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THE RELATIVE ECONOMICS OF FORESTRY AND AGRICULTURE
ON HILL LAND IN SCOTLAND

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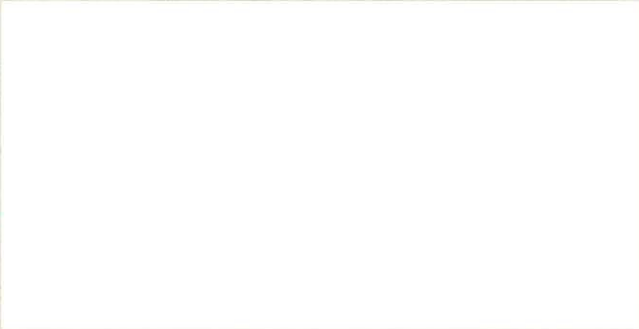


Preface

This thesis is written in fulfillment of the requirements for the degree of Master of Science, in the Faculty of Science of the University of Edinburgh. It is the outcome of two years study in the Department of Forestry and Natural Resources. The first year was spent studying agriculture and economics and the second was occupied by work specifically on the thesis project.

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PART ONE

Introductory

PART IChapter IAgriculture and Forestry in the British EconomyProduction

GROSS NATIONAL PRODUCT (GNP)

The Standard Industrial Classification (1958), used in compiling the annual 'Blue Book' of national income and expenditure, includes in one class agriculture, forestry and fishing^I. The Blue Book gives statistics for the class as a whole. Therefore, it is necessary to estimate the extent to which each of the three component industries contributes to the economic importance of their class. From figures for 1963 given in the Ellison Report (HMSO, 1966) it appears that, currently in the United Kingdom, agriculture accounts for approximately 92.6 per cent and forestry for approximately 2.6 per cent of the proportion of GNP (at factor cost) directly attributable to agriculture, forestry and fishing.

I Hereafter referred to as the 'agricultural sector'

In 1965 the national income amounted to £28,279 millions and the GNP to £30,904m (HMSO, 1966b). Agriculture forestry and fishing together directly contributed £1,056m or 3.5 per cent of the GNP. Assuming the proportions given above, then of the £1,056m provided in 1965 by the agricultural sector, agriculture itself contributed £978m and forestry £27m. That is, in 1965 agriculture provided 3.2 per cent and forestry rather less than ~~0.1~~ per cent of the total GNP of the United Kingdom. The contributions of agriculture and forestry per person employed in 1965 were approximately £1,200 and £1,300 respectively; the average for the whole economy in that year was £1,300.

The proportionate contribution of the agricultural sector to GNP is less in the United Kingdom than in any other country (McCrone, 1962). This is a reflection of the overriding importance of the manufacturing industries in the British economy and is a long-term result of Britain being first to undergo an industrial revolution. Nevertheless, the contribution of agriculture and forestry together (£1,005m in 1965) is more than a tenth that of the manufacturing industries (£10,805m in 1965). It must be noted, however, that the contribution of forestry alone is only one four-hundredth that of manufacturing and a thirty-sixth that of agriculture.

The relative contribution of the agricultural sector in Britain is declining. In 1955 these industries contributed 4.6 per cent, in 1960 4.0 per cent and in 1965 3.4 per cent of

the total GNP. In absolute terms, the contribution of the agricultural sector grows annually and the decline in its importance is due to the relatively faster growth of other industries, of, for example, manufacturing, construction and various service industries. In 1955, agriculture, forestry and fishing were seventh in order of magnitude out of the fifteen industrial classes in the GNP table; in 1965 they were ninth.

AGRICULTURAL PRODUCTION

The United Kingdom currently produces two thirds of that part of its food requirements which it is possible to produce in a temperate climate. It is self-sufficient, or nearly so, in milk, eggs and potatoes. The present level of self-sufficiency exceeds that obtaining at any time since the war years. Table I is a brief summary of the physical production from UK agriculture and compares 1963-64 production with the pre-war average.

In the year 1965 to 1966, the financial gross output of UK agriculture was £1,849.1m (including subsidies). Table 2 shows how this sum was made up. It can be seen from this table that Britain's agriculture is based on livestock; more than two thirds of aggregate farm income is derived from the sale of animals or their products. Fatstock production alone accounts for about 30 per cent of gross output and economically is Britain's main agricultural activity.

Table 1AGRICULTURAL PRODUCTION IN THE UK

<u>Produce</u>	<u>Units</u>	A	B
		<u>Pre-war Average</u>	<u>1963 to 1964</u>
Crops	I,000 tons	9,717	18,490
Livestock products:			
Milk	m gallons	I,566	2,509
Eggs	m dozen	558	I,132
Meat	I,000 tons	I,242	I,983

(Source: HMSO, 1965a)

Table 2GROSS OUTPUT OF UK AGRICULTURE 1965-66

	<u>£ Millions</u>
Crops	348.4
Livestock and livestock products	I,265.5
Fruit, vegetables and flowers	I78.7
Value of physical change in growing crops and livestock	+ 25.5
<hr/> Total <hr/>	<hr/> I,849.1 <hr/>

(Source: HMSO, 1966c)

Aggregate farm expenses currently amount to about £1,430m annually, leaving a net farm income of approximately £420m or £1,200 per farmer per annum.

FORESTRY PRODUCTION

Information on production from forestry in Britain is not available in the same detail as is that on agricultural production. Table 3 shows, for the years 1961 to 1963, the average annual UK production, in physical terms, of the chief categories of wood and wood products and the extent to which this production met home demand.

British timber production will increase substantially in future but, because of parallel increase in consumption, it is estimated that, in the year 2000, it will meet no more than 15 per cent of demand. By then, softwood production should have risen to 265m hoppus feet per year, which would represent an increase of 400 per cent over the 1965 level; annual hardwood production is expected to remain constant (HMSO, 1966). Table 4 shows how the annual output of timber in Great Britain is expected to grow during the decade 1970 to 1980.

The aggregate gross return to British forestry is currently of the order of £50m per year. This can be expected to rise at a rate faster than that for physical production, because of price increases due to world shortage of timber supply.

Table 3UK PRODUCTION OF WOOD AND WOOD PRODUCTS 1961 TO 1963Annual Averages for 1961-63

<u>Type of Produce</u>	A	B
	<u>Home Production (m hoppus feet over-bark equivalent)</u>	<u>Home Production as Percentage of Home Consumption</u>
Sawnwood and its products	66	12
Pulp and paper products	11	2
Panel products	4	6
Miscellaneous	22	50
<hr/>		
Total	103	9
<hr/>		

(Source: HMSO, 1966)

Table 4ESTIMATED FUTURE TIMBER PRODUCTION IN GREAT BRITAIN

	<u>Annual Output in M Hoppus Feet Over Bark</u>		
	A	B	C
	<u>1970</u>	<u>1975</u>	<u>1980</u>
Softwoods:			
Total ^I	70	88	135
Sawlogs (FC)	7.6	12.5	20.8
Sawlogs (private)	15.0	16.6	18.0
Small roundwood	43.1	59.1	76.0
Hardwoods:			
Total	45.4	45.1	45.3
FC production	2.2	1.9	2.1
Private production	43.2	43.2	43.2

(Source: HMSO, 1966)

I Figures for total softwood production in 1970 and 1980 are more recent estimates than, and do not correspond with, figures for production of the various softwood categories in those years

Consumption

AGRICULTURAL PRODUCTS

Over one quarter of the total UK consumers' expenditure goes on food. Table 5 shows the values of expenditure on different types of food (except fish) in 1965. Comparable figures for inedible agricultural products cannot be given because they are consumed largely in the form of manufactured goods.

The demand for food is related to numerous factors, of which the most important economically is real income per head. The income elasticity of demand for food in general is low in the developed countries; that for 'quality foods' (horticultural and livestock products) exceeds that for starchy foods. Between 1955 and 1965, real expenditure on fruit in the UK increased by 20 per cent while that on bread and cereals decreased by one per cent. Wibberley (1964) quotes figures of 0.16 per cent and 0.14 per cent for the income elasticities of demand for livestock and crop products respectively in Britain. A considerably higher estimate, of 0.3 per cent, was made in 1955 of the income elasticity of demand for food (Nash, 1959). Although this last figure was probably an overestimate, it is certainly true that the income elasticity of demand for food has declined markedly since the early 1950's, when the pattern of food consumption was recovering from the effects of rationing.

Table 5UK CONSUMERS' EXPENDITURE ON FOOD^I IN 1965

	<u>£ Millions</u>
<u>Household expenditure:</u>	
Bread and cereals	677
Meat and bacon	1,387
Oils and fats	249
Sugar, preserves, confectionary	492
Dairy produce	791
Fruit	307
Potatoes and vegetables	553
Beverages	309
Other manufactured food	156
	<hr/>
Total household expenditure	4,921
	<hr/>
Other personal expenditure	653
	<hr/>
Total	5,574
	<hr/>

Expenditure on food^I as a percentage
of total consumers' expenditure = 24.6

(Source: HMSO, 1966^b)

I Household expenditure on fish (£191m) is excluded as being on non-agricultural produce; some of the items listed, however, will include fish or fish products

Although the income elasticity of demand for food in Britain will presumably decline further in the future, the rising income per head can be expected to lead to increased expenditure on food, largely through the greater purchase of quality foods. The significance of food price changes can be expected to diminish.

FOREST PRODUCTS

Total UK expenditure on timber and its products amounts annually to about £600m. Table 6 shows the proportions, by volume, of the main categories of consumption.

By 1975, UK consumption of timber is expected to have increased by 50 per cent and by the year 2000 by 100 per cent over the 1960 level of 1,100m hoppus feet roundwood equivalent. These estimates, made in the Ellison Report, are intended to take into account both substitution of and new uses for wood. Expansion of demand is likely to occur largely through greater consumption of wood for industrial purposes, that is for conversion into non-timber materials such as paper and board. The Ellison Report quotes the figure of 1.55 for the current income elasticity of demand for paper and all board, although this value is expected to fall below unity by the year 2000.

Table 6UK CONSUMPTION OF WOOD AND WOOD PRODUCTS 1961-63

<u>Category</u>	<u>Average Annual Consumption</u>	
	A	B
	<u>Volume (m hoppus feet over-bark equivalent)</u>	<u>Percentage of Total</u>
Sawnwood and its products	537	47
Pulp and paper products	469	42
Panel products	64	6
Miscellaneous	56	5
<hr/> Total	<hr/> 1,126	<hr/> 100

(Source: HMSO, 1966)

Interdependencies

The importance of agriculture and forestry in the British economy depends not only on their size in the terms in which they have been discussed so far but also on the interdependencies between the agricultural and other sectors. The summary input-output transactions matrix, given annually in the Blue Book, shows, inter alia, how much of the output of each industry is sold as intermediate output to other industries.

Table 7 is extracted from the 1966 Blue Book and shows the values of transactions between the agricultural sector and other industries in 1963. Figures are not available for transactions between the component industries of the agricultural sector; as regards forestry and agriculture, in terms of cash flow the net direction of such transactions would be from agriculture to forestry.

The figures given in the summary input-output transactions matrix go only so far towards measuring the interdependencies between the various industrial classes. They do not throw any light on the more complex kind of interdependencies which show up as repercussions in one industry in response to changes in another, perhaps apparently unconnected, sector of the economy. It is not possible to say, for example, to what extent the level of purchases by the manufacturing industries from the construction industries may be affected by a change in the demand of the agricultural sector for farm implements. Interdependencies permeate the whole economy and it is not easy to trace them beyond the level represented in Table 7.

It is possible to make some estimate of the spillover effects of agriculture operating through the food, drink and tobacco industries. In 1963, the latter group made purchases from other industries of roughly £2,000m, of which £571m went to the agricultural sector and £605m on imports; the remainder, approximately £820m, was distributed between various other British industries. At a conservative estimate, perhaps half

Table 7TRANSACTIONS BETWEEN AGRICULTURAL AND OTHER SECTORS IN 1963

<u>Industries with which transactions carried out</u>	<u>£ Millions</u>	
	<u>A</u> <u>Purchases by</u> <u>Agricultural</u> <u>Sector</u>	<u>B</u> <u>Sales by</u> <u>Agricultural</u> <u>Sector</u>
Coal mining	I	5
Food, drink and tobacco	315	571
Mineral oil refining	20	-
Other chemicals and allied industries	91	-
Engineering and allied industries	36	-
Textiles, leather and clothing	4	28
Other manufacturing	61	9
Construction	30	-
Gas, electricity and water	16	-
Services	250	-
Total	824	613

(Source: HMSO, 1966^b)

of this £820m was associated with food which was home-produced; imported food and drink require relatively fewer ancillary purchases at home because of the tendency towards pre-export preparation for retailing, while home purchases necessary for the preparation of tobacco are also slight. This means that, in 1963, UK agriculture and fishing (forestry obviously may be excluded) were responsible, through the food, drink and tobacco sector, for sales by other British industries of more than £400m.

Interdependencies between forestry and other industries are likely to be more numerous and therefore more complex than those associated than agriculture. Food production lacks the strong forward linkage with other industries by which forestry is characterised. No attempt is made to trace forestry spillovers except to say that, at the simplest level, they are with industries such as construction, saw-milling and paper-making, in a forward direction, and with various manufacturing industries in a backward direction.

Because they are both essentially users of land, agriculture and forestry are particularly liable to have associated with them spillover effects of a technological nature. The two land-uses are themselves largely incompatible and expansion of the one commonly occurs only at cost to the other. Important technological interdependencies exist between both forestry and agriculture, on the one hand, and alternative land-uses on the other, such as urban development, water conservation, outdoor recreation and sport.

Imports and Exports

AGRICULTURAL PRODUCTS

The UK currently imports just under 50 per cent by value of its food requirements. A study made by the Agricultural Economics Research Institute at Oxford (US Department of Agriculture, 1962) forecasts that, by 1975, the proportion imported will be down to 44 per cent. At present, food accounts for more than a quarter of Britain's total expenditure on imports. Britain exports or re-exports a certain quantity of food, which amounts by value to rather less than 6 per cent of total exports.

Imports from non-sterling, hard-currency areas are those most detrimental to the UK's balance of payments. Wheat is the only major dollar-loser, nearly 60 per cent (HMSO, 1965a) of requirements being imported, mostly from the dollar area. Substantial imports of meat and coarse grain are necessary but are made largely from soft-currency countries which demand relatively valuable British exports in exchange. Blagburn (1950) therefore considers that, in order to make the most of its exportable products, Britain should strive to reduce imports from soft- as much as from hard-currency nations. The question arises, of course, as to whether British exports would be acceptable in, say, the Argentine or the USSR, if not balanced by food imports.

Table 8 shows the values of UK imports and exports of food (except fish) in 1965. As regards overseas trade in non-edible agricultural products in that year, imports amounted to about £700m and exports to just over £500m. Imports of raw wool cost £131.5m and exports of British wool realised £11.5m.

Imports of goods and services made in 1965 by the British agricultural sector totalled £157m. The bulk of this sum, it may be presumed, is attributable to agriculture and includes the £75.8m spent on imported animal feed and shown in Table 8. Imports of agricultural tractors and equipment amounted to rather less than £14m while exports of these came to approximately £130m. The incentive for this export trade in British farm machinery undoubtedly may be traced to the highly mechanised home agricultural industry.

FOREST PRODUCTS

The United Kingdom currently imports more than 90 per cent, by value, of its requirements of wood and wood products; since 1960, these imports have exceeded £400m annually. In recent years, the relatively highly valued pulp and paper products, which account for 90 per cent of Britain's exports of wood products, have made foreign exchange earnings averaging only £45m. Table 9 shows the values of UK imports and exports of wood and wood products in 1965.

The forestry and wood-using industries in Britain are

Table 8

UK FOOD IMPORTS AND EXPORTS IN 1965^I

	<u>£ Millions</u>	
	<u>A</u>	<u>B</u>
	<u>Imports</u>	<u>Exports</u>
Live animals	47.7	36.9
Meat and meat preparations	367.8	10.0
Dairy produce and eggs	208.3	10.6
Cereals and cereal preparations	231.9	21.9
Fruit and vegetables	289.2	11.3
Sugar, sugar preparations and honey	102.8	23.8
coffee, tea, cocoa and spices, and manufactures thereof	155.8	13.1
Miscellaneous food preparations	26.5	11.0
Beverages	52.7	123.2
Feeding stuffs for animals (excluding unmilled cereals)	75.8	5.9
Total	1,558.5	267.7
Food imports/exports as percentage of total imports/exports:	27.0	5.7

(Source: HMSO, 1966^c)

I Fish and fish products excluded as far as possible

responsible for substantial imports of machinery and equipment. The expansion of forest industries at home can be expected to stimulate, to some extent, increased production of such equipment by British firms.

Table 9

WOOD AND WOOD PRODUCTS:

VALUES OF UK IMPORTS AND EXPORTS IN 1965

	<u>£ Millions</u>
<u>Imports</u>	A
Wood, lumber and cork	220.3
Pulp and waste paper	139.6
Wood and cork manufactures (excluding furniture)	69.5
Paper, paperboard and manufactures thereof	123.0

Total imports	552.4

Imports as a percentage of total imported goods and services = 9.6	
<u>Exports</u>	B
Wood and cork manufactures	5.8
Paper, paperboard and manufactures thereof (not furniture)	50.5

Total exports	56.3

Exports as a percentage of total exported goods and services = 1.2	

(Source: HMSO, 1966^c)

Land Area

AGRICULTURE

Agriculture in the UK occupies approximately 49 million acres or 82 per cent of the total land area. More than one third of the agricultural area is rough grazing and is largely hill land.

The lowland agricultural area declines annually through loss of land to other land-uses, notably urban development. Table 10 shows this reduction in area for the decade 1955 to 1965 and also serves to illustrate the post-war swing from permanent grassland to the more capital-intensive arable farming.

Table 10

LAND AREAS UNDER ARABLE FARMING AND PERMANENT GRASSLAND
IN THE UK 1955 TO 1965

	<u>M Acres</u>		
	A	B	C
	<u>1955</u>	<u>1960</u>	<u>1965</u>
Arable	17.54	18.05	18.52
Permanent grass	13.53	12.81	12.14
Total	31.07	30.86	30.66

(Source: HMSO, 1966c)

The figures in Table 10 suggest a loss of land from agriculture to other uses of 414,000 acres in 10 years. Best (1959) forecasts that transfer of land from agricultural to urban use, during the decade 1960 to 1970, will be of the order of 450,000 acres in Great Britain alone; the National Plan (HMSO, 1965^b) states that, in the UK as a whole, the annual release of agricultural land for building is between 50,000 and 60,000 acres.

From the point of view of agriculture, the loss of land is more serious than may be inferred merely from the acreages quoted above: Wibberley (1959) considers that the average agricultural productivity of land used for urban development is at least 70 per cent above that of all enclosed farmland.

The area of rough grazing in Britain appears to have remained fairly constant, although past estimates tend to be somewhat unreliable because of imprecise classification. A recent figure for the total area of rough grazing in the UK is 17,830,000 acres (HMSO, 1966^c). About one million acres of this area is Scottish deer forest, some of which may get little or no agricultural use.

Hill land, too, poses problems of definition, as mentioned by Moisleley (1964). A number of different estimates have been made of the area of British hill land and Robson (1965) quotes figures ranging from less than 14 million to more than 18 million acres. The most recent figure, adopted by the Ellison Report, for the area of hill land under agriculture in Great Britain is

15.5 million acres, of which 11 million acres is said to be used for hill sheep farming and the remaining 4.5 million acres for upland stock-rearing. The Zuckermann Report (HMSO, 1957) states the view that about 3.25 million acres of British hill land is agriculturally improvable. In conclusion, it may be pointed out that, whatever may be the precise area of British agricultural hill land, it is apparent that the hills and uplands account for about one third of the total area of farmland in Great Britain.

