No. 114 ENERGY CROPS, FORESTRY AND REGIONAL DEVELOPMENT IN IRELAND Convery and Dripchak October, 1983

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FRANK J. CONVERY and KATHLEEN DRIPCHAK

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Responsibility for the Report's contents rests with us alone.

Preface

As will be demonstrated below, Ireland's mild, moisture-laden climate and relatively fertile soils provide an environment unparalleled in Western Europe for tree growth. Because of drainage conditions and the level of precipitation, many of these areas are at the same time difficult to work for agriculture. The bulk of these soils which are economically marginal to farm occur in the western areas of Ireland. These areas have relatively low levels of income and high levels of unemployment.

Ireland is among the most import-dependent energy consumers in Western Europe; in 1981 72 per cent of the nation's energy consumption was imported; oil, all of which is imported, accounted for 62 per cent of total primary energy consumption.

There is then the coincidence of large areas of land in a deprived region which are highly productive for tree growth, but poor for agriculture, combined with the need to diminish the nation's dependence on energy imports. This has led the EEC, the International Energy Agency and domestic agencies to explore the possibility of using this high inherent land productivity to produce energy crops, using short rotation forestry systems.

The work thus far has focused primarily on the biological and technical aspects. However, a comprehensive systems analysis effort — described by Lyons (1982) — is underway which involves modelling the energy crops system from crop establishment through to final processing, with an emphasis on the cutaway bog areas. Economic analysis is a component of this endeavour. Our study is distinct in its emphasis on the following: privately owned land, the attitude of landowners, the integration of conventional forestry and regional implications into the analysis, and the use of a large number — 106 — of (randomly selected) sets of actual field data. In this project we analyse the financial efficiency of investment in both energy crops and conventional forestry and then examine the implications for income and employment in the deprived regions of a combined[1] tree-growing investment programme.

A key determinant of success will be the attitude of private landowners in these areas towards a new land-use such as energy cropping. It is often argued that when the bulk of landowners are old and poor, and have small farms, they resist innovations, even when they can substantially increase their incomes thereby. We conducted a survey of landowners in three border (with

1. Energy crops and conventional forestry.

Northern Ireland) counties, in order to determine their socio-economic characteristics, the type and extent of their holdings and to assay their willingness to participate in energy crop production in various ways. A sub-sample of those who expressed interest was chosen, and the land which they said could be available was mapped, its productivity for growing both conventional forestry plantations and energy crops was estimated, and the costs of establishing the former were determined. Markets, and the price implications thereof, for energy crops and forestry, were analysed. The production, cost and price data provided the information for the economic analysis. The latter was combined with the findings of the ownership survey to provide the basis for a discussion of policy implications. Except where otherwise specified, all data refer to 1981.

In doing this study we were faced with the task of choosing between hectares and acres as our unit of area measure. In order to make the results clear to Irish landowners and policy-makers, we selected statute acres, which is the most commonly used and understood area measure in Ireland. However, productivity measures in both conventional forestry (yield class) and energy crops (dry tonnes) are typically expressed per hectare. We respect this convention in classifying the productivity of land, but convert everything to a per acre basis when we compare conventional forestry, energy crops and agriculture.

General Summary

The more than four-fold increases in real oil prices which occurred in the 1973-83 decade has combined with a perception that such supplies were susceptible to sudden interruption to result in greatly increased interest in the opportunities for providing indigenous energy supplies.

Ireland's climate and soils are ideal for tree growth. These two considerations – energy price rises and suitability for tree growth – led logically to a consideration of the question as to whether it could be to national advantage to grow wood energy crops in Ireland to meet some of our energy needs. Such crops typically comprise hardwood species such as willow, alder and poplar which are cut periodically, e.g., every 5 years, after which they re-sprout. Research on the biological potentials in this regard was initiated in Northern Ireland in 1973, and has been concentrated there on the wet mineral soils. In the Republic an extensive research programme started in 1976. Most attention has been devoted to the potential of the land remaining after Bord na Móna has extracted the peat – the cutaway – but other site types have been examined and some harvesting and utilisation studies have also been initiated.

Almost half of Ireland's land – 8.3 million acres – has been classified as marginal for agriculture. Just over 3.5 million acres of this area consist of wet mineral lowland, while peatlands and mountain/hill land comprise 2.8 million and 2.0 million acres, respectively. This marginal land is concentrated in the Western counties and those (excepting Louth) which border Northern Ireland. These counties are relatively economically disadvantaged. If energy crops are to be established in Ireland, they will have to compete successfully with agriculture and conventional forestry.

Objectives

This study – funded by the Regional Studies section of the Commission of the European Communities – had the following main objectives:

(1) To estimate net financial returns to agriculture, conventional forestry and energy crops on land which is marginal for farming.

(2) To determine the regional impact of an energy crops/conventional forestry planting programme in the border counties of Cavan, Leitrim and Monaghan and in the Western counties generally.

(3) To specify the implications for energy policy and cross-border co-operation of such a programme.
(4) To examine the manner and extent to which private landowners could be interested in tree growing.

