs	0.9	0.7	0.9	3.2	8.2	9.8
	Small wood	0.4	0.8	0.8	3.8	3.2	5.7
	Total	1.3	1.5	1.7	7.0	11.4	15.5
3	Sawlogs	0.9	0.7	0.9	3.2	8.9	12.6
	Small wood	0.4	0.8	0.8	3.8	4.1	7.5
	Total	1.3	1.5	1.7	7.0	13.0	20.1

SUSTAINED YIELD

F18. For comparative purposes, Table F10 shows the expected sustained level of production from the same total forest areas as used in each of the alternative rates of afforestation but assuming an equal distribution of age classes.

TABLE F10

Millions cubic metres

Alternative Planting Rates	*Broadleaves*			*Conifers*		
	Sawlogs	*Small wood*	*Total*	*Sawlogs*	*Small wood*	*Total*
1	1.6	0.7	2.3	3.8	8.3	12.1
2	1.7	0.9	2.6	6.6	15.5	22.1
3	1.3	1.7	3.0	8.2	19.0	27.2
3[(a)]	1.5	2.0	3.5	9.5	24.5	34.0

Note: (a) If Alternative 3 is extended to an area of 2.35 million hectares by 2050, then the sustained yield will be that shown on the fourth line.

F19. In practical terms, the soonest that an equal distribution of age classes might be achieved is by the end of the 21st century.

APPENDIX G

LABOUR

FORECASTS OF LABOUR REQUIREMENTS IN FORESTRY

TRADITIONAL CUTTING REGIME

TABLE G1

Thousands man years

EMPLOYMENT AT 0% PRODUCTIVITY INCREASE

Manual Labour only			*Planting Levels*	*Including 10 per cent for supervision*		
1985	*2000*	*2025*		*1985*	*2000*	*2025*
17.3	23.1	30.2	Alternative 1	19.0	25.4	33.2
20.3	27.5	43.4	Alternative 2	22.3	30.2	47.7
21.5	30.0	50.7	Alternative 3	23.6	33.0	55.7

TABLE G2

EMPLOYMENT AT 2.5% PER ANNUM PRODUCTIVITY INCREASE

Manual Labour only			*Planting Levels*	*Including 10 per cent for supervision*		
1985	*2000*	*2025*		*1985*	*2000*	*2025*
13.5	12.5	8.8	Alternative 1	14.8	13.7	9.7
15.8	14.8	12.6	Alternative 2	17.4	16.3	13.9
16.8	16.2	14.8	Alternative 3	18.5	17.8	16.3

TABLE G3

EMPLOYMENT AT 4% PER ANNUM PRODUCTIVITY INCREASE

Manual Labour only			*Planting Levels*	*Including 10 per cent for supervision*		
1985	*2000*	*2025*		*1985*	*2000*	*2025*
11.7	8.7	4.3	Alternative 1	12.9	9.6	4.7
13.7	10.3	6.1	Alternative 2	15.1	11.3	6.7
14.5	11.3	7.1	Alternative 3	16.0	12.4	7.8

LABOUR PRODUCTIVITY ASSUMPTIONS

FORESTRY: MANUAL LABOUR

TABLE G4

Operation	*Unit*	*FC*	*Private Woodlands*	
Establishment	Man years per ha	0.072	New planting:	0.09
			Restocking:	0.11
Forest Protection and maintenance, road maintenance	Man years per ha per year	0.0021	0.0040	
Road construction incl.reconstruction	Man years per km	2.42	3.5	
Logging	Man years per 000 m^3 OB	1.75	2.1	

FORESTRY: SUPERVISORY LABOUR

An additional 10 per cent of manual labour man years has been added to allow for supervisory, clerical and other ancillary labour located in rural areas.

FOREST INDUSTRY: ALL LABOUR

TABLE G5

1974 Labour input:

Transport	*Sawmills*	*Other Mills*	*Total*
1500	6800	6500	14300

Of the 6500 employed in pulp and paper mills, etc., only one half is assumed for calculation purposes to be associated with processing of home grown wood. The implied labour productivities in 1974 were, in man years per thousand m^3 OB.

TABLE G6

Transport	*Pulp & Paper, Particle Board*	*All other Processing*	*Overall Average*
0.27	3.1	2.9	3.2

TABLE G7

REDUCTION IN EMPLOYMENT IN AGRICULTURE

		Man years	
	1975	*2000*	*2025*
Alternative 2	-	1000	700
Alternative 3	-	1400	1200

APPENDIX H

LAND PRICE AND ESTABLISHMENT COST

The figures quoted below refer to costs in Forestry Commission practice.

£ per ha (October 1976 prices)

TABLE H1

Conservancy	*Land price including cost of acquisition*[(a)]		*Cost of establishment*			
			excluding overheads[(b)]		*including overheads*[(c)]	
North West England	225		210		330	
North East England	145		255		395	
Average England		185		235		365
North Wales	200		225		355	
South Wales	200		345		535	
Average Wales		200		285		445
Broad Average England and Wales		190		260		405
North Scotland	135		255		385	
East Scotland	170		230		355	
South Scotland	245		170		255	
West Scotland	195		180		270	
Broad Average Scotland		185		210		315

Notes: (a) Acquisition cost of £25 per ha assumed.

(b) Forest cost.

(c) Including supervisory and administrative overheads and appropriate to consideration of total costs of large programme and in the more distant future.

APPENDIX J

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