FORESTRY

The total area of productive forest in Great Britain increases annually and is currently rather less than 6 per cent of the total land area. In 1964, 3.25 million acres of land was under productive forest (HMSO, 1966); 1.5 million acres was in Forestry Commission management and the rest was privately owned. A further one million acres of scrub and felled woodland may be included, nine tenths of which is in private ownership.

Only part of the total acreage held by the Forestry Commission is presently planted or potentially plantable. Of the Commission's total land holding, in 1965, of 2.7 million acres, 0.8 million acres was, for one reason or another, neither planted nor scheduled for planting (HMSO, 1966a).

The Commission's programme is that, in the ten years 1964 to 1973, they should afforest 450,000 acres. In the years 1963

to 1965, new planting by the Forestry Commission amounted to, on average, 42,000 acres per year, so falling short of the planned annual average by 3,000 acres. In the past, actual Commission planting has generally been less than that forecast. With the plantable land they already have in hand, the Commission need acquire only a relatively small further acreage for their current planting target. If, as is to be expected, the Commission are to embark on a new planting programme of comparable magnitude after 1974, their rate of land acquisition will have to be stepped up; in the years 1963 to 1965, their average annual acquisition of bare plantable land was only 20,000 acres. As is mentioned later, in Chapter 2, the acquisition of land by the Forestry Commission has proved increasingly difficult in England and Wales although, in the last year or two, the recession in hill sheep farming has greatly facilitated the acquisition of large blocks of hill land in Scotland.

Private planting in Great Britain, in the years 1963 to 1965, averaged approximately 33,000 acres per year. This figure includes both new afforestation and also the replanting of felled and derelict woodland. The Ellison Report states that new planting on private land has been at a rate of between 15,000 and 20,000 acres per year, in recent years.

Private land-owners are, in general, reluctant to invest in forestry. The 'Economist' Intelligence Unit (1957) attributes their reluctance to the absence of a sheltered home market and to the fact that labour accounts for a high proportion (up to 70 per

cent) of forestry costs. The Unit says that, although there is no lack of outlets for home-grown timber, private growers are doubtful of their chances of securing a foothold in the market; their doubts are said to stem from their failure to cooperate with each other in management and marketing, in contrast to their counterparts in, say, Scandinavia.

Employment

Agriculture in the UK occupies about 820,000 and forestry about 22,000 people; the total number in all civil employment is rather more than 25 million. The numbers employed in both forestry and agriculture are declining steadily. Table II shows the numbers of employees occupied in each of the two industries in the UK in 1960 and 1965 respectively.

The number of farmers in Britain (357,000 in 1965) is large in relation to the annual aggregate net farm income and to the total area of agricultural land. On average, there is one farmer to every 140 acres of farmland (including rough grazings) and to every £1,200 net farm income. Nash (1958) stresses that the amalgamation of farms, resulting in fewer farmers, is the most necessary step towards raising farmers' incomes and so reducing their reliance on government support. It is obvious that, the fewer farmers there are, the greater will be each one's share of the aggregate farm income, provided, of course, that this

Table II

EMPLOYEES IN AGRICULTURE AND FORESTRY
IN THE UK IN 1960 AND 1965

	A	B
	<u>Agriculture</u>	<u>Forestry</u>
Employees 1960	598,000	24,000
Employees 1965	463,000	22,000
Percentage fall in employment 1960-65	23	8
Average annual fall in employment	27,000	400

(Source: HMSO, 1966c)

does not diminish proportionately. There is no doubt that there are many small farms in Britain which could be incorporated into larger units, with no loss and almost certainly a gain in production in both physical and financial terms.

In 1965, the government introduced measures to encourage small farmers to discontinue farming and so facilitate small farm amalgamation (HMSO, 1965c). These measures have so far evoked little, if any, response from the farmers at whom they are aimed. It is a characteristic of the agricultural community that its members are generally reluctant to stop farming even when to do so would pay them and to continue can bring only a minimal return, and that mostly in the form of government support.

Government Support

AGRICULTURE

The scale and pattern of agricultural production in the UK are to a great extent dependent upon government support. This support consists mainly of Exchequer subsidies and grants on production and on farm improvement, of price guarantees and of tariffs against imports. Of these three measures, the first two, that is the Exchequer support element, are the most important, together currently totalling about £250m annually; only a few small tariffs are maintained. Three quarters of the £250m Exchequer support is received by farmers in price guarantees, just under a quarter as grants and subsidies and about 2 per cent is spent on the research and advisory services.

Government support is also administered indirectly through the government-approved, monopolistic marketing boards which wholesale certain agricultural products. Each board obtains for the product with which it is concerned a price almost certainly above that which would apply under free market conditions. Producers' marketing organisations have been set up for milk, eggs, potatoes, sugar beet and wool.

The British system of agricultural support is distinguished from those of other developed countries by the magnitude of the Exchequer support element and its pre-eminence over the tariff control of imports. The intention in Britain is that,

in general, a laissez-faire price mechanism should operate for agricultural produce and that farmers should be compensated out of fiscal revenue for the resulting low price levels. From the consumer's point of view, the British approach to agricultural support constitutes a 'cheap food' policy which, it may be argued, is of considerable social benefit.

The situation is markedly different in, say, most other European countries, where the retail prices of most foodstuffs (milk is an important exception) are significantly higher than the equivalent British prices and more of the cost of food production is met directly by consumers at the retail level; tariffs are widely used to raise the retail price of imported food. Exchequer support amounts generally to much less than it does in Britain, in relation to national agricultural output and employment.

The magnitude of agricultural support in Britain is difficult to assess precisely, because a considerable part of the support is not itself directly measurable. Nash (1962) calculates that, in the year 1957/58, government support, excluding grants and subsidies, amounted to £370m. The Ministry of Agriculture (HMSO, 1965^a) state that, in recent years, the annual level of support has been at about £300m, while Houston (1963) says that it approached £350m in the year 1961/62. In a more comprehensive assessment of government support for agriculture, McCrone (1962) arrives at a figure, for the year 1960/61, of between £400m and £430m which, as McCrone points out, exceeds the aggregate net farm income for that year.

The level of support has almost certainly diminished somewhat since the early 1960's, while the net farm income has risen. It is probable that the two are currently about equal. This would mean that government support for British agriculture is roughly equivalent to £16 per head of the total working population, £500 per head of the agricultural population and £1,200 per farmer.

FORESTRY

Government support for forestry, unlike that for agriculture, is available only to the private sector of the industry. The non-private sector of the agricultural industry is so small as to be negligible; British forestry, however, is increasingly dominated by the state-run Forestry Commission and it seems anomalous that this sector of the industry should be excluded from the government support programme. Support for private forestry is provided both directly, through the Commission's various grant schemes and indirectly, through fiscal relief for forestry enterprises.

In the three years 1963 to 1965, the total direct support, administered by the Forestry Commission, averaged approximately £1.5m per year (HMSO, 1964, 1965, 1966a). Grants under the dedication scheme, towards the costs of planting and management, accounted for nearly 70 per cent of this figure and planting grants for approved woodlands and small woods respectively accounted for about 6 per cent each; the remainder was spent on

the Commission's advisory services.

The government's policy of generous taxation relief on woodlands is a strong incentive to private land-owners to invest in forestry. Tax relief tends to encourage the mere ownership of woodlands rather than their management in a way which, in the absence of special fiscal measures, would be especially profitable. This means that, while woodland kept for the purpose of taxation relief may be profitable to its owner, in the sense that it reduces costs, it does not necessarily follow that it is of as much benefit from the national point of view. The grant schemes for private forestry supplement fiscal relief and help to foster among private owners a more positively commercial attitude towards forestry instead of the intention simply to minimise tax liability.

The Forestry Commission, as a state organisation, pay no tax and their freedom from taxation may be claimed to constitute an indirect measure of support not available to private owners. The Commission, however, unlike private owners in receipt of grants, theoretically are meant to repay the Treasury grant, upon which they operate, at the Treasury borrowing rate of interest. Moreover, private owners, by appropriate manipulation of the bases upon which their woods are assessed, can reduce their tax liability on forestry assets to virtually nil.

The government support programme for forestry conspicuously lacks any measures to shelter the market; neither market nor price is guaranteed for home-produced timber. Such

measures are ruled out by Britain's low degree of self-sufficiency in forest products.

Chapter 2The Importance of Hill Land
to Agriculture and ForestryAgriculture

Hill land is used for the production of livestock, mainly sheep; some dairying is done in the hills and there is also a small output of crops for stock feed. Typically, hill farming is extensive and is characterised by low stocking rates, low inputs and low outputs.

Commonly included in hill farming statistics are the upland, marginal farms. These are principally livestock-rearing or dairy units on improved hill land at elevations up to about 1,200 feet. Although the marginal farms qualify for hill subsidies, they are much more intensively managed and stocked than, and are distinct from, the traditional type of hill farm. They produce both store and fat animals, while the true hill farms currently supply only the store market. The upland marginal farms represent the intensive margin and the traditional hill farms the extensive margin of agricultural use under present economic conditions.

This study is concerned not with upland stock-rearing farms but with traditionally farmed hill land. However, in

assessing the importance of hill land to agriculture, it is not possible to obtain information referring to hill land but excluding upland marginal farms.

The Ellison Report (HMSO, 1966) accepts that the contribution of the hills to agricultural gross output is about 4 per cent. This is based on an estimate made by Davidson and Wibberley (1956) and agrees closely with the figure of 3.4 per cent advanced by Robson (1965). Nash (1957) arrives at a figure of 7.5 per cent. As both Nash's calculation and that of Davidson and Wibberley refer to the early 1950's, they are not relevant to the present day except in so far as they suggest that the proportionate contribution of hill agriculture has declined during the last fifteen years. This is not surprising in view of the rapid rate of increase in productivity in the agricultural industry as a whole. Except for the marked expansion in production from upland marginal farms, this increased agricultural productivity has been a feature largely of low ground rather than hill agriculture.

The decline in the agricultural importance of the hills is adequately illustrated by figures for sheep production: Robson calculates that, in 1961, 24.6 per cent of the total sheep slaughtered in the UK came from the hills and uplands; this compares with an estimate of 32 to 49 per cent made by Davidson and Wibberley for the years 1951 to 1953.

Because hill farms produce predominantly store stock, the proportionate value of their output is less than its proportionate size in physical terms. For example, by value only 15.8 per

cent (compared with 24.6 per cent by number) of the 1961 UK sheep output came from the hills. Table 12, below, shows the output of the hills and uplands in 1961, compared with that of the agricultural industry as a whole in the same year:

Table 12

AGRICULTURAL OUTPUT OF HILLS AND UPLANDS
COMPARED WITH UK TOTAL AGRICULTURAL PRODUCTION IN 1961

	<u>Output in £ Millions</u>		
	<u>A</u>	<u>B</u>	<u>C</u>
	<u>Hills and Uplands</u>	<u>UK Total</u>	<u>A as Percentage of B</u>
Sheep	14.1	88.7	15.8
Cattle	19.6	232.7	8.4
Milk	6.9	364.8	1.9
Wool	4.9	17.1	28.8
Other	10.0	907.2	1.1
<hr/> Gross output	<hr/> 55.5	<hr/> 1,610.5	<hr/> 3.4

(Source: Robson, 1965)

Exchequer support for hill farming in 1961 amounted to 44 per cent of gross output, compared with 20 per cent for agriculture as a whole.

In physical terms, the hills and uplands currently produce approximately 25 per cent of the total sheep and 9 per

cent of the total beef slaughtered as well as 20 per cent of the total wool produced in the UK. Robson shows that, if hill and upland farming were to cease, the lowland sheep flock could produce 80 per cent of the present number of sheep slaughtered and 90 per cent of the present wool clip; a further 310,000 acres of average low ground would be enough to make up the 9 per cent loss in beef production.

The number employed in hill farming is disproportionately high in relation to its gross output. Robson estimates that agriculture in the hills occupies about 12 per cent of the total farmers and about 6 per cent of the total farm workers in the UK. This means that gross outputs per man employed and per farmer are about one third those for agriculture as a whole.

Forestry

It is not possible to make a meaningful calculation of the economic significance of hill land to British forestry. The Forestry Commission's land is largely, but by no means exclusively, in hill areas, while private forestry is practised on both hill and low ground but mostly on the latter. The reasons for this are partly historical and partly that the Commission favour large blocks of forest while much private forest consists of woodlands only a few acres in extent. The acquisition of large blocks of land for forestry is normally practicable only in the hills, where land values are low and

agricultural opposition less strong. Private woodlands are often a feature of lowland agricultural estates, where small woods may serve other purposes besides the production of timber.

Table I3, below, shows the distribution of state forest and dedicated and approved private woodland between England, Scotland and Wales. There is, of course, a preponderance of hill land in Scotland and Wales but not in England. It is noteworthy that half of the Commission's forest land is in Scotland alone while over half the private woodland is in England. There is no reason to suppose that the inclusion in Table I3 of that private woodland which is neither dedicated nor approved would significantly affect the overall picture.

Table I3

PRIVATE AND STATE FOREST IN GREAT BRITAIN

(as at 30th September 1964)

	<u>Forestry Commission Forest Land</u>		<u>Dedicated and Approved Private Woodland</u>	
	A	B	C	D
	<u>Acreage Planted and Plantable</u>	<u>Percentage of FC Total</u>	<u>Acreage in Both Schemes</u>	<u>Percentage of Private Total</u>
England	623,099	33	561,628	57
Scotland	912,274	49	372,934	37
Wales	324,125	18	55,757	6
Total	1,859,498		990,319	

(Source: HMSO, 1966a)

Of greater importance than the present status quo is the outlook for the future. In recent years, state acquisition of land for forestry in England and Wales has proved increasingly difficult and the Scottish conservancies, especially in the Highland counties, are viewed by the Commission as being their main area for expansion. From 1969 onwards, the Commission's planting programme in Scotland is to be increased by 20 per cent (HMSO, 1966a), presumably to offset acquisition difficulties elsewhere. Table I4 shows the acreages of bare plantable land acquired in Great Britain by the Forestry Commission during the period 1963 to 1965. It can be seen from this table that in that period Scotland and Wales together accounted for four fifths of the Commission's total acquisition of bare plantable land.

Table I4

FORESTRY COMMISSION ACQUISITIONS OF
BARE PLANTABLE LAND 1963 TO 1965

	A	B
	<u>Acreage</u>	<u>Percentage</u>
England	11,539	19
Scotland	34,002	57
Wales	14,122	24
<hr/>		
Total	59,663	
<hr/>		

(Source: HMSO, 1964, 1965, 1966a)

In recent years, new planting, both private and Commission, has been mainly on the hill land of Scotland and Wales. Table I5 shows the distribution of new planting between the three countries during the period 1963 to 1965:

Table I5

AFFORESTATION IN GREAT BRITAIN 1963 TO 1965

	<u>Private Planting</u>		<u>FC Planting</u>		<u>Total Planting</u>	
	A	B	C	D	E	F
	<u>Acres</u>	<u>Per Cent</u>	<u>Acres</u>	<u>Per Cent</u>	<u>Acres</u>	<u>Per Cent</u>
England	46,817	47	20,512	16	67,329	30
Scotland	42,133	43	83,211	66	125,344	56
Wales	9,646	10	22,682	18	32,328	14
Total	98,596		126,405		225,001	

(Source: HMSO, 1964, 1965, 1966a)

British forestry is concerned largely with coniferous species. While, like any other species, these grow faster on low, fertile ground in, say, the south of Britain than on hill land in the north, the better quality timber is produced under the more rigorous conditions. To date, quality in home-produced softwood timber has earned little reward from buyers. In the absence of price differentials, growers, especially private growers, have tended to aim for quantity and cost-minimisation rather than for quality. The sheer volume of home-produced

softwood which will be on the market in the next few decades is likely to change this situation. It seems certain that, in the near future, the quality of stands will be matched by the prices obtained for their produce. Therefore, generally speaking, prices for coniferous timber from the hills can be expected to exceed those for softwood timber from low ground.

At present, stumpage values in some hill areas are reduced by transport costs higher than those obtaining in lowland areas. This differential is likely to cease as the future scale of hill forestry not only spreads these costs more thinly but reduces them by attracting the proximal establishment of wood-processing industries.

The importance of hill land to present and, presumably, to future planting is adequately illustrated by Table 15, which shows that, in the period 1963 to 1965, only 30 per cent of total British planting was done in England. It is significant that not only state afforestation but also private planting is now done mostly in Scotland and Wales: the figures in Column B of Table 15 form an interesting comparison with those in Column D of Table 13.

Conclusion

It has been shown that, in terms of production, hill land is of little importance to agriculture in Britain while,

in terms of area, it is of very considerable importance to forestry. However, it is production, not land area, which is of economic significance. On the evidence presented here, can a valid comparison be drawn between the significance of hill land to agriculture and its significance to forestry ?

The agricultural productivity of hill land is generally much lower than that of low ground. Although hill farming employs a tenth of those occupied in agriculture and uses a third of the farmland in Britain, it contributes only one thirtieth of gross agricultural output. Robson (1965) estimates that the efficiency of resource use by hill farming is only 60 per cent that of lowland agriculture, even with government support.

The difference between the productivities of hill and low ground under forestry is undoubtedly less than that for agriculture. As regards forestry, the importance of hill land in relation to total output is likely to be much the same as, or at any rate not much less than, its predominance in terms of area would suggest. This means that, while the hills are of small and declining significance to agriculture, they are of major importance to forestry; moreover, an adequate supply of hill land will be vital to the expansion of forestry in the future.

Chapter 3

Government Policy

Land Allocation

Agriculture in Britain has long been established as a major industry and is traditionally the principal use of rural land. The gradually declining margin of cultivation and the demands of other land-uses for land have resulted in the reduction in agricultural area noted in Chapter I. Forestry, on the other hand, is a relatively new industry in most of Britain and is progressively occupying more land. Therefore, the allocation of land between the two uses consists largely of a transfer of land from agriculture to forestry rather than vice versa.

The lack of forestry tradition in Britain and the fact that most rural land is already in agricultural use place agriculture in a much stronger position than forestry, with respect to land allocation. The private land-owner, of course, is theoretically at liberty to allocate his land in whatever way he chooses. However, private afforestation is usually done under one of the dedication schemes; before private land can be incorporated in one of these schemes, the approval of the local planning authority is required. In National Parks and other areas where amenity is a major consideration, such

approval is often withheld and the use of private land for forestry effectively prevented. The Forestry Commission must try to fulfil a planting programme approved by Parliament; to do this they have to acquire privately owned agricultural land. Therefore, Commission land acquisitions commonly involve both a change of land-use and the change from private to state control. The acquisition of land by the Forestry Commission can proceed only with government approval at a level above that of the Commission themselves. As the Commission are responsible for most of the new planting in Britain, government policy towards the transfer of land from agriculture to state forestry is of crucial importance to the expansion of the forestry industry.

It is generally accepted by both government and other interested parties that only hill farmland is suitable for transfer to state forestry and that, as a rule, low elevation rural land should be retained in agriculture. The wisdom of this assumption is not the subject of this study and further discussion is concerned specifically with the allocation of hill land in Scotland. This is not to suggest that the process of land allocation in Scotland differs markedly from that used in the rest of Britain. It is convenient at this point to confine the discussion to Scotland, firstly, because Scotland contains a predominance of hill land and, secondly, because its relevant government department, namely the Scottish Department of Agriculture (DAFS), is autonomous; remarks made concerning it do not necessarily apply to the Ministry of Agriculture or to the Northern Ireland Ministry of Agriculture.