Method

We estimated the net financial returns to agriculture, conventional forestry and energy crops. For agriculture, the financial returns are derived annually by staff of An Foras Talúntais and published as the Farm Management Survey. For conventional forestry, the Forest and Wildlife Service gathers productivity and cost data, while the price for which the Service sells standing timber is also available. The basis for estimating net returns is therefore available.

Unfortunately, in the case of energy crops there are no productivity data available in the Republic for the lowland wet mineral soils – which are the most promising site types in the border county area. Information on costs of crop establishment and harvesting, and on market outlets, is likewise deficient. We drew on productivity research in Northern Ireland and on costs derived by Lyons of an Foras Talúntais, Carlow and the Forest and Wildlife Service. We analysed the output price implications of selling wood into three categories – domestic, industrial/institutional and electricity generation – of the energy market.

The Survey of Landowners: A random sample of landowners in the border county area was selected. Almost 900 owners were visited and interviewed. Information on their socio-economic status and land-use was gathered and they were asked whether they were interested in energy crop production, and, if so, which of renting, growing their own or selling their land for this purpose they would favour, and what area of land they would consider making available, at what price. They were also asked some questions about conventional forestry.

The Land-Use Survey: A sub-sample of these landowners who said that they would be interested in energy crops was selected and visited. The land which they said could be available was surveyed, given a productivity assessment, and the costs of establishing conventional forestry were estimated.

The sample of landowners was selected so that this result could be generalised to the landowning population of the border county area as a whole. We extended the canvas of our concern to include the Western counties, because we believe that the soil and climate conditions and socio-economic situation are sufficiently close to justify such an extension.

Results

All data are for 1981 unless otherwise specified.

1. *Returns to Agriculture*: There is a very wide spread of performance, as can be seen below:

	£ per acre			
	Wet mineral soils		*Hill and peat*	
	Lowest 25 per cent	*Highest 25 per cent*	*Lowest 25 per cent*	*Highest 25 per cent*
Management and investment income	−125	47	−121	16
Family farm income	4	129	0	95

2. *Returns to Conventional Forestry*: Based on the 120 sites examined as part of the land-use survey, the per acre annual equivalent returns – the maximum amount which an investor could afford to pay landowners to grow trees on their land and still cover all costs (including interest charges) – are specified below:

	$i = 0.02$			$i = 0.04$		
	Price			Price		
Site type (per acre)	*High*	*Medium*	*Low*	*High*	*Medium*	*Low*
Peat	58	31	12	28	9	−5
Clay (wet mineral)	82	48	24	49	24	6

The outcomes are very sensitive to real interest rates (i) and the price for which the standing timber is sold. The high price represents the highest annual average price obtained for standing timber by the Forest and Wildlife Service over the 1972-81 period. The medium price is the unweighted annual average price obtained, while the low represents the lowest annual average price achieved over the period. The annual equivalent is comparable with management and investment income in agriculture, although in certain circumstances family farm income may be the more appropriate measure for comparison purposes.

3. *Returns to Energy Crop:* There is great uncertainty concerning both the production and the price which can be achieved with energy crops. There is a correspondingly great variability in the estimated returns, depending on the assumptions made:

Mineral soils Production level (Dry tonnes per ha)	*Annual equivalent returns per acre i = 0.02 Price per dry tonnes (standing) £*		
	3	*17*	*22*
7	–26	12	25
10	–23	32	51
15	–17	65	94
20	–11	98	137

4. *Returns Compared:* Since even under low price assumption, the returns to conventional forestry on the wet mineral soils are positive over the 2-4 per cent real interest range, a strong presupposition exists that it would be economically efficient to convert some of the lowest yielding land in agriculture to this use. For energy crops, we cannot yet draw this conclusion, because we cannot indicate with any assurance the combination of production and prices likely to obtain. However, it is clear that if standing prices per dry tonne for wood biomass achieve at least £17 – this standing price is derived from the delivered price which the ESB had been paying for chips – then energy crop production would also be attractive.

5. *Survey Results:* The socio-economic status of landowners conformed to our expectations. Eighty-two per cent had holdings in the 0-50 acre size class, 88 per cent were male, 52 per cent were over 56, 28 per cent were above 66, 33 per cent were single and 84 per cent had no formal education beyond the primary school level.

Nearly a third of the landowners contacted, owning 37 per cent of the land area, indicated a willingness to allocate land to energy crop production. The combinations of characteristics producing the greatest and the least willingness to participate were as follows:

Regional Impact

Per cent of category	*Category*
Most likely	
77	Off-farm income £5,000-10,000/Age 46-50
70	Secondary education/Age 26-35
66	Off-farm income £5,000-10,000/Age 56-65
Least likely	
5	Aged 0-25/farmer
5	Off-farm income of £10,000 + per year/dairying + drystock
8	Aged 66+/mainly drystock

The extremes of age and income – the very young and/or poor, and the rich and/or old – are least interested: those in the middle are most likely to get involved.