PROCEDURE

The present procedure for the acquisition by the Forestry Commission of land in Scotland dates from the 1945 Forestry Act, by which the power to acquire land for state forestry was transferred from the Forestry Commission to the Secretary of State for Scotland. Before the Commission can take steps to acquire a property, they must first seek the approval of the Department of Agriculture. The Department consider the proposed acquisition from the point of view of agricultural interests and confidentially sound out local farming opinion through the Agricultural Executive Committee for the area.

Views on how the proposal relates locally to their respective interests are also sought from other local and national government bodies, such as the Nature Conservancy, local planning authorities, the Scottish Development Department and, in crofting areas, the Crofting Commission. Forrest (1960) comments on the thoroughness of these consultations as follows:

"I often think that it is a miracle that we [the Forestry Commission] get any land at all and it may certainly occur to some of you that we are overdoing the consultations."

While the opinions of the various interested bodies are taken into account by both the Department of Agriculture and the Commission, it is the Department which at this stage make the decision. The Department may agree

"...to the proposed acquisition in whole or in part or on the basis that certain areas, if acquired, should nevertheless

remain in agricultural use, or it may be considered that agricultural interests are such that 'clearance' for forestry cannot be given." (DAFS, 1961)

Once an acquisition proposal has been agreed to by the Department of Agriculture and before proceeding further, the Forestry Commission must obtain the approval of the Secretary of State. He does not normally oppose an acquisition provided that the Department agree to it. With the Secretary of State's approval, the Commission can then enter the market for the land in question. They offer whatever price they think appropriate but frequently fail to acquire 'cleared' land through being outbid. Walker (1958) claims that the Forestry Commission are limited by the Treasury in the price they are able to offer for land; he quotes as a maximum price £5 per acre. The object of the limitation, according to Walker, is to ensure that the Commission acquire only the poorer land. There is no evidence of such a constraint having been applied to Commission acquisitions. Moreover, a price constraint for the purpose stated seems unnecessary in view of the scrutiny which each acquisition proposal undergoes. Walker's allegation of a Treasury limitation is rejected as rumour by Ryle (1960).

Should the Forestry Commission wish to proceed with an acquisition opposed by the Department of Agriculture, the Secretary of State is required to adjudicate on the basis of a joint submission from the two bodies, in which are set out the arguments for and against acquisition. On average, about one such dispute per year is brought before the Secretary of

State.

The Forestry Commission have the power to acquire by compulsory purchase land 'cleared' by the Department of Agriculture. The few attempts they have made to compulsorily purchase land have failed because of agricultural opposition. However, it has been common for much of the land concerned in a proposed compulsory purchase to pass subsequently into Commission ownership by voluntary sale, so tending to vindicate the Commission's original judgement. There is a serious disadvantage to the Commission in having to wait for voluntary sale. This is that the units of land finally offered to the Commission are normally not only of the poorest quality but are of such a shape, size and distribution that they will provide maximum shelter for whatever land is retained in agricultural use; such units are unlikely to be the most economic for forestry.

GLENLIVET

The recent history of Glenlivet^I serves to illustrate some of the points made above. The Glenlivet Estate consists of 56,000 acres of Crownhold land, most of which is exposed, at an elevation above 1,000 feet and of low agricultural productivity. In 1951, the acquisition for planting by the Forestry Commission of 21,000 acres of rough grazing on Glenlivet was successfully

I Details concerning Glenlivet from Horne (1964)

resisted by a large body of opinion in support of the hill sheep farmers to whom the land was let. The low average farm income, which was due partly to the small size of many of the holdings on the area, resulted, during the next few years, in a large proportion of the tenant farmers being forced by economic necessity to relinquish for planting some or all of their land. The Commission acquired over 10,000 acres of plantable land, of which 6,000 acres was given up by the tenant farmers of their own volition. Glenlivet Forest now comprises about 70 separate forest blocks, the smallest of which is only 5 acres in area. The blocks are distributed so as to provide most shelter for the retained agricultural land and, where possible, to act as field boundaries. Because of the generally small size of the blocks and their very irregular shapes, forestry suffers from inflated unit costs at no extra return. Agriculture on Glenlivet has benefited from the amalgamation into larger units of the smaller and partially surrendered farms and from the shelter and subdivision provided by fenced plantations. On a number of representative farms, during the decade 1954 to 1964 sheep stocks were increased by up to 25 per cent and cattle stocks by up to 70 per cent.

The significant feature of the Glenlivet story is that the land-use pattern there is the result of a political, not economic, government decision. Except for a survey of the forestry potential of the area, carried out in the late 1940's and which recommended the ill-fated forestry scheme, no attempt was made to discover whether forestry, agriculture or the now widely praised 'integration' of the two would be economically

best. This political nature of government thinking typifies their attitude to land allocation in general. At Glenprosen, an investigation of the relative profitabilities of forestry and agriculture was made (DAFS, 1958) two years after the Secretary of State had adjudicated in a land allocation dispute between the Forestry Commission and the Department of Agriculture. The Secretary of State's decision on Glenprosen indicates the government's general reluctance to permit the complete replacement of agriculture in an area by forestry:

"I agree with the Department's submission. Not only does it seem right on the merits of the case that a farm unit should be retained, but there is also the point, surely, that what is preached should be practised wherever possible, i.e. the integration of forestry and agriculture." (DAFS, 1957)

INTEGRATION

The integration of agriculture and forestry on hill land is a principal recommendation of the Zuckermann Report (HMSO, 1957) and is widely accepted as being a desirable objective in allocating land between the two uses (e.g. Ellison, 1958; Forrest, 1960; Nichols, 1960). The economic advantages of integration accrue only to agriculture, as demonstrated at Glenlivet and elsewhere. Experience is hardly necessary to demonstrate this fact as the very nature of forestry is such that scale economies are of major importance to its economic performance. The only benefit which integration may be said to bestow on forestry is that, as Ryle (1958) points out, by a policy of integration afforestation may be rendered acceptable

to agriculturists, who stand to gain from the provision of shelter and roads:

"The pure sheep farmer....may see in integration the opportunity largely to preserve the status quo of hill farming as it is today, but improved by a good network of small shelterbelts fenced and maintained by, or at the expense of, a welfare State."

The 'integration' of forestry and agriculture does not necessarily mean the practice of both land-uses at the same time on the same piece of land. Such an integration of livestock grazing and forestry, although practised in many parts of the world, is successful only in certain forest types of North America (Chaffey, 1965). The level of integration intended in this discussion is that implied in the Pearson approach to multiple land-use (Pearson, 1944): forestry and agriculture are practised simultaneously on the same recognisable land unit but are spatially separated by discrete subdivision. This is the degree of integration achieved by partial acquisition of an area for forestry, as at Glenlivet and Glenprosen. Various other land-uses, for example outdoor recreation and sport, may however be more closely integrated with both forestry and agriculture.

A major criticism made by hill farmers of forestry is that afforestation 'sterilises' hill land by occupying the sheltered lower slopes but leaving unused the more exposed hill tops; the latter are no use for summer grazing unless balanced by the more sheltered wintering. Much hill land was sterilised by the Forestry Commission in this way between the wars when, because of the depressed state of hill farming and their then greater powers, the Commission were able to acquire and plant

land with much more freedom than they enjoy today. Although, as Walker (1958) shows, it may be economically sound to accept sterilisation of the hill tops by large scale, exclusive afforestation, the aim of the Department of Agriculture is

"...to ensure that so far as is economically possible the proper integration of forestry and agriculture is effected. This may mean some compromise to secure the continued agricultural use of the higher (unplantable) ground, or to prevent the creation of uneconomic agricultural units."
(DAFS, 1964)

The integration of forestry and agriculture on hill land in Britain is sometimes advocated on the grounds that it is a successful system of land utilisation on comparable sites in other parts of Europe. In the Swiss Jura, for example, forestry and dairy farming are practised; the integration of the two uses is traditional and is carefully planned with regard to each, as is described by Rieben (1957). In Sweden, a farm may comprise both agricultural land and a small woodlot; there is commonly some exchange of land between the two uses on a rotational basis. Logging and farm work alternate seasonally because of the harsh winter. Farm forests are of considerable importance in Sweden in the production of timber both for farm use and for sale and in the provision of winter employment in rural areas.

The land-use pattern of a developed country is the result of a number of factors, many of which are specific to the country concerned. Meaningful comparisons between the systems of land-use in different countries are difficult to make, even when those countries are closely similar. The allocation of hill land in Britain simply on the basis of what is done elsewhere

would be unjustified and would ignore more valuable criteria. Moreover, although forestry and agriculture may be integrated harmoniously in, say, the Swiss Jura or Sweden, it does not follow that such a system is economically better for those places than a single-use policy would be. In other countries besides Britain, land allocation is the subject of tradition, politics and prejudice.

Government Support

AGRICULTURE

In all parts of the world, agriculture is essentially a low-income activity. There are two basic reasons for this: firstly, for agricultural produce in the world as a whole, supply exceeds effective demand and, secondly, the number of people employed in agriculture is excessive. The first factor will be eradicated only by raising the effective demand of the under-developed countries for farm products. The second factor, it may appear, is of a less difficult nature, at least in the industrialised countries where alternative employment is available to absorb manpower released from agriculture. In practice, however, as mentioned in Chapter I, the reduction of the agricultural population is not easily effected. With reference to their member countries, of which the UK is one, the Organisation

for Economic Co-operation and Development (1964) state:

"The main factor directly responsible for the low-income farm problem is the existence of excess manpower in the agricultural sector and its underemployment."

In Britain, as in other OECD countries, the policy of the government is artificially to raise agricultural incomes, largely through price support. The support measures adopted positively discourage a reduction in agricultural population and so help to perpetuate the problem it is partly their purpose to solve.

Without some form of government support or protection, the agricultural industry in Britain would contract severely and leave the country much more dependent on imported supplies of food. Too great a reliance on imports has strategic disadvantages in time of war. This fact is the basis of the 'strategic argument' for a sizeable agricultural industry in Britain and for the concomitant government support. The strategic argument undoubtedly still applies, although its relevance in the present day is considerably less than it was, say, thirty or forty years ago; the present degree of Britain's self-sufficiency in food, however, is greater now than it was when the strategic argument was most cogent.

The government's agricultural policy can be properly related to strategic requirements only by an appropriate cost-benefit analysis; the problem is closely similar to that of defence expenditure, discussed by Hitch and McKean (1960) and by McKean (1963). In practice, of course, in Britain at least, such problems are still resolved largely by arbitrary, political

decisions, unsupported by any serious attempt to analyse the situation.

As McCrone (1962) says, the only strictly economic justifications which may be advanced for the British agricultural support policy are, firstly, that agriculture makes an essential contribution to the country's balance of payments and, secondly, that a high degree of agricultural self-sufficiency is a necessary safeguard against future world food shortage; in the event of such a shortage, Britain might experience difficulty in competing with other food-importing countries for food supplies. McCrone shows that neither argument is tenable:

The contribution of agriculture to Britain's balance of payments amounts to little or nothing and, because of imports of animal feedingstuffs, may even be negative. Britain's balance of payments deficit is attributable to trade with the non-sterling area; for various reasons, food imports from these countries, and especially from the dollar countries, cannot be replaced to any great extent by home production. Imports replaceable by British agriculture are largely from the rest of the sterling area, British trade with which shows a surplus. Further import-replacement by British agriculture would be likely to impair the favourable trade balance between Britain and the other sterling area countries by rendering the latter less able to buy British exports. Nash (1962), too, remarks on the irrelevance of the balance of payments to the question of government support for agriculture; he points out that such a policy is no less prominent in countries which are self-sufficient



in food or, like the United States, are agricultural exporters.

Because of the as yet unrealised agricultural potential of many parts of the world, a future world food shortage is by no means certain. Should one develop, it would be sufficiently foreseeable for Britain accordingly to adjust its agricultural production well in advance. The fact is that such a shortage is not foreseeable at present. Through the normal operation of the price mechanism, a world food shortage would, of course, solve the problem both in Britain and elsewhere of low incomes in agriculture and would largely obviate the need for government support.

The real reason for government support for agriculture is the democratic principle that those employed in industries where the market value of their services is low should not be subject to an income level substantially lower than that applying in the more profitable industries. To quote Nash (1962),

"The basic purpose of support policy is to give agriculture a 'fair deal' and to raise its income-level to an approximate parity with that of other occupations."

Evidence that agricultural support is essentially a social measure is adequately provided in Britain by the government's attitude towards hill farming, an attitude which not even the strategic argument would justify. Were government support to be directed exclusively to lowland agriculture it would result in a greater incremental production than it does by being directed in part to hill farming. The only reasonable explanation for the government's persisting in supporting hill

farming is that they are concerned for the welfare of the hill farmers.

Much agricultural support is incident wholly or partly outside the agricultural industry. It is sometimes claimed by agriculturists that government support merely fulfills a cheap food policy (as mentioned in Chapter I), the benefit of which is felt largely by consumers and the net cost of which to the nation is nil. According to this argument, the total amount transferred fiscally from consumers to producers is no greater than the projected aggregate increase in retail food prices which consumers would have to face if agricultural support were to cease. This argument is unsound primarily because it ignores the fact that, in the absence of the present system of government support, food prices would be significantly higher only if Britain were to continue producing a large proportion of its own food and were to ensure the consumption of British produce by restricting cheaper imports. This argument does not, in fact, hypothesise the withdrawal of government support but presupposes its continuance in a different form.

Even discounting the question of imports, it is doubtful whether consumers benefit from lower prices to the full extent of government liability, especially when this runs at a high figure (Houston, 1963). For certain agricultural commodities, selling prices at the retail and distributive levels tend to remain fairly constant despite wide fluctuations in farm-gate buying prices; the selling prices maintained in the retail and

distributive trades are sufficiently high to ensure an acceptable profit margin at any probable supply price. A classic example is provided by retail margins on meat in 1961, when retail prices were certainly not low enough to pass on to consumers the full benefit of the prevailing supply situation of low market prices and high subsidies. Houston (1962) shows that the retail butcher trade in particular is liable to the charge that it absorbs the benefits of the agricultural support policy.

Subsidies on farm expenditures are apt to be taken advantage of by those with whom the expenditures are made. Houston (1963) cites as an example fertiliser price increases in the 1950's apparently associated with the fertiliser subsidy. The effective misappropriation of this type of government support is especially unfortunate as grants for farm improvements are the most defensible of the various support measures. Such grants stimulate real improvement in farm productivity and are not merely compensatory in character.

Undoubtedly the chief criticism which may be made of agricultural support in general is that it discourages the mobility of agricultural manpower and so impedes not only the necessary structural changes in the industry itself but also the rational allocation of land between agriculture and other land-uses:

"The question of a change in land use cannot be separated from the mobility of manpower. Whether it is a matter of using agricultural land for urban purposes, of converting poor agricultural land to forest or of enlarging farms, the prerequisite for any development is the departure of a certain number of agricultural workers. Land reallocation is therefore conditioned by mobility of manpower; in other

words, the chief obstacle to changes in land allocation is the lack of manpower mobility." (OECD, 1965)

This aspect of agricultural support is, of course, especially pertinent to the question of the transfer of land in Britain from agricultural to forestry use.

FORESTRY

Government support for private forestry was justified initially by a strategic argument for home timber-production, analagous to that already discussed in relation to agriculture. Similar thinking gave rise to the Forestry Commission, which was set up, in 1919, to provide a strategic reserve of growing timber. The strategic justification for British forestry is no longer of major importance, although it is stronger than that for agriculture: while the creation of a reserve of growing timber takes at least one forest rotation, food production can be increased relatively quickly.

Once having started a support programme for forestry, the government are effectively committed to continuing it. In view of the long-term nature of forestry as an investment, it would be politically difficult for the government unexpectedly to withdraw established support measures. The most the government might do is to cease opening new agreements under the grant schemes. Even this step is unlikely while the Forestry Commission continue to undertake new planting. In fact, so long as the government consider a British forestry industry so necessary as to warrant a

state-run forestry service, they are bound also to give some encouragement to private growers. The popularity of the Forestry Commission is by no means established but it is liable to be strengthened more by the existence of a state-assisted private sector than it would be by the Commission's development along monopolistic lines; for without government support there would be virtually no private forestry.

Economically, government participation in the private sector is justified in that both private and state interests stand to gain from the increased scale of the industry as a whole. In this respect, an expanding private sector is all the more desirable in view of the Commission's own difficulties in acquiring more land for planting.

Government support for forestry is at a much simpler level and, in absolute financial terms, amounts to much less than that for agriculture. Its effects and implications, too, are comparatively slight. The most significant side effect of the government's policy towards private forestry has been the prevention of the fragmentation by estate duty of many landed estates.

Financing the Forestry Commission

The Forestry Commission are financed largely by an annual

Treasury grant, repayable at a rate of compound interest which varies from year to year. In recent years the rate has been in the region of 6 per cent. For the purpose of internal accounting, however, the Commission apply an interest rate of only 3.5 per cent.

The rates themselves are of less significance than is the fact that they differ. The Commission take the view that by discounting at 3.5 per cent they are discounting, in effect, at 5 per cent (Forestry Commission, 1965). This view is based on the assumption that real demand prices for timber are rising, and will continue to rise, by 1.5 per cent per annum in relation to those of other commodities. There is little justification for this assumption. Nicol (1966) shows that direct price substitution can be expected to result, during the next few decades, in a substantial contraction in many of the traditional markets for timber.

There remains to be explained the difference between the Commission's rate of 5 per cent and the Treasury borrowing rate. The reason for the discrepancy may be inferred from the Commission's remarks concerning their annually increasing book deficit:

"An appraisal of the financial results must take into account the factors peculiar to public investment in forestry. These are the immaturity of most of the Commission's plantations; the high rate of compound interest on Exchequer advances; the intangible returns from the social services rendered directly or indirectly by the Commission, which are not a proper charge to the purely commercial enterprise; and the fact that the economics of ancillary activities such as estate management have to be subordinate to the overriding needs of forest management and extension."
(HMSO, 1967)

The clear implication here is that the Treasury rate is too high because it ignores the intangible benefits of state forestry. The other two factors mentioned, that is the Commission's need to concentrate on management and extension and the immaturity of most of their plantations, are irrelevant both to the question of interest rate and to the long-term profitability of the Commission's activities.

The Commission's published accounts are increasingly dominated by the accumulated interest due on Treasury advances. In the forest year 1966, the Commission's debt to the Treasury reached a total of £280m (HMSO, 1967); 40 per cent of this sum, that is £114m, is attributable to accumulated interest. The incremental interest, accrued during 1966, was £14m; this exceeds that year's Treasury grant of £12m.

The Commission's deficit is accumulating at such a rate that there is no prospect of its ever being eliminated or even reduced. As the Commission make it clear that, in their view, the deficit is more apparent than real because the Treasury rate responsible is inappropriate, it is difficult to see why they persist in publishing accounts which must, therefore, misrepresent their economic position.

Considered in conjunction with their managerial practice, the Commission's accounting indicates a confusion of investment goals. The Commission's management is in accordance with their goal of commercial timber production but is less obviously related to the promotion of intangible benefits. In particular, it takes little cognizance of the high recreational value, both

actual and potential, of forest land in a densely populated country such as Britain; and this despite the fact that the encouragement of open air recreation is one of the Commission's stated policy objectives (HMSO, 1964). The Commission's expansion is largely confined to areas which are remote from major centres of population and where recreational demand is minimal; in Commission forests near urban areas, generally little or no provision is made for recreational use.

The Commission's published accounts, on the other hand, also refer only to the commercial enterprise but the inevitable deficit is explained in terms of intangible benefits. Such an explanation seems incompatible with the present managerial approach to what is certainly the most important of those benefits, namely the provision of facilities for outdoor recreation.

It is true that the Commission's activities in the remoter parts of Britain might be defended on the grounds that they help to retard rural depopulation. The provision of employment to this end is also an objective of Commission policy. However, it is now generally accepted that, in Britain, a viable community cannot be created or sustained on the basis of forestry alone. Rural depopulation is prevented, if at all, only by diversification of the local economy to include a number of new industries (Simpson, 1963). Timber production and its associated industries can contribute to such diversification but do not in themselves provide the key to long-term stability. If there is real justification for forestry on the grounds of employment it is likely to be strongest in areas where forestry can meet

a recreational demand. In such areas, recreational use may be expected to foster the development of the relatively labour-intensive tourist industry.

If the Commission continue, by publishing the present form of accounts, to demonstrate their failure as a strictly commercial enterprise, they risk severe public criticism with its possibly serious consequences. If their activities are to be justified partly on the basis of intangible benefits, then the attainment of those benefits demands changes in managerial practice.

Chapter 4Aims of Thesis

The objects of this study are defined as follows:

1. To examine criteria by which may be appraised public investment in the land-using industries. This necessitates a study of the theory of investment appraisal.
2. The investigation of the relative costs and benefits of forestry and agriculture on selected case-study areas of hill land in Scotland.
3. The investigation of the extent to which the economic performance of agriculture on hill land may be improved by certain technical changes in the traditional system of hill farming.
4. The formulation of conclusions, in the light of the results of investigations 1, 2 and 3, regarding government policy in Britain towards the utilisation of hill land.

PART TWO

Investment Appraisal

PART IIChapter 5Private and Public Investment Compared

Investments are made because they yield utility, which is, of course, purely subjective and directly neither identifiable nor quantifiable. The utility yielded by an investment usually depends upon a number of variables, at least some of which are likely to be measurable. For most investments, the total number of relevant variables is very large and only a few of the more easily measurable ones feature explicitly in the goals of investors.

Typically, the utility yielded by a private investment to those undertaking it depends largely upon its financial profitability, and that usually in the short term. Investment decisions in the private sector are not markedly affected by the external repercussions which are generated by investments as spillover effects and, more generally, through the multiplier.

Financial profitability, in the narrow sense, is by no means always a goal of public investment. Many of the projects undertaken by government bodies do not yield a tangible profit

although their overall social benefit may be considerable. Moreover, government investment planning may be influenced to a large extent by its wider and long-term implications. In short, government investment is for the public good and not for the good of any one section of the public.

There are therefore two broad types of investment which tend to be unattractive to private entrepreneurs but which may be undertaken by the government. The least attractive of the two, from the private point of view, is that type of investment which does not yield a tangible financial profit. The benefits gained from investment in, say, roads or a dam are normally so widely dispersed that it does not pay a private investor to invest in such a project; as it is the public as a whole who benefit from this sort of investment, it is generally public money which finances them.

The second type of investment unattractive to private enterprise is the investment which is financially profitable only in the long term. As a rule, investments in the private sector are required to show a profit fairly quickly; an investment period of even four or five years would be considered long rather than short. The main reason for the preference for short-term investments is simply that the degree of uncertainty associated with a project is proportional to the length of the investment period. A long-term investment is to be preferred to a short-term one only when it is both the more profitable and of an equal or lesser degree of uncertainty; for the latter condition to obtain, factors other than the time factor must

compensate for the intrinsically greater riskiness of the long-term investment. Short-term investments are favoured also because they permit investors greater flexibility of action: investors are deterred from committing funds to long-term projects by the possibility that, during the course of the investment period, more attractive investment opportunities may arise.

The remarks made above are generally true but not universally so. Real investment situations are normally complex and any brief and generalised discussion of them is bound to be an over-simplification. There is a certain amount of private investment both in long-term projects and in those which are not conventionally profitable. The utility required from a private investment does not always lie in profit but may be in, say, prestige or some other intangible. For example, the importance of profitability as an investment goal may be relatively small for an already successful entrepreneur for whom the marginal utility of profit has considerably diminished; prestige, however, may well rank as an important goal. Government investment is not confined to projects which do not yield a tangible profit or which would be otherwise unattractive to private investors. Much government investment is in strictly commercial enterprises which may be under private, government or joint control. Also, while the goal of public investment in general is the public good, any single investment is almost certain to have different effects on the different sections of the public and may benefit one of these but not another.

Chapter 6

Investment Appraisal: First Considerations

Among economic theorists the subject of investment appraisal is an intensely controversial one; few settled conclusions have been reached. A large number of criteria (that is, decision rules for determining the selection of investment projects) have been advocated but none has universal application to all investment situations. It is fairly certain that if and when such a model is devised it will take the form of a complex mathematical programme.

The currently fluid state of investment theory does not preclude the vigorous defence of one approach or another as being generally the best. Dryden (1964), in a survey of the principal developments in the subject, attributes much of the argument about investment criteria to lack of definition of the problem:

"Logically a discussion of criteria of choice should be preceded by the definition of goals and the specification of alternatives and constraints. Much of the confusion in the literature (as evidenced by the multiplicity of investment criteria advocated) may be traced to the absence of these prerequisites. Investment criteria...cannot be pronounced as either rational or otherwise unless the goals, alternatives and constraints are known."

Depending on the goals, alternatives and constraints which obtain, any one of the available criteria may be the best for a particular

investment problem.

GOALS

It was said in Chapter 5 that the goal of investment is utility. It is useful, although not accurate, to assume further that investments are intended to maximise utility. For practical purposes, investment goals are then those variables which represent maximum utility for the investors.

It is generally assumed that, in the private sector, maximum utility is synonymous with maximum profit. This assumption, often shared by entrepreneurs, managers and consumers alike is seen, upon observation, to be manifestly untrue. Profit maximisation appears seldom to be a principal aim of any but some small-scale enterprises. It is obvious that in private enterprise, and excluding utility as such, there is no single overriding objective; no factor or factors are necessarily maximised. Some firms may try to maximise turnover, others to minimise costs. Many private firms seek to achieve only a fairly constant but sub-maximal return, or mark-up, associated with a turnover level below which they are reluctant to fall but above which they are not anxious to rise.

In the public sector, considerations of profit tend to be less important than in private enterprise. Many public investment projects are executed at a substantial net cash deficit but are proceeded with on the grounds that their

unmeasured benefits to the community outweigh their measured costs. Many non-profit-making services, for example defence, education and medicine, fall into this category.

The government increasingly take a direct financial interest in certain commercial industries which are considered to be essential from the national point of view but which are distinct from the non-profit-making services. To an extent, the government have long taken an interest in private commercial activity, in the sense that they have imposed taxation upon it. This more recent interest takes the form of either nationalisation or subsidisation and, in Britain, stems largely from the experience of the pre-war depression.

Generally speaking, it appears that any industry in Britain which is regarded as essential can expect government assistance should its economic viability become unsure. Certain of the so-called essential industries have been nationalised while others remain in private management but receive periodic financial help. Typically, it is capital which ailing firms or industries require and which the government gives or lends in a lump sum. Among British industries, agriculture is unique in that it receives a large, permanent and apparently open-ended subsidy while remaining squarely within the private sector of the economy:

"Agricultural subsidies provide the outstanding British example of an open-ended scheme of public support for an industry of private businesses." (Houston, 1963)

There is no objective yardstick by which the degree can

be measured to which an industry is essential. An assessment of the national importance of an industry or firm must attempt to take into account a large number of factors including employment, spillover effects on other industries and the balance of payments.

Public investment especially is liable to the charge that its goals are often inadequately defined. The lack of clarity in this respect is due largely to the inherently political nature of government economic activity.

CONSTRAINTS

It is difficult to generalise about constraints as they vary greatly from project to project. They may be imposed externally, as are budgetary constraints due to lack of capital, or voluntarily by investment decision-makers; the specification of a payback period, for example, is an internal constraint. Public investment is subject to constraints of a purely political nature.

For the purpose of investment analysis, many of the wider aims of an investment are better regarded as constraints, so permitting the isolation of a single goal. For simple profit-making investments it may be convenient to treat as the goal profit-maximisation and as constraints other aims, such as prestige, cost-minimisation, tax avoidance and so on.

Prest and Turvey (1965) list six types of constraint:

constraints may be physical, legal, administrative, budgetary or due to uncertainty. The authors state that budgetary and distributional constraints are generally the most important. All investments are subject to uncertainty, the treatment of which is discussed in greater detail in Chapter 8.

ALTERNATIVES

Many investment decisions involve choice between alternative courses of action. The choice may be between entirely different types of investment project, between different projects of the same sort or between alternative ways of executing a single project; in selecting between projects of different investment period, the time element may be of critical importance. Investment decisions commonly require selection between at least one and possibly all three types of alternative.

In the private sector, only uncommitted, shareholding investors and large, diversified firms normally have to choose between different types of project. Once a firm is established in a particular industry it may well decline to consider undertaking projects in other industries. The adherence of firms to their respective types of activity is in fact an important constraint. Without this constraint, for example, there would be little or no investment in agriculture in Britain, as farmers would presumably invest in more profitable alternatives.

A government department is to some extent comparable with

a private firm in that such investment projects as it may be concerned with are likely to be of broadly the same sort. The government as a whole, however, have to choose between projects of many different types.

The correct treatment of alternatives is especially important when they are mutually exclusive. In practice, such alternatives are comparatively rare, at least at the project level. The most common instance of mutually exclusive alternatives is there being more than one method of executing a single project. In the field of land utilisation, however, at least in a densely populated country, the short supply of resources may render mutually exclusive certain land-uses.

INTERDEPENDENCIES

A note on interdependencies is included in this chapter because they impinge on the other factors discussed. Spillover effects may be goals or constraints and may be highly relevant in the choice between investment alternatives.

Briefly, and to use the terminology adopted by McKean (1958), spillover effects may be technological or pecuniary. Technological interdependence involves one project having a direct physical effect on another and may imply either joint or competitive production. The pecuniary spillover effects of an investment are the price changes it occasions. McKean distinguishes four categories of pecuniary spillover effect: these are,

for a given project, changes in the price of the output of the project itself, in the prices of substitute and complementary products and, finally, in the factor rate of hire.

In the private sector, an investment appraisal takes into account only those spillover effects relating to the profitability of the investors concerned. The same principle applies in the public sector, of course, but here it means deciding which spillovers are related to net social benefit. According to McKean, public investment appraisal should attempt to take cognizance of technological but not pecuniary spillovers. In choosing to ignore pecuniary spillovers, McKean, like Prest and Turvey (1965) is apparently taking for granted the proper functioning of the price mechanism and is therefore avoiding the question of income distribution. It would appear that, in fact, pecuniary spillovers perhaps should be taken into account. In practice, of course, it is feasible to include in an investment appraisal only a few of the probably numerous spillover effects; the aim should be that those included are at least those most relevant to the investment goals.

Chapter 7

Cost-Benefit Analysis and Investment Criteria

Investment appraisal is essentially a comparison of costs and benefits. The conventional methods of investment appraisal are merely measures of forecast profitability. While these measures are useful for the majority of private investment decisions, they have considerably less application in the field of government expenditure. The need for techniques by which to appraise and plan government investment has led, during the last twenty years or so, to the development of what is widely known as cost-benefit analysis.

The term 'cost-benefit analysis' signifies a broad approach rather than a particular method or criterion. This approach recognises that the social value of an investment, public or private, is not synonymous with and may not be simply related to its financial profitability. Cost-benefit analyses are essentially exhibits of the costs or disadvantages and the benefits or advantages of investments (McKean, 1963). Although cost-benefit analysis has been developed for the appraisal of investments from the national point of view, cost-benefit techniques can also assist decision-making in the private sector, particularly in the appraisal of large-scale projects.

For the purpose of assessing the social value of an

investment, cost-benefit methods attempt to identify and quantify its social costs and benefits; these can then be compared. If possible, costs and benefits are both quantified in the same, usually financial, terms so that they can be compared by a profitability forecast model. In practice, attempts to quantify the social costs and benefits of investments have led to some very complex expressions, as yet none of which has been entirely satisfactory. Part of the difficulty, as Solow (1962), Feldstein (1964) and others emphasise, lies in selecting an appropriate 'social' rate of interest. The determination of interest rates is discussed in Chapter 8.

Investment criteria may be conveniently divided into three groups. Firstly, there are those simple techniques which are widely used in practice but which academically are unsound because of their failure to take proper cognizance of the time element; these are only briefly discussed below but are included for the sake of completeness. More attention is given to the discounting techniques which comprise the second group of investment criteria. In the third group are included various other more advanced models which do not conveniently fit into either of the other categories.

Most of the techniques discussed have, of course, been developed for use in private enterprise. The principles underlying them, however, are compatible with the wider cost-benefit approach. It must be pointed out that the following discussion covers only what are considered to be the more

important investment criteria and makes no attempt to be exhaustive.

Conventional Criteria

These rules are in most circumstances inadequate substitutes for the more complex models available and often produce capricious results. They are attractive because of their simplicity, although this arises only from the oversimplification of the complex problems of investment appraisal.

While these conventional techniques conspicuously lack academic respectability, it must be pointed out that in practice they are used with a subjective awareness of the factors they ostensibly ignore. As the conclusions drawn from the application of these methods are not blindly accepted, the resulting decisions are generally not as unsatisfactory as the criteria themselves.

RATE OF RETURN (RR)

This is basically the ratio of profit, net of capital depreciation, to capital invested. This ratio is compared with the estimated cost of capital, which includes an allowance for risk. The figure for profit may refer to initial profit, in the first year of operation, or to an average profit over the whole or some part of the investment period.

The RR method does not allow for the incidence of capital outlays and earnings. An enterprise with rising profits is classified the same as one with falling profits so long as the total profits of the two are equal. In fact, a project with high early profits is to be preferred to one where the bulk of the profit comes later in the investment period; by the RR method, however, projects with the same capital cost, life and total profitability are inevitably ranked equally; no distinction is made between £I now and £I in, say, five years time.

PAYBACK

The payback is the time taken for an investment to generate enough incremental cash to recover in full its initial incremental capital outlay. It is simple and popular. However, the payback method cannot be said to measure profitability; it is a liquidity not a profitability concept. It takes cognizance of net cash flows only up to the point where they equal initial outlay and ignores subsequent returns.

This method of investment appraisal is widely used, especially in industries subject to rapid, technological changes which are liable to out-date expensive machinery. A firm stipulating a low payback period may claim to be pursuing a 'dynamic' investment policy although, in fact, use of the payback criterion results in particularly conservative decisions.

Because the payback method ignores the cost of capital

it fails in the limited objective it purports to achieve. A project does not 'break even' until capital has been recovered plus interest (which could have been earned elsewhere), not capital alone. Being purely a time concept the payback is incapable of being weighed against risks other than those of a time nature and then only against the specific and unlikely risk that a project may proceed satisfactorily for a time and then collapse.

As a straightforward forecast profitability criterion, the payback is useful for certain types of investment. Gordon (1955) shows that it is a good approximation to the yield criterion (discussed below) for long-term or perpetual investments with constant returns.

According to Merrett and Sykes (1963), the payback criterion is inapplicable to optimisation either within or between projects. However, recent re-examination of the payback (Dryden, 1960; Smith, 1961) has found it a useful criterion in this respect under certain circumstances. Dryden states that for projects with return streams decreasing linearly over time the payback is identical as a ranking device to the more sophisticated models usually advocated.

For most types of investment the payback may be used as an initial screening device. Its usefulness as such lies largely in the private sector where, as discussed in Chapter 5, long-term investments are unpopular.

NECESSITY-POSTPONABILITY

This is a ranking criterion by which investment projects are ranked on the basis of urgency. A project which must be commenced 'now or never' is rated highest while an indefinitely postponable project is rated lowest.

The criterion of necessity-postponability is applied after sub-marginal projects have already been eliminated by the use of the payback or RR. It is clear that the urgency of a project need not be synonymous with its profitability and this method of investment appraisal is particularly unjustifiable.

ANNUAL RETURN ON CAPITAL EMPLOYED

This method purports to show the profitability of an investment project for a single, current year. As no account is taken of future cash flows, projects with long gestation periods are wrongly shown to be unprofitable. In its simple form the method is too crude to be of any real value. A slightly better version of the method is to make forecasts for several years ahead and to compare actual net cash flows with forecasted targets.

Discounting Techniques

Although basically simple and greatly superior to the more

popular criteria already discussed, the discounting techniques have been adopted only slowly by private enterprise in Britain. Sykes (1966) attributes the lack of enthusiasm for these criteria to their frequent presentation in abstruse mathematical forms not readily comprehended by businessmen.

Three discounting techniques are described below. The first two, that is the yield and net present value criteria are then discussed in some detail.

NET PRESENT VALUE (NPV)

The net present value of an investment is basically the discounted value of its forecast net earnings over a stated period; it is synonymous with net discounted revenue (NDR), the term favoured by the Forestry Commission who use this criterion. A NPV may be calculated for any point in the life of an investment but it is usual for NPV calculations to precede outlay and therefore to refer to the time of commencement of a project. The NPV of an investment at its commencement is the difference between the sum of its discounted net earnings and its initial capital cost. Capital outlays subsequent to the initial outlay are incorporated into the net cash flows of the appropriate years; some net cash flows may therefore be negative.

Instead of discounting costs and returns to give the present value of an investment, they may be compounded to give its terminal value. This is merely the reverse of the NPV

technique and does not constitute a different approach. For most situations, NPV is preferred because it gives a figure which can be related to existing funds presently available. Moreover, the choice of the present day as the point at which to compare costs and returns is less arbitrary than is the adoption of a date some years in advance.

YIELD

The yield of an investment, or its internal rate of return, is that rate of interest which discounts future net cash flows into equality with the capital cost; it is that rate of interest resulting in zero NPV. A firm making an investment appraisal by the yield method accepts a project giving a yield in excess of the cost of capital and high enough to compensate for the risks involved.

All capital outlays subsequent to the initial outlay are incorporated into the net cash flows of the appropriate years; as above, some net cash flows can therefore have negative values. The criterion works so long as all the negative cash flows precede the positive ones. For a project which involves a capital outlay right at the end of its life, for instance quarrying with an obligation terminally to replace agricultural land, the yield calculation must be adjusted in order to give a meaningful result; by the extended yield method a sinking fund is in effect created to pay off the late capital requirement.

ANNUAL CAPITAL CHARGE

This method is commonly used only for projects giving regular net cash flows. It consists of a comparison of the annual net cash flow with the average annual capital charge; this capital charge comprises the cost of capital and capital depreciation, the latter being calculated on a sinking fund basis. For a project to be acceptable, the annual net cash flow must exceed the average annual capital charge; the margin between the two is weighed against the risk involved.

The distinguishing characteristic of the annual capital charge technique is its use of the sinking fund method of depreciation. This renders it attractive to enterprises financed by debt capital; it is usual for such enterprises to make formal provision for capital redemption via sinking funds.

The annual capital charge is less flexible than the two methods previously described. It is readily used only for projects with regular annual returns following an initial capital investment. While such projects do occur, they are in the minority. This method is obviously not the most suitable approach for the appraisal of investment in forestry, where net cash flows fluctuate widely, or in agriculture, where there is also considerable variation in return from year to year. Therefore, the annual capital charge method is not considered further.

YIELD AND NPV COMPARED

Used merely as a formal accept/reject criterion for an individual investment, each of the two methods normally gives the same result. Used for optimisation and ranking decisions the two criteria may point to quite different courses of action.

Merrett and Sykes (1963), whose views probably typify current thinking on the subject in private enterprise in Britain, argue that yield is a better criterion than NPV. They favour yield over NPV on the grounds that it is a more useful measure of profitability in relation to risk, that it is simpler to apply and that it has greater appeal among businessmen. In making these conclusions the authors are specifically excluding from consideration the use of the criteria in ranking decisions which, they say, are rarely required in commercial practice:

"Involved in any investment decision there will normally be a great deal of interesting information which is nevertheless generally irrelevant to the decision: the ranking position of a project is generally in this category."

The above remark is not so naive as it may at first appear. It is a comment on how businessmen behave in fact rather than in theory. As Turvey (1963) mentions, in real situations there are always only a small number of projects to be considered. A single firm is unlikely to contemplate at any one time more than, say, two or three projects; assuming they are not incompatible, the need to choose between them implies a capital constraint. In fact, provided, of course, that the projects are all profitable, it may be possible to raise

enough capital to finance them all. The same is not true, however, of the public sector. Because of the sheer scope of its activities relative to its inevitably limited resources, the government as a whole is forced into capital rationing:

"...governments, especially, like to decide how much is to be invested and by whom;" (Feldstein and Fleming, 1964).

For the purpose of the allocation of public funds, therefore, the ability of a criterion satisfactorily to rank projects is of the utmost importance.

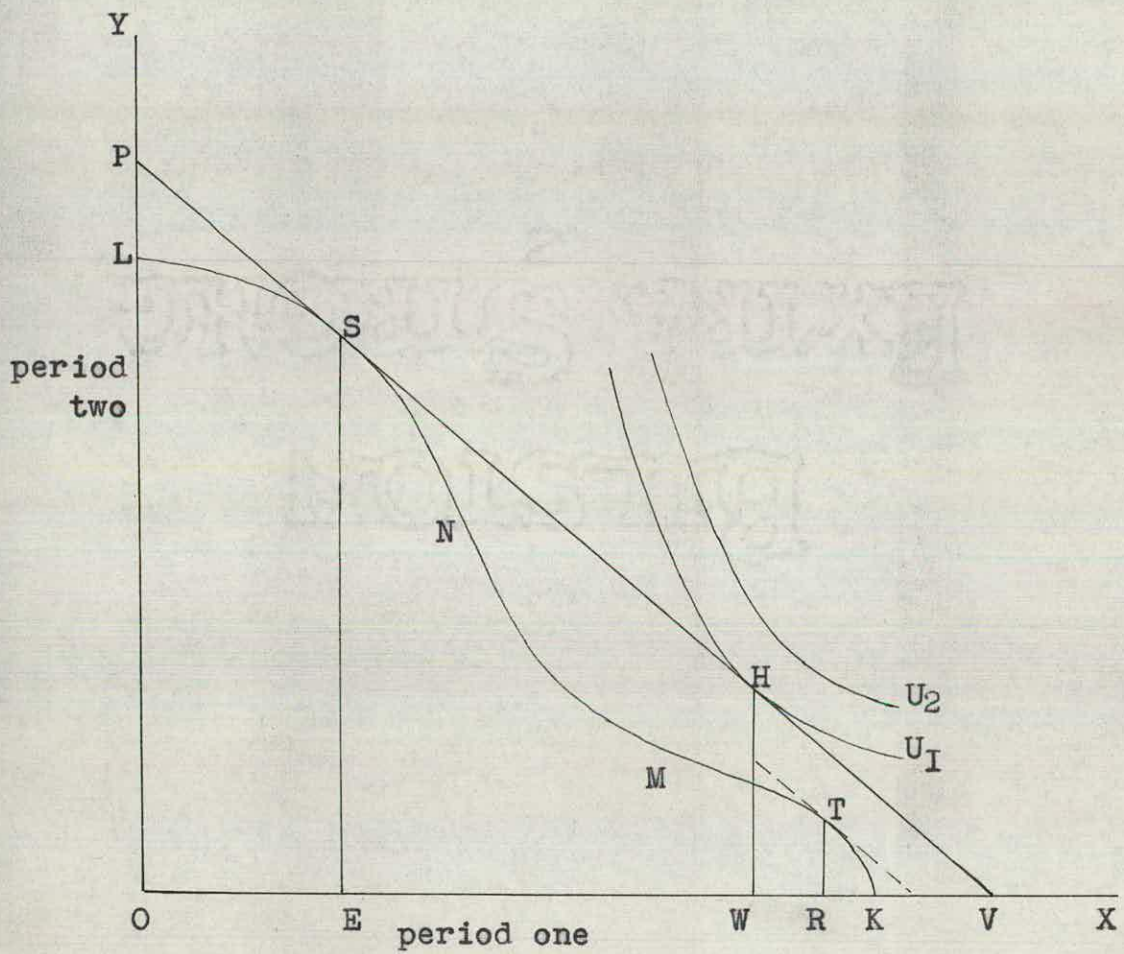
The majority of authors on the subject of investment appraisal differ from Merrett and Sykes in rejecting the yield criterion in favour of NPV. This more widely accepted view appears sound and is based on the conceptual superiority of NPV, used either as a simple accept/reject criterion or for ranking.

The superiority of NPV can be seen from an examination of Figure I which, together with its analysis, is after Dryden (1964). Figure I is a geometrical representation of an investment decision involving the selection from non-independent investment opportunities. For simplicity, the total investment period is considered to be one of only two distinct, shorter periods; the latter might, for example, be years or months.

The curves U_1 and U_2 are indifference curves and are the loci of those combinations of X and Y (income or consumption, in periods one and two respectively) which give the investor the same amount of utility; U_2 represents a higher level of utility than U_1 . The curve KL shows the distribution of income between periods one and two according to the production opportunities

Figure I

GRAPHICAL REPRESENTATION OF THE APPLICATION OF NPV AND YIELD
TO AN INVESTMENT DECISION



(After Dryden, 1964)

taken. By implementing all the opportunities open to the investor, OK units of current income in period one may be converted into OL units of income in period two. Another possible decision is to exchange KR units of present income for TR units of income in period two. The curve KL , therefore, represents a sequence of production opportunities, starting at K , its shape reflecting interdependence among these opportunities: some expenditures of current income yield almost no future income (as at M) but make possible additional production opportunities which are highly profitable (as at N).

Assuming a single market rate of interest (i), the present value of an opportunity is shown geometrically by the intercept made on the X axis by a line with a slope of $-(1 + i)$ and which passes through the point representing the flow of net receipts of the opportunity. Thus, all points on PV represent combinations of X and Y having a present value equal to OV . The highest indifference curve is reached by making production decisions until point S is reached, followed by a market decision, namely borrowing EW units of X . In this example, therefore, although the NPV criterion does not lead directly to the point H it dictates decisions consistent with reaching that point.

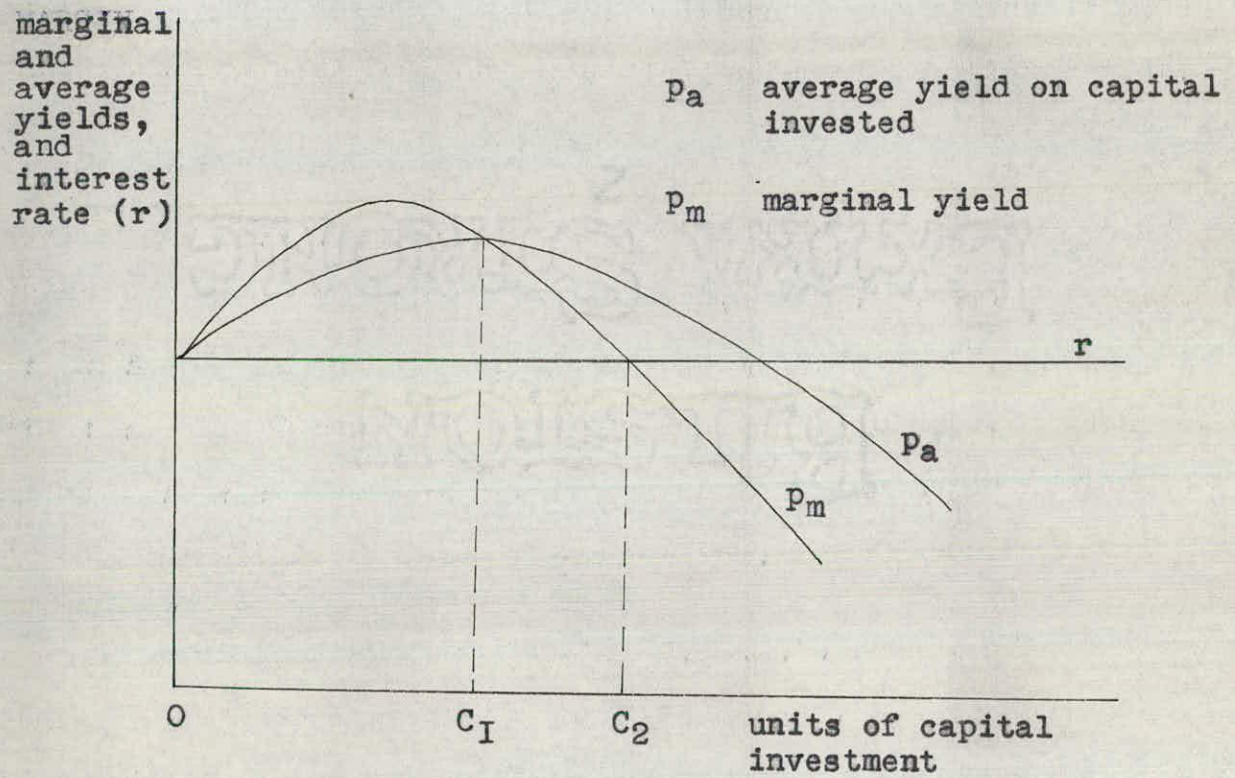
The yield is denoted in Figure I by the slope of the production opportunity locus KL , reduced by unity. Since the use of this criterion requires the acceptance of opportunities up to the point where the yield equals the market rate of interest (i), production decisions up to the point T are made. These decisions, however, cannot enable U_I to be reached. That is,

in this example of non-independent two-period opportunities, the use of the yield criterion is not consistent with the maximisation of utility to the investor.

A simple and more direct comparison of the two criteria can be made merely from a consideration of their basic meanings. NPV is essentially the difference between total benefits (V) and total costs (C), that is $V-C$. Yield is the rate of profitability, not a measure of profit (or net benefit) as such. A project giving a high rate of profit is not necessarily one giving a high total profit. Figure 2 is a simple representation of the relationship between NPV and yield for a classical investment schedule and is after F. and V. Lutz, who advocate $V-C$ as being the correct criterion (Lutz, F., 1945; Lutz, F. and V., 1951). The conceptual weakness of the yield method is exactly analagous to that of the straightforward V/C criterion; the latter is now generally rejected (McKean, 1958; Prest and Turvey, 1965). A number of other criteria advocated are similarly theoretically incorrect, for example the MAPI urgency rating, discussed by Dryden (1960, 1964), and the capital-output ratio and social marginal productivity criteria, both of which are discussed by Dosser (1962).

A disadvantage of the yield method, which is not shared by NPV, is that, under certain circumstances, the calculation of yield may give multiple or unreal solutions. Feldstein and Fleming (1964) state:

"Only if the net revenue stream changes sign once only, from negative to positive, it is the case that there must be a unique internal rate and that it is a reasonable thing to

Figure 2GRAPHICAL ILLUSTRATION OF YIELD AND NPV

NPV maximised by OC_2

Yield maximised by OC_1

(After Lutz, F. and V., 1951)

'maximise'. If it changes sign once, but in the opposite direction, a unique rate will exist but the larger it is the less desirable the project will be on present value grounds; for the higher the future cost of some present gain the higher the rate of discount needed to reduce them to the same value. If the net revenue stream changes sign n times there may possibly be up to n distinct values of the internal rate of return."

Dryden (1964) gives as an example the investment opportunity $A(-I, 7, -I2)$, the yield of which has two possible values, namely 200 per cent and 300 per cent. The difficulty of multiple yield values can be overcome by use of the extended yield technique, already mentioned. However, the adjustments this involves considerably reduce the simplicity of yield as an investment criterion and, therefore, its attractiveness.

The ranking of mutually exclusive investment opportunities obviously requires more precise investment appraisal than that needed for an accept/reject decision on a single investment. Although yield or a benefit/cost ratio is advocated by some authors (e.g. Eckstein, 1961) for ranking investment alternatives, it seems fair to say that, in general, this type of criterion is inferior for ranking to NPV.

Because yield fails to take account of the scale of investments, the order of ranking dictated by it may be the opposite of that obtained by the use of V-C, or NPV. A larger project may have a lower yield than a smaller one but still have a higher V-C value.

Implicit in the use of the yield criterion is the assumption that the revenues from a project can be reinvested at the rate of return, or yield, calculated. This assumption

is invalid and misleading, as pointed out in the Ellison Report (HMSO 1966), and, depending on the circumstances, may be unduly either optimistic or pessimistic for a particular opportunity; in ranking, it can of course result in a false ranking order.

The example represented by Figure I shows how NPV but not yield allows for the existence of borrowing and lending opportunities at a market rate of interest. The choice between investment projects involving yet further opportunities cannot, therefore, be satisfactorily made by use of the yield criterion.

Merrett and Sykes advocate the use of incremental yield for discriminating between alternative projects (Merrett, 1965; Merrett and Sykes, 1963). This criterion is the same as Fisher's rate of return over cost rule (Fisher, 1930). Where two projects are being compared, the rate of return over cost is defined as that rate of discount which equates to zero the stream of differences between the net cash flows (or net benefits) of the two investments. Of two admissible but incompatible projects, say A and B, A is chosen in preference to B if the yield of the stream of differences (A - B) exceeds the minimum rate required.

Fisher's rate of return rule obviates the difficulty posed by differences of scale of investment. However, a time stream of incremental benefits is especially liable to have frequent changes of sign, so giving multiple values of incremental yield. The results obtained by Fisher's rule, where they are meaningful, are effectively the same as those obtained by comparing present values at the minimum acceptable discount rate.

This is because the rate of return over cost is simply that rate which equates the present values of the alternatives being compared. For discriminating between a large set of incompatible projects, it is considerably easier to compute and compare present values than to use Fisher's rate of return rule.

A similar adaptation may be made of the NPV rule. An advantage of incremental NPV as a ranking criterion is said by Merrett and Sykes to be that it can conveniently be weighed against incremental risk. A straight comparison of present values is probably equally useful; differential interest rates can be applied, if necessary, to allow for differences between the respective degrees of risk involved in alternative opportunities. Both approaches require a value judgement on probable risks.

Among the criteria used in the Ellison Report for comparing forestry and agriculture is NPV per unit of capital invested. The use of this criterion implies a capital constraint and is in line with the views of Ashby (1961). This criterion is of the V/C type and does not take into account the absolute size of investments. To overcome this difficulty, Feldstein and Fleming (1964) suggest its use in an incremental form, analagous to that of Fisher's rate of return rule:

"If the present-value-per-current-pound ratio for the border-line project is called the 'marginal' value of the ratio, a larger project is to be preferred to a smaller one with a higher value of the ratio so long as the incremental value of the ratio for the larger project is greater than the marginal value."

A simpler approach to ranking under conditions of capital rationing would appear to be to apply a capital constraint

initially; those opportunities with capital requirements inside the constraint can then be compared on the basis of NPV.

The simple NPV rule is convenient not only for selecting between distinct projects but also for evaluating possible project combinations. The NPV of a project combination is simply the sum of the present values of the individual projects. A particular project or its variants may be included or excluded without necessitating entire recalculation; only the NPV of the one project need be reassessed. Evaluation on the basis of yield requires the computation of the overall time stream of each alternative project combination. Holden (1966) favours the use of the NPV rule for evaluating agricultural development programmes involving a number of farms.

The rate of interest is discussed in Chapter 8. However, it may be stressed here that the rate of interest is of the utmost significance in appraising investments by the discounting techniques described. The outcome of a NPV calculation can be highly sensitive to the interest rate imputed; in ranking, the ranking order obtained at one rate of interest may be the opposite of that obtained at another. Yield, or internal rate of return, on the other hand, is relevant only in relation to an external interest rate. It is self-evident that an investment appraisal can be only as accurate as the data on which it is based. The interest rate is among those data most difficult to assess.

Other Methods

The separation of this group of methods from the discounting techniques already discussed is done merely for convenience. The majority of other investment appraisal models advocated, including those discussed below, also involve time stream evaluation by discounting.

GREGORY'S MODEL

Gregory (1955) describes a method for determining multiple land-use optima by the application of inter-related supply theory. The model is applicable to both joint and competitive production and, of course, is not restricted to analyses in the land-use field. It is essentially an attempt to use the NPV rule for selecting the optimum scale and composition of output from a continuous series of alternatives involving two or more types of product; different products may be associated with the same basic project or with different, non-independent, projects. Gregory's model is only briefly described here; a fuller description is given by Chaffey (1965).

For a number of known output alternatives, schedules of iso-cost and iso-revenue combinations are constructed. From these schedules can be delineated an expansion path for increased inputs, along which lie the most profitable product combinations for different input levels. The optimum output combination is

then at that point along the expansion path at which total benefit most exceeds total cost.

Gregory's model is conceptually sound and academically attractive. As a workable criterion, however, it fails. More information is required concerning production alternatives than is ever likely to be available in real situations. In its theoretical merit and practical inutility, Gregory's model is exactly analagous to classical marginal analysis.

MUHLENBERG'S MODEL

Muhlenberg's model (Muhlenberg, 1964), like Gregory's, is advocated for the determination of multiple land-use optima and is described in some detail by Chaffey (1965). Muhlenberg accepts the impractability of true optimisation, for which he advances his own method as a workable, though imperfect, substitute.

The method consists essentially of ranking by the NPV rule those possible product combinations for which information is available. The best of these alternatives is then the first approximation to the optimum. The production possibility surface in the vicinity of this product combination is investigated by introducing variable inputs, to discover whether these increase net benefit, and, if they do, at which input level NPV is maximised; the corresponding output combination is then the final approximation to the optimum. The first step, that is

the initial ranking, is straightforward. The second step is more difficult and might, in practice, have to be omitted.

As the model is really only a special application of the NPV rule, it hardly deserves treatment as a distinct method. Muhlenberg's description of the technique, however, is an interesting exposition of the use of the NPV rule for assisting in a specific type of analysis.

COST-EFFECTIVENESS

For certain types of investment project, any attempt to express costs and benefits in the same terms must be quite meaningless. Such projects are normally confined to the public sector. Investment in defence provides an example.

Two possible decision rules for discriminating between alternative investments of this sort are, firstly, the maximisation of gain for a given cost and, secondly, the minimisation of cost for a specified gain; that is, to maximise V/C with C fixed or to minimise C/V with V fixed.

The cost-effectiveness rules can be used only to rank projects having the same sorts of costs and benefits respectively. In practice, this means that they are applicable only to selection between alternative ways of executing a single type of project. A decision on the absolute desirability of investment in a particular direction requires a value judgement.

Conclusion

The present value rule is clearly superior, on both theoretical and practical grounds, to the other criteria discussed. As it is logical to assume that net present value is the maximand for all investments, it follows that the present value rule is the correct criterion to use. Other criteria may be viewed simply as different methods of pursuing the present value maximand (Feldstein and Fleming, 1964^a); although generally less satisfactory than the present value rule, these criteria may have application in certain circumstances.

Real investment decisions, especially those made by government departments, commonly require ranking under fixed-budget conditions. Where capital rationing obtains, the criterion adopted may be present value per unit of capital invested; this criterion should be applied in an incremental form.

Finally, it must be stressed that as utility functions are, in reality, unknown, it is impossible to develop the perfect criterion. The criteria discussed amount, in practice, to partial tests involving only some of the many relevant variables.

Chapter 8

Interest and Uncertainty

The Rate of Interest

The choice of discount rate is of the utmost importance and constitutes one of the major difficulties in investment appraisal.

A rate of discount is used in order to take cognizance of two factors, namely the consumption time preference of investors and the opportunity cost of resources, or capital. According to classical theory, the marginal productivity of capital and the marginal time preference of consumers are equated by the 'market' rate of interest to produce the Paretian social optimum. In the real non-Paretian world, the two factors cannot be so equated and, at any one time, each may dictate more than one possible rate of discount.

In the private sector, time preference varies between investors; each investor, in effect, makes a subjective decision as to what shall be his personal rate of time preference. In an imperfectly competitive economy there can be no single opportunity cost of capital. It is observable that capital is offered on a wide range of terms (Krutilla and Eckstein, 1958).

A 'social' rate of discount is necessary for appraising investments on the basis of net social benefit and specifically for the evaluation of public investment. Ideally a net social benefit assessment should be capable of taking into account both the social opportunity cost of capital (SOC) and the social time preference (STP).

In the welfare economists' perfectly competitive model, SOC is equated with the market rate of interest. As, in reality, there is more than one market rate of interest, the question arises as to which of these rates, if any, may be taken as a measure of SOC. Dorfman (1961) considers market rates of interest are irrelevant for public investment because there is no market on which a closed economy as a whole may borrow or lend. In fact, as Feldstein (1964^a) says, the SOC depends on the multiplier and upon the STP. It can therefore change through time.

The rate of social time preference poses special problems. Dobb (1960) points out that an individual's time preference may either be due to irrational weakness or it may be a rational reaction to the possibility of death. A consideration of individuals' time preference rates therefore cannot help in determining a social rate.

There are two basic approaches to the problem of STP. Eckstein (1957), Solow (1962) and others take the view that society as a whole has, at any one time, a preferred time-profile of consumption which can be elucidated by economic analysis. The alternative view, represented by Dobb (1960), Feldstein

(1964, 1964^a) and others, is that it is futile to search for a perfect formula specifying social time preference; the STP rate should be the subject not of economic analysis but of a government policy decision. It would appear that the second view is the more realistic of the two. Among those advocating the theoretical determination of STP, Krutilla and Eckstein (1958) attempt to calculate a social rate of discount from various market rates.

In the light of what has been said above concerning SOC and STP, what rate should be taken as the social interest rate? The SOC must be rejected as being unidentifiable and possibly non-existent. The STP rate exists because it is fixed, implicitly if not explicitly, by government; it is therefore also identifiable and obviously must be accepted, on practical grounds at least, as the social rate of discount.

The problem remains, of course, as to what STP rate the government should dictate. This is, in fact, a moral problem; the choice of discount rate ultimately depends upon the degree of consideration which the government think should be given to the welfare of future, as opposed to present, generations. In practice, public investment is normally discounted, as Eckstein (1958) advocates that it should be, at a rate somewhat lower than contemporary commercial rates. Discounting at too low a rate, however, results in waste of the nation's capital, while the use of too high a rate may leave resources undeveloped.

Uncertainty

The investment criteria discussed in Chapter 7 do not in themselves take cognizance of uncertainty. They are able to forecast the outcome of an investment, given specified conditions, but are incapable of assessing the likelihood of those conditions being fulfilled. The degree of certainty which can be attached to forecasts effects the overall attractiveness of individual investments and is of major significance in ranking.

Two relatively simple approaches to uncertainty are, firstly, the introduction of a risk rate and, secondly, sensitivity analysis. The risk rate technique, which consists of increasing the assumed rate of interest, is crude but practical. The assessment of the necessary risk increment, however, constitutes a difficulty. The sensitivity of NPV calculations to discount rate renders somewhat hazardous the use of the risk rate technique in conjunction with the NPV rule.

By sensitivity analysis is meant the calculation, either for an individual investment or for each of a set of alternatives, all likely outcomes. This involves varying the assumptions on which an investment appraisal is based. Sensitivity analysis exhibits a set of possibilities but does not itself distinguish between them on the basis of probability. The technique shows the sensitivity of forecasts to changes in given variables. At least some of the variables most relevant to a particular decision are therefore emphasised; the probable

behaviour of these variables may then be further investigated. The value of an investment appraisal is greatly enhanced by the inclusion in it of a realistic sensitivity analysis. Also, the technique is a pre-requisite to the application of the decision rules discussed below.

The application of game theory to the subject of investment appraisal has led to the formulation of several decision rules for selecting between investment alternatives. These rules take no account of probability and are based on the assumption that probabilities cannot in fact be specified.

Given a set of investment alternatives, for each of which the possible outcomes are known, the minimax rule dictates acceptance of that alternative having the highest minimum consequence. The minimax approach implies severe pessimism and results in extremely conservative decisions; the rule cannot be regarded as being generally useful. Savage's minimax regret principle (Savage, 1951), which seeks to minimise decision-makers' potential regret, is closely similar to the simple minimax rule and is open to the same criticisms.

The Hurwicz criterion is basically the same as the simple minimax rule but involves the computation, for each investment alternative, of a weighted average of both the highest and lowest possible consequences. The dependence of the decision upon extreme values is therefore avoided. However, the criterion cannot be regarded as satisfactory as it poses the problem of deciding upon the correct weights and ignores the

distribution of consequences between extreme values. A more detailed exposition of the game-theoretic rules is given by Dryden (1964).

Dryden also describes a number of decision rules designed to take cognizance of probability. These rules require that subjective estimates of uncertainty be accepted as objective probabilities; this is tantamount to ignoring the conventional distinction between risk and uncertainty and treating uncertainties as risks. The probabilistic rules are derived partially from the observation of how decision-makers react in fact to uncertainty; none, however, is entirely adequate and their appeal would appear to lie in their theoretical interest rather than in their practicability.

For the appraisal of very expensive investment projects McKean (1958) favours what amounts to a sensitivity analysis incorporating a probability estimate by Monte Carlo techniques. This involves forecasting a number of possible outcomes, the values of the most relevant variables being determined for each forecast by random selection from a series of possibilities. McKean takes a realistic view of uncertainty, however, and accepts that, in practice, the most useful approach is often simply the identification of its sources and patterns as an aid to subsequent subjective judgement.

Chapter 9

The Comparison of Forestry and Agriculture

The appraisal of land-use investments presents the same basic problems as does the appraisal of investment in other fields. To summarise, the most difficult problems are the measurement of costs and benefits, the choice of interest rate and the treatment of uncertainty. The difficulties are intensified, however, in a comparison of forestry and agriculture, because of the markedly different production periods involved and specifically because of the long production period in forestry.

It is interesting to note that although the discounting techniques of investment appraisal have yet to gain universal acceptance in industry at large, they have long been used in forestry. The profitability measure 'land expectation value', for example, given by the Faustmann formula, is simply an adaptation of the NPV rule to forestry investment. The early recognition in forestry of the importance of discounting over time is a reflection of its unusually long production period, a feature by which forestry, as a commercial investment, is distinguished from practically all others.

Assuming that investment in forestry requires afforestation, as in Britain it normally does, a meaningful comparison

of forestry and agriculture can be made only on the basis of at least one forest rotation. This means that costs and benefits must be identified and in so far as is possible, their values forecast for a period of about fifty years. The inevitable difficulty of forecasting over such a period of time introduces a very considerable degree of uncertainty. As the Ellison Report points out, the outcome of a comparison by either yield or present value is very sensitive to only small changes in imputed costs and returns.

The comparison is complicated by the need to take into account intangible costs and benefits, the satisfactory measurement of which may be difficult or impossible. Land-use investments, especially in forestry, are characterised by having associated with them numerous intangibles, of which the private investor is able to take a purely subjective view. In Britain, virtually all investment in forestry and agriculture is financed at least partly by public funds. An appraisal of such investment must therefore attempt to take a more objective view of intangibles and of their relevance to social benefit.

It is generally accepted that, as a rule, investment in forestry and agriculture is less profitable than is that in other industries. The fact that investment is nevertheless undertaken in these activities may be interpreted as evidence that their intangible benefits are sufficient to compensate for their financial shortcomings. The latter, it may be argued, should therefore be obviated by adjusting the assumed rate of interest. This line of argument is advanced by Hiley (1930)

in relation to public investment in forestry and is essentially that taken by the Forestry Commission, as already mentioned in Chapter 3. In the Ellison Report, the question of interest rate is avoided by making calculations for several rates.

Selecting the rate of interest to suit the investment is theoretically unsound. Adjusting the interest rate to allow for intangibles not only implies their measurement but assumes their appreciation at a rate equal to the adjustment made. The technique has practical merit, however, for ranking investments having apparently different intangible benefits or costs. For the appraisal of public investment in land-using activities generally, a more realistic although effectively similar view is simply to accept that the social rate of time preference implicit in the government's actions is not what it is said to be. There is no need to confuse the question of interest rate as such with intangibles.

The relative degrees of uncertainty in forestry and agriculture are related to their production periods. In forestry, capital is at risk for a whole rotation and it is a number of years before any return at all is obtained. In agriculture, at least some outlay is repaid annually and the period necessary to recover total outlay plus interest is likely to be considerably shorter than a forest rotation. The capital invested in forestry is not easy to realize during the course of a rotation, even should the need arise, and can be quite unrealizable in the early years. This may apply even to land which, once afforested, is not readily converted to another use. In

agriculture, much of the capital invested goes into readily realizable assets such as livestock and equipment, while agricultural land is very flexible in the uses to which it can be put.

PART THREE

Review of Literature

PART IIIChapter 10Review of Literature

The allocation of hill land between forestry and agriculture is a subject which has aroused considerable interest in a number of countries. However, in Britain at least, comparatively few studies have been made of the relative economics of the two land-uses.

Walker (1958) examines some economic implications of government policy in Britain towards the acquisition of hill land by the Forestry Commission. He stresses the inconsistency of the Commission's being under the dual control of the Treasury and (in England) the Ministry of Agriculture. In Walker's view, the Ministry of Agriculture, by frequently obstructing the transfer of land from agriculture to forestry, are to blame for the Commission's failure both to fulfil their planting programmes and to become economically viable, as the Treasury require that they should be.

Walker compares the economic performances of the two land-uses on the basis of present value at the end of one forest

rotation. He finds the results of this comparison are determined by five major variables; these are the rate of interest on capital, the wage rates for forestry and agricultural workers, the relative prices of farm products and timber, the inclusion or exclusion of housing costs in the forestry account and the trend of net output in agriculture.

Walker's general conclusion is that the Forestry Commission justify their demand for land in most hill areas, provided the rate of interest on capital does not exceed 4 per cent. At this rate of interest, the Commission could afford to pay for their workers' houses, to outbid farmers for hill land and to pay 30 per cent higher wages. Assuming, however, that timber prices rise in relation to farm product prices and that the Commission do not in fact have to meet housing costs, Walker finds that, on the basis of NPV, forestry would replace agriculture at interest rates up to 7 per cent.

Walker's principal recommendations are, respectively, that the indiscriminate allocation of hill farming grants should cease, that the Forestry Commission should pay their workers higher wages, that the Commission should acquire land in large blocks rather than through the integration of forestry and agriculture and, finally, that the Commission should be permitted to pay higher prices for land. The last of these recommendations is based on the wrong assumption, already mentioned in Chapter 3, that the Commission are limited by the Treasury in the price they can pay for land.

As a study of government policy, Walker's study is comprehensive and informative. His accounting, however, is based on assumptions which are deliberately optimistic with regard to forestry but not to agriculture. In particular, he ignores the possibility of technical changes in hill farming rendering it a more profitable activity. A more serious criticism is that Walker, in effect, recommends the allocation of land between private agriculture and state forestry simply on the basis of financial profitability. Though presumably accepting as a maximand net social benefit, Walker does not attempt to include in his appraisal social costs and benefits. It is true that the satisfactory inclusion in Walker's model of such costs and benefits would be difficult or impossible, but to ignore them altogether is less defensible than would be to note their omission.

The Ellison Report (HMSO, 1966), which represents a review of the Zuckerman Report (HMSO, 1957), is a comprehensive study of agriculture and forestry in Britain. It investigates the economic performance and wider social implications of each of these land-uses, in relation to the utilisation of marginal land.

Economic comparisons of forestry and agriculture are made, like Walker's, on the basis of forecast profitability. Considerable attention is given in the Report to the choice of investment criteria and three criteria are in fact used. These are NPV per acre, NPV per £100 invested and yield. NPV calculations are made for interest rates of 3 per cent, 5 per cent and 7 per cent; by graphical interpolation, present values at all rates between

3 per cent and 7 per cent are determined.

Comparisons are made of the profitabilities of the two uses on three categories of land, namely unreclaimed marginal land, reclaimed marginal land and relatively fertile low ground capable of more intensive agricultural use. 'Marginal' land, in the context of the Report, refers to all land which, if in agricultural use, is only extensively farmed; the term appears to be synonymous with 'rough grazing'. Forecast profitabilities are calculated for both private and state investment, production grants and subsidies being deducted from the gross costs of the private investor but not from those of the state.

In terms of yield, agriculture is found to be more profitable than forestry, as a private investment, in all twelve of the areas for which results are quoted. As a state investment, agriculture gives the higher yield on all but one of those areas; on unreclaimed marginal land in Argyll, the yield from agriculture is found to be negative and that from forestry 2.5 per cent.

In terms of NPV per acre and NPV per £100 invested, agriculture is found generally to be more profitable than forestry on marginal land, both as a private and as a state investment, except at an interest rate of 4 per cent or less. On the better quality land, agriculture is found to be more profitable than forestry even at 3 per cent.

The Ellison Report stresses the need for larger scale

of enterprise in agriculture, especially on marginal land. This need is adequately demonstrated by an investigation of the relationship between farm size and NPV for extensive hill farming in Argyll.

The Report acknowledges that, from the national point of view, land should not be allocated between agriculture and forestry simply on the basis of financial profitability. It therefore seems anomalous that so much attention is paid in the Report to measures of forecast profitability and their application in ranking forestry and agriculture. As an exercise in methodology, the Report is relevant to decision-making in the private sector but contributes little to the analysis of the costs and benefits of public investment.

One of the conclusions made in the Report is the desirability, from the national point of view, of multiple land-use, including the integration of forestry and agriculture. It is unfortunate that this conclusion, apparently accepted from the earlier Zuckerman Report, is not substantiated by some form of economic analysis.

Undoubtedly one of the more pertinent conclusions of the Report is that it is possible that further investment in forestry or agriculture may be unjustified. This suggestion is in contrast to the view, widely held by both agriculturists and foresters, that because land is available it should be put to some formal use.

Simpson (1963) examines the economic implications of

government policy towards investment and land utilisation in the Scottish Highlands. He shows that the government have failed in their efforts to reduce Highland depopulation and attributes their failure to the absence of a unified approach based on economic analysis.

Simpson says that the criteria by which public investment in the Highlands should be assessed are profitability and employment. On the basis of these criteria, he concludes that further investment in either agriculture, fisheries or forestry is unjustified. Highland depopulation continues in spite of government support to these traditional, primary producing industries, while the very need for such support is prima facie evidence of their unprofitability. Simpson takes the view that government investment designed to favour a particular industry is almost always indefensible. The more effective type of investment is that which induces an increase in general productive capacity. He concludes that a policy of investment to promote industrialisation in the Highlands should therefore replace the present system of capital assistance to the primary producing industries.

Grayson (1964) refutes the validity of Simpson's criticisms in relation to forestry in the Highlands. He says that during the period studied by Simpson, while the numbers employed in agriculture and fisheries in the Highlands declined the numbers employed in forestry increased. Grayson also disputes Simpson's contention that, in the Highlands, neither agriculture, fisheries nor forestry have increasing returns

foreseeable; he claims that because of rising timber prices and the continuously increasing volume sold by the Forestry Commission, forestry in the Highlands is in fact showing increasing returns.

A study of north-west Scotland by Darling (1955) tends to support Grayson's argument concerning forestry and employment. Darling finds that wherever the principal land-use is sheep grazing the decline in population is continuous and severe; in areas where forestry and dairy farming are the principal uses, the population remains steady or the rate of depopulation is checked.

Taylor (1960) accepts that, on hill land, forestry is relatively more profitable than agriculture and is capable of providing more rural employment. He advocates integration, however, on sociological grounds, especially with regard to Wales, where he considers that a major change of land-use could adversely affect the national culture; this is the viewpoint to which Walker attributes the comparative failure of the Forestry Commission in Wales.

Taylor (1961) describes a general order of national priority for hill land utilisation, the uses for which hill land should be considered being, in order of national importance, water conservation, forestry, and stock rearing. He lists recreation among local priorities. Cooper (1959), describing the order of priority observed in allocating wild land in Arizona, ranks recreational use second in importance to water conservation

and above timber production and grazing; this well may be the more realistic evaluation for a densely populated country and may be relevant also to Britain. The overriding economic importance of water conservation as a hill land-use is stressed by Gregory (1960). He says that although hill land in Britain is only marginal in other forms of economic activity it can make a very significant contribution to national productivity through the supply of water to industry.

Ellison (1953) argues for the greater agricultural use of hill land in Britain and advocates capital injection to hill farms. He says that capital is better invested in this way than in industry because Britain sells industrial goods in a buyers' market but buys food in a sellers' market. This view is contrary to the principle of comparative advantage; Ellison is writing, however, against a background of food (especially meat) shortage and rationing. Ellison (1953, 1958) advocates the co-ordination of hill land-uses, this to include the integration of agriculture and forestry. His plea for integration appears to be based on the advantages to be gained from it through hill farming rather than upon a consideration of its overall desirability.

Ward (1963) and Ward et alia (1966), in reference to the allocation of land between agriculture and forestry in New Zealand, advocate the economic comparison of the two land-uses on the basis of land expectation value. Ward (1963) suggests the use of a differential risk rate to compensate for the relatively greater risks involved in forestry.

Ward et alia state the need for regional land-use planning according to the principle of comparative advantage rather than on the basis of straightforward profitability comparisons. This approach, incorporated within the framework of a national development programme, enables each region to specialise in those land-uses in which it has a comparative advantage over other regions. Although the authors are referring specifically to New Zealand and to land-uses in which that country has an overall comparative advantage, the approach they advocate is generally applicable.

Ward et alia favour the cost-benefit approach to national land-use planning but do not themselves attempt to develop a cost-benefit model. They stress the significance of the rate of interest and suggest that the rate of return on government bonds may be taken as an approximation to the social rate of time preference. Ward (1965) points out that a realistic investment appraisal in terms of net social benefit must involve complicated inter-sector analysis. He modifies the NPV criterion to include a balance of trade factor; the modified criterion is suggested for the appraisal of import replacement schemes and of other investments markedly affecting the balance of payments.

Thomson and Grainger (1961) are also concerned with the relative economics of forestry and agriculture in New Zealand. Their description of the general opposition there to forestry expansion could equally apply to Britain: in New Zealand, too, the transfer of land from agriculture to forestry has to be

economically justified while continued agricultural use does not.

Thomson and Grainger compare agriculture and forestry in New Zealand in terms of their relative contributions both to gross national product and to export earnings and in terms of the employment they provide. On each of these bases, forestry is found to be preferable to agriculture. The GNP comparison, however, favours forestry only because the time element is ignored. The comparison is made on the basis of forests already in full production and no account is taken of the long productive period in forestry. The authors take the view that, from the long-term national point of view, it is unimportant that land should be effectively unproductive for two or three decades. Such a view ignores the fact that other resources as well as land are invested in forestry and quite denies the concept of interest rate. In New Zealand especially, where investment in forestry means afforestation, a comparison of forestry and agriculture must take cognizance of the different productive periods of the two land-uses. With regard to employment, the valid point is made that employment provided in New Zealand by the various wood-processing industries considerably exceeds that provided by food-processing.

Treloar and Morison (1962) describe three case studies involving the economic comparison of forestry and agriculture in the hardwood/butterfat region of Western Australia. They investigate the economic effects of factor-factor adjustments within the butterfat activity, of alterations of the balance

of activities on existing butterfat farms and of the substitution of forestry for agricultural activities. The criteria used are gross and net present values, both per acre and as a percentage of costs. Calculations are made for a range of interest rates. The authors comment on the difficulty in assessing a social rate of interest and state that there is no identity between existing commercial rates and a meaningful social rate.

Treloar and Morison discuss criteria for a number of social goals. They equate the maximisation of net profit with the maximisation of economic welfare and advocate gross profitability in relation to the full employment goal. They say that profitability per acre is relevant where land but not capital is in short supply. In taking this view they differ from Ashby (1961), who says that because of its flexibility, only capital can be the limiting factor of production; Ashby's would appear to be the more realistic view.

PART FOUR

Case-Studies

PART IVChapter IIPossible Changes in Hill Farming Practice

The capital requirement of forestry is much greater than that of traditional hill farming. Given the necessary capital, however, it is possible to effect considerable changes in the agricultural productivity of hill land. The question arises as to whether the injection of capital into hill farming on the same scale as that into forestry would significantly affect the relative economics of the two land-uses and the allocation of land between them.

The overwhelming argument against greater investment in hill farming is unrelated to the desirability of investment in forestry; it is simply that any extra funds to be allocated to agriculture are best directed to low ground farming where returns are higher in both physical and financial terms. To produce at high cost in the hills what can be produced for less on low ground is contrary to the principle of comparative advantage.

An alternative to greater intensification in hill agriculture is extensive ranching, with no permanent labour.

Robertson (1964) says that this can be economically very successful and that it is particularly compatible with the use of land for sport. Generally, however, it is not technically feasible and it is seldom practised.

The basic aim in the intensification of hill sheep farming is to overcome the winter restriction on stock numbers and lamb production. This may be achieved by increasing the supply of winter feed, by more intensive pasture management and by wintering part or all of the flock on low ground farms or in buildings. Generally speaking, an increase in stocking or lambing percentage is desirable only if it requires no extra labour. If possible, a reduction in labour input is affected.

Two techniques which give both higher total production and higher productivity per man are the sub-division of pasture and inwintering. Sub-division is the most important prerequisite of any pasture improvement programme and is intended to procure the complete utilisation of pasture throughout the year.

The effects of sward improvement measures and of increasing the supply of winter feed are limited in the absence of sub-division because of the social behaviour of sheep. Pasture improvement on the unfenced hill must be done in scattered blocks if it is to benefit a high proportion of the sheep flock (Hunter, 1964). Sward improvement by cultivation and re-seeding is particularly costly and, in many areas, may be precluded by mechanical difficulties. Given the capital and easily accessible land, the achievement of as much as a

fifteen-fold increase in summer stocking rate presents no problem. No investigations have been made of the economics of large-scale hill sward improvement in Britain but from preliminary investigations the indication is that such measures are generally not financially profitable^I.

With sub-division, considerable improvement in sward production can be achieved simply by grazing management techniques, especially where both sheep and cattle are grazed. As Robertson (1964) and Hunter (1962) point out, the quality of pasture tends to degenerate when grazed by sheep alone. The ecological disadvantages of hill sheep farming are, of course, one of the more widely advocated justifications for the transfer of hill land to forestry (e.g. Edwards, 1964; Steven, 1964). Suckling (1965) cites an example in New Zealand of the stocking rate being doubled by sub-division alone.

Flock inwintering necessitates outlay on buildings and involves increased annual expenditure on feed. It enables lambing to take place in a relatively controlled environment and obviates nutritional stress. The number of lambs weaned is increased by about one quarter and, largely because of the fresh pasture available, they can be sold fat instead of in the store market. Ewe mortality is reduced and each ewe can be run for an extra year, that is, on average, for five years instead of four. Hill ewe mortality is usually about 7 per cent, although in particularly unfavourable years it may rise

I Personal communication from R.L. Reid, Hill Farming Research Institute, Edinburgh.

to as much as 60 per cent. By inwintering, ewe mortality is reduced to about 4 per cent and the possibility of occasional catastrophes due to exceptional weather is avoided. Depending on the degree to which the summer pasture is under-utilised, flock size may be increased by up to 50 per cent. There is also the possibility with inwintering of changing from the traditional hill breeds to a heavier type of sheep.

Instead of inwintering the entire flock, only the ewe hoggs may be inwintered. This saves the cost of overwintering them on low ground farms, which is the normal practice. The savings made by inwintering hoggs are unlikely to be enough to justify outlay on new buildings. Hogg inwintering may be a more economic proposition where buildings are already available.

The chief disadvantage of inwintering sheep is the possibility of disease. The prevention of disease can be expected to become a major problem and a considerable expense where sheep are overwintered in buildings.

Chapter 12Case-Studies

The two case-study areas chosen are Rowardennan in west Stirlingshire and Glenprosen in Angus. Each area comprises a forest unit managed by the Forestry Commission and a farm managed by the Department of Agriculture for Scotland. They are areas where forestry and agriculture are integrated. In terms of physiography and ecology, both are fairly typical of the bulk of hill land in the central Highlands and the retained agricultural land on each is farmed according to traditional hill sheep-farming practice.

Both areas have the same background of acquisition as hill farms by the Forestry Commission, followed by partial afforestation. The acreage of farmland on each has declined as the area of forest has increased by progressive 'resumptions'. The present distribution of land between forestry and agriculture, however, is unlikely to be markedly changed on either area. Management of the retained farm units was undertaken by the Department of Agriculture because of their poor condition at the time of acquisition by the Commission. The Department's intention is that the farms should be sold or let as soon as they have been made into economically viable units. This stage has in fact been reached at both Glenprosen and Rowardennan and the Department will dispose of the farms there as soon as possible.

Rowardennan

The area referred to as Rowardennan is made up of Rowardennan forest and Blairvockie farm and extends along the east side of Loch Lomond.

The area is subject to a distinctly maritime climate, with high annual precipitation and mild winters. The land rises from practically sea level at the loch side to 3,200ft at the summit of Ben Lomond and comprises a number of soil types, mostly of fairly low pH.

Because of its proximity to Loch Lomond and to Glasgow, which is 25 miles away, the area is subject to considerable recreational use. In response to the recreational demand, the Forestry Commission have recently established a camp site on the loch side. Rowardennan forest is one of the three forests comprising the Queen Elizabeth Forest Park.

AGRICULTURE

Table I6 is a statement of the area, stocking and valuation of Blairvockie farm for the year 1966. The valuation of stock and equipment is from the Department's annual farm accounts, the values shown being accurately computed on the basis of market prices. The figure for land is a rough estimate made by the Department of the price for which the land and buildings at Blairvockie would sell for agricultural use.

Table 16BLAIRVOCKIE: AREA, STOCKING AND VALUATION FOR 1966

	<u>Valuation (£)</u>
<u>Area</u> 5,480 acres	20,000
 <u>Stock</u>	
Sheep (blackface):	
1,840 ewes and gimmers	11,040
550 ewe hoggs	3,163
50 rams and ram lambs	939
	<hr/>
total sheep	15,142
	<hr/>
Cattle:	
15 Aberdeen Angus cross cows	715
8 Highland cows	288
4 Highland heifers	260
2 Shorthorn bulls	128
	<hr/>
total cattle	1,391
	<hr/>
<u>Equipment etc</u>	223
	<hr/> <hr/>
Total valuation (to nearest £100)	36,800
	<hr/> <hr/>

The sheep flock comprises two hirsels of a high quality strain of blackface sheep. The lambing percentage is usually in the region of 80 per cent which compares with the average for the locality of about 65 per cent. The relatively high percentage at Blairvockie is attributable solely to good management by the Department and is achieved at no extra cost.

One quarter of the annual lamb production is retained for flock replacement. The need to retain such a high proportion of lambs each year has the disadvantage that it reduces the degree of selection possible. The purchase of ewes from outside is precluded by price and only rams are normally bought in.

Ewe hoggs are wintered away and no supplementary feeding is necessary for the breeding flock left on the hill. The cattle are outwintered on low ground and require supplementary feeding. Both lambs and calves are sold in the store market.

Blairvockie has a total labour force, excluding the Department's supervisory staff, of two men, both shepherds. This is the minimum possible labour strength at the present level of stocking. The breeding flock in 1967 has been reduced to 1,680 ewes and is likely to remain at about this figure.

Table I7 shows the annual net cash-flows for Blairvockie farm for the years 1961 to 1966 and the average net cash-flow for the last three years of that period. The figures in columns A, B and D are extracted from the Department's accounts. As the Department's farm accounting system ignores supervisory and clerical costs, it is necessary to make an estimate of overheads

Table 17BLAIRVOCKIE: ANNUAL NET CASH-FLOWS 1961-66

<u>Year</u>	<u>Costs (£)</u>			<u>Returns (£)</u>	<u>Net</u>
	A	B	C	D	<u>Cash-flow</u>
	<u>Purchases</u>	<u>Subsidies</u>	<u>Overheads</u>	<u>Sales</u>	E
61/62	4,906	1,169	1,500	5,939	-1,636
62/63	6,193	1,319	1,500	7,246	-1,766
63/64	6,270	2,718	1,500	5,833	-4,655
64/65	5,764	2,393	1,500	7,013	-2,644
65/66	7,143	2,447	1,500	6,995	-4,095
3 year average (1963-66)	6,392	2,519	1,500	6,614	-3,798

expenditure; the estimate made, of £1,500 annually, is for overhead costs up to area office level. Because of the diversity of overheads involved, their accurate assessment is not possible in the absence of appropriate records; the figure assumed is the maximum probable cost of overheads and their actual cost may be somewhat lower. Supervisory and clerical expenditure (up to area office level) is likely to be less for a Department farm than for one in private ownership because of the division of the Department's costs between a number of farms.

It can be seen from Table 17 that, treating subsidies as costs and taking annual overhead costs as £1,500, Blairvockie yielded a negative net cash-flow in each of the years 1961 to 1966.

It is interesting to note that the deficit in each year exceeds the assumed overheads expenditure; even if overheads are ignored, therefore, the net cash-flows are all still negative. Table I8 is a detailed statement of the net cash-flow for the year 1965/66. It can be seen that from this table that, excluding assumed overheads, the major items of expenditure are labour, the overwintering of hogs and the hill sheep subsidy.

The costs and returns for the years 1963 to 1966 may be used as a basis for forecasting future net cash-flows; no marked changes are foreseeable in the general level of either costs or returns associated with traditional hill farming. The annual net cash-flow forecast must be adjusted to allow for the recent reduction in the ewe flock to 1,680 ewes. A reduction in flock size affects the returns from the sale of both lambs and wool but affects only certain costs; these are the costs attributable to overwintering, dipping and the sheep subsidy. The weighted average difference between these costs and returns in the years 1963 to 1966 was £1.2 per ewe; the average ewe flock during this period was 1,778 ewes and gimmers. The present ewe flock therefore represents a reduction of 98 ewes or £118 annual net cash-flow. The forecast annual net cash-flow then becomes £(-3,798 - 118), which is -£3,916 or -£0.7 per acre.

Table I9 is a forecast of incremental costs and returns for flock inwintering at Blairvockie. The forecast assumes minimal building costs and that ewes and hogs each receive,

Table 18BLAIRVOCKIE: NET CASH FLOW FOR THE YEAR 1965/66

	£
<u>Costs</u>	
labour	2,123
overheads	1,500
cattle	475
sheep	670
wintering of hoggs	1,705
feeding stuffs	948
sheep dipping expenses	338
manures and fertilisers	190
implements, equipment and repairs	49
carriage and transport	228
petrol and oils	192
maintenance of buildings	90
hill cattle subsidy	273
calves subsidy	186
hill sheep subsidy	1,932
fertiliser subsidy	56
miscellaneous	135
	<hr/>
total costs	11,090
	<hr/>
<u>Returns</u>	
cattle	786
sheep	4,474
wool	1,735
	<hr/>
total returns	6,995
	<hr/>
NET CASH-FLOW	-4,095

Table 19BLAIRVOCKIE: FLOCK INWINTERING FORECAST

	£
<u>Incremental Costs</u>	
initial outlay (building):	
£2 per ewe for 1,680 ewes	3,360
£2 per hogg for 336 hoggs	672
£2 per ram for 40 rams	80

total initial outlay	4,112

annual costs:	
84 fewer cast ewes at £4.25	357
feed £2.09 per ewe for 1,680 ewes	3,502
feed £2.09 per hogg for 336 hoggs	702
feed £1.64 per ram for 40 rams	66

total annual cost	4,627

<u>Incremental Returns</u>	
cost of overwintering hoggs and rams	1,120
extra revenue from sale of lambs	2,678

total return	3,798

approximate CAPITAL COST	4,100
approximate ANNUAL NET CASH-FLOW	-830

over a period of 100 days, 150lb hay at £18 per ton and 60lb concentrates at 3.5d per lb; the assumed feed input for rams is 150lb hay and 30lb concentrates. It is assumed that under the present system the number of hoggs overwintered each year is equivalent to one quarter of the ewe flock and that, by inwintering, this number is reduced to one fifth because of longer ewe life. This means that fewer cast ewes and more lambs are sold each year. The incremental return estimate incorporates the further assumptions that the percentage of lambs weaned is increased by 25 per cent and that the average lamb price rises from £4.75 to £5.25.

The assumption that, under the existing system, only a quarter of the ewes are replaced annually is not accurate as it ignores ewe mortality. In recent years, the number of hoggs overwintered each year, to replace both cast ewes and losses, has been nearer one third of the total ewe flock; this high proportion, however, has been partly due to the fact that the ewe flock has, until this year, been annually increased in size. By reducing ewe mortality, inwintering might be expected to result in a somewhat greater return than that shown in the table. On the other hand, a significant incremental cost which is omitted is veterinary expenses.

In view of the fact that the breeding flock at Blairvockie normally receives no supplementary feeding, the negative cash-flow forecast for flock inwintering there is to be expected. Even if the labour input could be reduced by flock inwintering from two men to one, the net return would, on the other assumptions

made, still be negative or nil. In fact, because of the flock size alone, it is unlikely that a labour reduction could be effected at Blairvockie without a more elaborate and more expensive type of building than that envisaged in the financial forecast given.

Table 20 is a forecast of the probable incremental costs and returns for hogg inwintering at Blairvockie. The substantial positive net cash-flow is a reflection of the expense incurred by overwintering hogs on a low ground farm. This cost is not constant for all hill farms but depends on where and how far away the hogs are sent for overwintering. As for the flock inwintering forecast, the assumption is made that the number of hogs overwintered is equivalent to only one quarter of the ewe flock. In fact, as more than this number of hogs is retained, both the capital cost and the net cash-flow from inwintering could be expected to be slightly greater than the figure shown.

Although hogg inwintering at Blairvockie would appear to be, as an investment in itself, worthy of consideration, its net return would make only little impact on the overall annual deficit. Assuming, however, that hill sheep farming is to continue at Blairvockie, the adoption of hogg inwintering could obviously reduce the net cost of the enterprise. In terms of financial profitability, the net cash-flow shown in Table 20 has a present value, at, for example, 5 per cent over 20 years, of £2,200. 20 years is the sort of period for which the cheapest type of building might reasonably be expected to last. The net present value of the investment at 5 per cent is then £1,280.

Table 20BLAIRVOCKIE: HOGG INWINTERING FORECAST

	£
<u>Incremental Costs</u>	
initial outlay (buildings):	
£2 per hogg for 420 hoggs	840
£2 per ram for 40 rams	80
	<hr/>
total initial outlay	920
	<hr/>
annual costs:	
feed £2.09 per hogg for 420 hoggs	878
feed £1.64 per ram for 40 rams	66
	<hr/>
total annual cost	944
	<hr/>
<u>Incremental Returns</u>	
cost of overwintering hoggs and rams	1,120
	<hr/>
total return	1,120
	<hr/>
<hr/>	
approximate CAPITAL COST	920
approximate ANNUAL NET CASH-FLOW	176
	<hr/>

FORESTRY

Rowardennan forest has been created since 1951, the year in which the area was acquired by the Forestry Commission. The forest provides employment for six forest workers and two foresters, all of whom are housed at Rowardennan by the Forestry Commission.

With the exception of a substantial area of oak, which is retained for amenity, none of the plantations dates from before 1951. From Table 22, it can be seen that, in terms of area planted, the principal species are Sitka and Norway spruce and Japanese and hybrid larch. It is intended largely to replace the larch with spruce in the next rotation because of the latter's greater volume production; larch is currently planted only on the less productive sites, for amenity.

Tables 21 to 23 constitute a financial forecast for Rowardennan, on the basis of net present value. The forecast assumes an interest rate of 5 per cent.

The unit costs shown in Table 21 are, with the exception of the brashing cost, actual weighted averages for Rowardennan, extracted from the Commission's accounts. The brashing cost is taken from the most recent survey of private forestry costs in Scotland (Aberdeen University, 1966) and is probably an underestimate for Rowardennan in view of the high proportion of spruce there. In general, costs at Rowardennan are high by comparison with many of the Commission's forests. This is attributable, firstly, to the nature of the terrain, secondly

Table 21ROWARDENNAN: FORESTRY COSTS

	<u>weighted average cost per acre (£)</u>
Establishment:	
preparation of ground	8.54
planting	17.30
new drains	4.73
new fences	4.41
weeding (5 years at £3.5)	17.50
beating up	1.91

total direct cost	54.39
add 57 per cent overheads	85.40

Maintenance:	
drains	0.30
fences	0.10
protection	0.38
roads	0.10

total direct cost	0.88
add 57 per cent overheads	1.38

Brashing (£12.2 plus 57 per cent overheads)	19.15
Roads £6,460 per mile (including overheads)	

to the high rainfall and, thirdly, to the fact that slightly higher wages are paid at Rowardennan in order to attract and retain forest workers.

The figures for discounted revenue given in Table 22 are based on estimates given in the Forestry Commission's Working Plans Code (Forestry Commission, 1965). The estimates have been reduced to the extent recommended in the Code, to take account of the long haulage distance necessary for small roundwood. Rowardennan is at present on the fringe of the supply area for the Fort William pulp mill but this market will be lost as the radius of the supply area contracts. No other markets have yet been established for Rowardennan produce.

The Commission's discounted revenue estimates incorporate the assumption that timber prices will, in the future, rise by 1.5 per cent per annum in relation to the prices of other commodities. The undue optimism of this assumption has already been discussed in Chapter 3. In view of the probable inaccuracy of the Commission's basic forecasts and the paucity of markets at Rowardennan, at least for early produce, Table 22 almost certainly represents a gross over-estimate of the forest's discounted revenue.

Table 23 is a forecast of the net discounted revenues per acre and per £100 invested for Rowardennan. It assumes a continuing series of 50 year rotations. Although undesirable, the assumption is necessary because the Commission's discounted revenue estimates are made on the basis of an infinite investment

Table 22

ROWARDENNAN FOREST: DISCOUNTED REVENUE

A	B	C	D
<u>Species</u>	<u>Acreage</u>	<u>Weighted Average Yield Class</u>	<u>Revenue Discounted at 5 per cent</u>
Scots pine	135	100	10,125
lodgepole pine	90	80	5,400
European larch	35	80	2,800
Japanese/hybrid larch	500	120	72,500
Norway spruce	620	140	74,400
Sitka spruce	890	180	186,950
Douglas fir	65	160	12,675
western hemlock	40	180	6,600
noble fir	55	180	9,625
oak and other hardwoods	385		
	2,815		381,000

Discounted revenue per acre of productive woodland
(i.e. excluding oak etc) = £157

Table 23ROWARDENNAN FOREST: PROFITABILITY

	<u>Expenditure Discounted</u> <u>at 5 per cent (£ per acre)</u>
<u>Establishment</u> £35.4 in year I, then every 50 years	93.56
<u>Brashing</u> £19.15 in year 20, then every 50 years	7.90
<u>Maintenance</u> £1.38 annually	27.60
<u>Roads</u> 2 miles per square mile in year I	20.18
6 miles per square mile in year 20	22.81
	<hr/>
total discounted cost	172.05
	<hr/>

Discounted Revenue	£ 157
Discounted Cost	172
	<hr/>
Net Discounted Revenue	-15 per acre
	<hr/>

Discounted Investment = establishment, brashing, roads,
two thirds maintenance

= £163

Net Discounted Revenue
per £100 Discounted Investment = -£9.3

period. The choice of rotation length has, within wide limits, little affect on the outcome of the calculation.

For convenience, all establishment costs are contracted into one year. Although inaccurate, this is unlikely to greatly affect their total value. Roothing costs are based on actual unit costs for the area but the timing of roads expenditures and the final rooding density are assumptions; they are probably realistic enough not to invalidate the calculation.

Although the conclusion that, at an interest rate of 5 per cent, Rowardennan forest yields a negative return is almost certainly correct, the calculation is included rather as an illustration of the NPV technique to a forestry investment than as an accurate forecast for a particular forest. The sensitivity of the calculation to the rate of interest may be demonstrated by the fact that, if the rate of interest is taken as 3.5 per cent instead of 5.0 per cent, the total discounted revenue becomes approximately £1m instead of £381,000.

NET SOCIAL BENEFIT

It is not suggested that the financial forecasts made are equivalent to estimates of the net social worth of the various alternatives discussed. The choice of an interest rate of 5 per cent is arbitrary and is not advanced as a measure of social time preference. A net social benefit calculation of land utilisation at Rowardennan would need to take into account

numerous other factors, of which one of the more important is recreational use.

The significance of recreational use at Rowardennan is indicated by the gross annual revenue from the Forestry Commission's permanent camp-site. The average gross annual revenue for the three years 1963-65 was approximately £2,350. The figure for net revenue is not known, although an estimate may be made by subtracting from the gross revenue figure an estimate of supervisory and overhead costs. Taking the annual cost of supervision at £800 and overheads (60 per cent) at £480, the annual net revenue becomes £1,070. This is on a capital outlay of approximately £13,000. A meaningful measure of the recreational value of Rowardennan would require a comprehensive study of recreational demand. Although this demand is undoubtedly high, it is unlikely that its value could fairly be considered as a benefit of the whole of either the forest or the farming enterprise.

Apart from recreation, the other major local benefit from the use of the land at Rowardennan is the employment provided. Forestry employs and houses in the area a total of eight personnel, at the rate of one man per 470 acres; agriculture employs a total of only two workers, at the rate of one man per 2,740 acres. As the Commission are themselves to undertake harvesting operations at Rowardennan, the timber production enterprise is unlikely indirectly to provide much other employment in the locality. The greatest contribution to employment is likely to be made by the recreational use of

the area.

Glenprosen

The area referred to as Glenprosen comprises Glenprosen forest and Runtaleave farm and is situated about 12 miles north-west of Kirriemuir.

As regards climate, annual precipitation is moderate but snow lies for some months during winter. Most of the area is exposed and cold east winds are a disadvantage for both forestry and stock-rearing. The land varies in elevation between 1,000ft and 2,000ft above sea level. The predominant site type is Calluna heath. Glenprosen is far from the major centres of population and is not distinguished scenically. Its only recreational use is in grouse-shooting. Glenprosen is in fact one of the most highly valued grouse-shooting areas in Scotland.

AGRICULTURE

Table 24 is a statement of the area, stocking and valuation of Glenprosen for 1966. As for Blairvockie, the valuation figures are from the Department's farm accounts; the figure for land is an estimate made by the Department of the value of the land as sheep pastures.

Table 24RUNTALEAVE: AREA, STOCKING AND VALUATION FOR 1966

	<u>Valuation (£)</u>
<u>Area</u> 4,683 acres	13,500 ^I
 <u>Stock</u>	
Sheep (blackface):	
863 ewes and gimmers	5,894
248 ewe hoggs	1,631
30 rams and ram lambs	624
	<hr/>
total sheep	8,149
	<hr/>
 <u>Equipment etc</u>	 422
	<hr/> <hr/>
Total valuation (to nearest £100)	22,100
	<hr/> <hr/>

I £13,500 is the estimated price which the land would fetch for sheep farming alone and excludes the sport value; for grouse-shooting alone, the price of the land could be as much as £25,000

The sheep stock comprises one complete and one incomplete hirsel of blackface sheep. The lambing percentage is up to 100 per cent in favourable years. The difference between the lambing percentage of Runtaleave and that of Blairvockie is a reflection of the relatively high rainfall to which the latter area is subject.

As at Blairvockie, ewe hoggs are wintered away and the breeding flock remain on the hill. At Runtaleave, however, because of the less favourable climate it is necessary to feed the breeding flock during winter. Cattle are not kept because of the absence of buildings for inwintering. The outwintering of cattle is precluded by the generally high altitude of the land and by the concomitant exposure. There is no inbye or sheltered land. As at Blairvockie, lambs are sold in the store market.

Excluding supervisory staff, Runtaleave has a labour force of one shepherd. The breeding flock at Glenprosen has been reduced to 620 ewes in 1967. This is as a result of a 550 acre resumption by the Forestry Commission during the preceeding year. No further large resumptions are likely and the breeding flock is likely to remain at about this figure.

Table 25, for Runtaleave, is analagous to Table 17, for Blairvockie. Because Runtaleave necessitates less supervisory and clerical time than does Blairvockie, the estimate for overhead costs is reduced to £1,000. The table shows that Runtaleave yielded a negative net cash-flow in each of the

Table 25RUNTALEAVE: ANNUAL NET CASH-FLOWS 1961-66

<u>Year</u>	<u>Costs (£)</u>			<u>Returns (£)</u>	<u>Net Cash-flow E</u>
	A	B	C	D	
	<u>Purchases</u>	<u>Subsidies</u>	<u>Overheads</u>	<u>Sales</u>	
61/62	4,973	562	1,000	5,152	-1,383
62/63	5,338	977	1,000	5,370	-1,945
63/64	4,726	1,314	1,000	4,382	-2,658
64/65	4,995	1,497	1,000	4,981	-2,511
65/66	4,228	967	1,000	4,360	-1,835
3 year average (1963-66)	4,650	1,259	1,000	4,574	-2,335

years 1961 to 1966. As with Blairvockie, the deficit exceeds the estimated overheads. Table 26 is a detailed statement of the net cash-flow for the year 1965/66.

In order to make a net cash-flow forecast, the three year average must be adjusted to take account of the recent reduction in flock size. The necessary adjustment to the Glenprosen forecast, calculated as for Blairvockie, is £2.1 per ewe. The average ewe flock in the period 1963 to 1966 was 913 ewes and gimmers. The present ewe flock of 620 therefore represents a reduction of 293 ewes or £615 annual net cash-flow. An additional adjustment is necessary because the labour input in the period was two men (i.e. in the period 1963 to 1966) but is now only one man. This represents a

Table 26RUNTALEAVE: NET CASH-FLOW FOR THE YEAR 1965/66

	£
<u>Costs</u>	
labour	1,916
overheads	1,000
sheep	367
wintering of hoggs	603
feeding stuffs	533
sheep dipping expenses	178
cultivations	40
implements, equipment and repairs	5
carriage and transport	177
petrol and oils	28
repairs to buildings and fences	265
hill sheep subsidy	905
fencing grant	62
miscellaneous	116

total costs	6,195

<u>Returns</u>	
sheep	3,368
wool	897
grazing rent	95

total returns	4,360

NET CASH-FLOW	-1,835

reduction in costs of approximately £800 per year. The forecast annual net cash-flow then becomes $\pounds(-2,335 - 415 + 800)$, which is $\pounds-1,950$ or $\pounds-0.4$ per acre.

Table 27 is a forecast of incremental costs and returns for flock inwintering at Runtaleave. The table is based on assumptions similar to those made for the equivalent forecast for Blairvockie. A larger increase in lamb prices is assumed, however, because of the generally greater potential of Runtaleave; the average lamb price is assumed to rise from $\pounds4.75$ to $\pounds5.55$. The positive net cash-flow forecast in Table 27 is due to the fact that, under the present system, the breeding flock receives supplementary feed during the winter months.

During the summer, the hill pasture at Glenprosen is definitely under-utilised and could support a considerably increased sheep flock. An associated increase in flock size could obviously make inwintering an even more attractive investment. An increase of approximately 30 per cent or 200 ewes, for example, would involve an additional capital outlay of about $\pounds500$ and additional annual feeding costs of about $\pounds400$; additional annual returns would be of the order of $\pounds1,300$. The final net cash-flow would then be $\pounds840$, on a capital outlay of just over $\pounds2,000$. This net cash-flow, however, would still be quite inadequate to eliminate the overall annual deficit of the farm enterprise.

Table 28 is a forecast of incremental costs and returns for hogg inwintering at Runtaleave. It differs from the equivalent Blairvockie forecast in that the imputed saving on

Table 27RUNTALEAVE: FLOCK INWINTERING FORECAST

<u>Incremental Costs</u>	£
initial outlay (buildings):	
£2 per ewe for 620 ewes	1,240
£2 per hogg for 124 hoggs	248
£2 per ram for 30 rams	60
	<hr/>
total initial outlay	1,548
	<hr/>
annual costs:	
31 fewer cast ewes at £4.85	150
feed £1.39 per ewe for 620 ewes	862
feed £2.09 per hogg for 124 hoggs	259
feed £1.64 per ram for 30 rams	49
	<hr/>
total annual cost	1,320
	<hr/>
<u>Incremental Returns</u>	
cost of overwintering hoggs and rams	380
extra revenue from sale of lambs	1,381
	<hr/>
total return	1,761
	<hr/>
approximate CAPITAL COST	1,550
approximate ANNUAL NET CASH-FLOW	440
	<hr/>

Table 23RUNTALEAVE: HOGG INWINTERING FORECAST

	£
<u>Incremental Costs</u>	
initial outlay (building):	
£2 per hogg for 180 hoggs	360
£2 per ram for 30 rams	60
	<hr/>
total initial outlay	420
	<hr/>
annual costs:	
feed £2.09 per hogg for 180 hoggs	376
feed £1.64 per ram for 30 rams	49
	<hr/>
total annual cost	425
	<hr/>
<u>Incremental Returns</u>	
cost of overwintering hoggs and rams	43I
	<hr/>
total return	43I
	<hr/>
<hr/>	
approximate CAPITAL COST	420
approximate ANNUAL NET CASH-FLOW	6
	<hr/>

overwintering costs is the actual average overwintering cost, adjusted for flock size, for the last three years. The use of this figure results in a greater forecast return than would the assumption that, under the present system, only one quarter of the breeding flock is annually replaced; at Runtaleave, too, the number of hogs overwintered each year is equivalent to nearer one third than one quarter of the breeding flock. The negligible net cash-flow forecast in Table 28 is a reflection of the comparatively low cost of overwintering hogs from Runtaleave on low ground farms.

FORESTRY

Glenprosen forest has been created by the Forestry Commission since their acquisition of the area in 1955. The total area of forest land is approximately 2,660 acres, of which 1,500 acres is planted to date. It is expected that the forest, when fully planted, will consist of roughly equal areas of Sitka spruce, lodgepole pine and Scots pine, all of low yield class. The estimated average yield class for Sitka spruce is 140, for lodgepole pine 60 and for Scots pine 60.

Information on Glenprosen forest is not available in the same detail as is that on Rowardennan and it is not proposed to attempt a financial profitability forecast. A previous study made of forestry and agriculture at Glenprosen (DAFS, 1958) sought to compare the forecast yields from the existing system of integration with those from an imagined system of pure

forestry. This study forecast a yield of about 2.5 per cent for the integrated system and of just over 2.5 per cent for forestry alone. This forecast, made on the assumption that the predominant forestry production would be Quality Class III Scots pine, is probably fairly realistic.

NET SOCIAL BENEFIT

As at Rowardennan, an appraisal of the net social benefit yielded by land utilisation at Glenprosen would need to take into account factors other than the financial profitabilities of forestry and agriculture. The most important of these factors locally is likely to be the value of the area as a grouse-moor. Shooting on the agricultural area is currently let at a rent of £1,000 per annum, a figure which could almost certainly be raised. The grouse-shooting rent is a net revenue. While the income from grouse-shooting is small on a per acre basis, being only £0.2 annually, it is high in relation to capital invested. Virtually no capital outlay is necessary except for the provision of the land itself. Where, as at Glenprosen, the price of publicly owned land is effectively increased by its value for grouse-shooting, the most profitable course of action, from the national point of view, might well be the disposal of the land to a private buyer.

The use of land for grouse-shooting is compatible with the traditional system of sheep-farming but not with forestry. Thus the grouse revenue may be included as a benefit of the

agricultural enterprise. The continued agricultural use of Glenprosen, however, is not essential to its continued use as a grouse-moor. In view of the negative return from agriculture, a higher net revenue is to be obtained by using the land only for grouse-shooting than by using it also for agriculture.

None of the land-uses at Glenprosen contributes significantly to employment in the area. Forestry workers are brought from another forest 25 miles away, while the agricultural enterprise and grouse-shooting each provide permanent employment for only one man.

PART FIVE

Conclusions

PART 5Chapter 13Conclusions

I. Although largely under agricultural use, hill land in Britain is of little real importance to the country's agricultural industry. Hill agriculture contributes only 3 to 4 per cent by value of gross agricultural production and it appears that low ground farming could, if necessary, replace production lost by the contraction or cessation of agriculture in the hills. On the other hand, hill land is of major importance to British forestry. If there is to be a forestry industry in Britain and if the Forestry Commission are to execute their programme of expansion, then an adequate supply of hill land for afforestation is essential. The difference between the productivity of hill land and that of low ground is very much less for forestry than it is for agriculture. As far as coniferous timber is concerned, the production capability of hill land relative to that of low ground may be enhanced by higher prices obtaining for hill produce. According to the principle of comparative advantage, low ground should, in general, be allocated to agriculture and hill land to forestry.

2. Government support for agriculture in Britain is essentially a social measure and is not justified either by balance of payments considerations or by the possibility of future world food shortage; nor can it be interpreted as a consumer subsidy or cheap food policy. The most serious disadvantage of subsidising agriculture is that it discourages the mobility of agricultural manpower. Necessary structural changes within the industry itself are impeded and so too is the transfer of land from agriculture to other land-uses.

3. The financial position of the Forestry Commission clearly needs clarifying in relation to their investment goals. As a commercial organisation they fail because of the interest charged on their Treasury advances. The Commission's explanation of their annually increasing book deficit in terms of intangible benefits is not supported by their managerial practice. Justification of the Commission's expenditure partly in terms of intangible benefits is plausible only if these intangibles observedly feature in their investment objectives. By continuing to publish accounts demonstrating their financial shortcomings, the Forestry Commission risk severe public criticism and its possibly serious consequences; such a policy seems particularly inadvisable.

4. The basic goal assumed for the purpose of investment appraisal must be the maximisation of utility; for public investment, this may be termed net social benefit. The present value rule is conceptually and practically superior to the yield criterion and is the logical maximand for all investment.

5. The determination of interest rate presents a peculiarly difficult problem in investment appraisal, especially for public investment, the benefits and costs of which should be discounted at the rate of social time preference. This rate cannot be determined empirically but is dictated by government.

6. From the case-studies, it appears that hill sheep-farming cannot be justified in terms of financial profitability. By yielding a negative annual net cash-flow, hill farming must be unprofitable at all positive rates of interest. Forestry, on the other hand, can be represented as being financially profitable by the assumption of a low rate of interest.

7. The financial prospects of flock inwintering depend largely upon whether or not the flock normally receives supplementary winter feed when overwintered outside. On the majority of hill farms, supplementary feeding is necessary and flock inwintering is, as an investment in itself, likely to be well worth consideration.

8. The financial attractiveness of hogg inwintering depends upon the normal cost of overwintering hogs on low ground. This cost varies from farm to farm. On farms where normal overwintering costs are high, the change to hogg inwintering can serve to reduce costs.

9. Although no information is presented in this study on the probable financial results of other methods of increasing the agricultural productivity of hill land, it seems unlikely that, in general, such improvement can be justified in terms

of net financial return. The chief argument against greater capital injection into hill farming is that such public funds as may be made available for agriculture are better directed to low ground agriculture, where they can earn a higher return in both physical and financial terms.

IO. Neither forestry nor agriculture is justified as a hill land-use by the employment it provides. Forestry undoubtedly does more to prevent rural depopulation than does hill sheep-farming but, in Britain, cannot itself foster long-term stability. Rural depopulation is prevented, if at all, only by diversification of the regional economy to include a number of new industries. The creation or maintenance of a local population on the basis of the primary producing industries is not practicable.

II. The overriding conclusion to be drawn from the study of agriculture and forestry on hill land in Scotland is that perhaps further public investment in either is, in general, unjustified. The implementation of this conclusion would mean the severe contraction of hill farming and the cessation of forestry expansion. The future of existing state forests would depend upon their stage of maturity, upon their local interdependencies and upon their intangible benefits; it is generally true to say that the most important of these benefits, the provision of facilities for outdoor recreation, currently obtains only in the vicinity of the major centres of population. Grouse-shooting is compatible only with traditional sheep-farming. It cannot, however, be advanced as a justification

for the agricultural use of the hills. The maintenance of grouse moors need not involve ancillary investment in agriculture.

12. While the continuation of hill agriculture is evidently a political expedient, the real reasons for state participation in forestry are less clear. It may be that the strategic argument which justified the Forestry Commission initially is still regarded, although not explicitly, as being sufficiently relevant in the present day to warrant the continued expansion of the national forest estate. If this is so, then the present system of land allocation is all the more unreasonable. In particular, the integration of forestry and agriculture on hill land, as a matter of policy, is unjustifiable in that it generally precludes the minimisation of forestry unit costs. In the absence of precise investment goals, which are both attainable and of which the relationship with net social benefit is known, and accepting that the strategic justification for forestry may still have cogency, the most logical approach to forest planning, in general, would appear to be on the basis of cost-effectiveness. Depending on the extent to which intangibles such as recreational value are in future shown satisfactorily to be measurable, public forestry investment may be locally appraisable by the direct present value rule.

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