Regarding the manner of their participation in energy crop production or tree growing generally, landowners expressed preferences as follows:

Preference	*Per cost of total area*
Rent their land for this purpose	67
Grow their own	9
Sell land for energy crop production	23

Although 27.5 per cent of landowners said that they had already planted trees, the area involved is very modest, amounting to only about 1,000 acres in aggregate, comprising 2.1 per cent of the total land area. Eighty per cent of them listed provision of a windbreak as the most important reason for tree planting. Only 1 per cent listed their agricultural adviser and the planting grant, respectively, as the most important reason.

6. *Regional Impacts:* In order to estimate the regional impact, it is necessary to make some assumptions as to the area devoted to energy crops/conventional forestry, and the region within which the land-use change takes place. We took the Western and Border counties as our region. We feel that 500,000 acres – representing 8.4 per cent of the *marginal land* in the area – could be allocated to tree growing to considerable financial advantage. We estimate that if those areas are chosen where tree growing has the greatest net income-generating advantage, an average increase of £45 per acre per annum could be achieved by the transfer.

For expository purposes only, we assume that half of the area – 250,000 acres – is devoted to conventional forestry, with the other half being used for energy crops. The data on production and the prices obtainable for output are as yet insufficient to justify such investment in the latter. We assume that the area is planted in equal annual increments over 20 years, i.e., 12,500 acres each of conventional forestry and energy crops.

The primary regional benefit over the first 20 years would be the increase in income. The direct annual income supplement would increase from £1.125 million in year one to £22.5 million after 20 years, and then remain at this level. The latter gain amounts to 7.1 per cent of the 1977 aggregate farm income in the region. If tree growing were concentrated in particular areas, the proportionate income contribution would be correspondingly greater. For example, if 20 per cent of County Leitrim's marginal land area were allocated to tree growing, the annual income increase would amount to £3.216 million, comprising 37.3 per cent of the farm income generated in 1977.

If an income multiplier effect of 1.3 is assumed, then the total net income contribution would amount to 9.5 per cent of the 1977 aggregate farm income for the region.

The establishment and management of either conventional forests or energy crops is not a labour-intensive activity. The net employment effect of displacing marginal agriculture would be either neutral or mildly negative over the first 15 years. Thereafter, because of activity in wood harvesting, transportation and processing, there would be a substantial net employment impact, amounting to perhaps 9,000, forty years after programme initiation.

7. *Energy Impacts:* If we assume an average output of 13 dry tonnes per hectare and the planting of 250,000 acres of energy crops over 20 years (see *Regional Impacts* above) then, by the year 25 the energy contribution would amount to 7.6 per cent of the 1980 level of total primary energy consumption, or 34.6 per cent of domestic primary energy production. It would contribute 3.2 per cent of energy consumption projected for the year 2000. It would take over half a million acres under energy crops to provide sufficient fuel for 600 MW of electricity generating capacity; this is the size of unit generally prepared for a nuclear power station in Ireland.

We emphasise again that the production and output price data are not yet sufficient to justify an investment programme in energy crop production.

8. *Cross-Border Co-operation*: The high productivity for tree growth of land which is marginal for agriculture is common to both sides of the border with Northern Ireland. The border county areas on both sides are relatively economically deprived; an increase in income would be particularly beneficial. It follows that it would be mutually advantageous if research and development programmes could be planned and implemented co-operatively.

9. *Costs:* If a 500,000 acre planting programme were implemented over 20 years, the crop establishment costs each year would amount to £9.4 million. If, on average, rental of £45 per acre were paid to all landowners involved, annual costs under this heading would grow from £1.125 million in year 1 to £22.5 million in year 20. Revenues from the energy crops component would start in year 5; for conventional forestry the bulk of revenues would accrue in year 30 to 40.

Conclusions and Recommendations

The case is very robust for converting to conventional forestry some of the marginal land in the Western and Border region. Policy in this area should focus on identifying and relaxing the constraints in the system which are inhibiting the realisation of this incomes-increasing opportunity. With regard to energy crops, if the production and output prices which have been projected were to be attained in practice, encouragement of an investment programme in this area would be warranted. However, evidence in support of the projected performance is not yet available which would justify the undertaking of a substantial investment programme in this area. Policy should concentrate on acquiring sufficient knowledge of performance under normal conditions to make wise investment decisions.

Specifically, the following steps should be taken:

That conventional forestry and energy crops be treated as complementary activities. Combination would facilitate risk-spreading, provide early-on returns, allow energy crops to take their most favourable market niches and maximise the silvicultural possibilities.

Develop demonstration projects for both conventional forestry and energy crops on privately owned lands, with a focus on the wet mineral soils. These pilot schemes should be designed to provide information on productivity, costs and the most appropriate means of involving private landowners under actual field conditions. Rental should be emphasised as one means of getting participation.

The market potential for energy crop output should be explored more vigorously than heretofore. This should take the form of both desk studies and pilot utilisation schemes. The latter should involve industrial, domestic and electricity generation users. In such cases, costs, efficiencies, etc., should be monitored, so that valid comparisons can be made across users.

A large volume of heterogeneous work has already been undertaken, mainly under the general inspiration and guidance of the NBST. It is now time to integrate the resulting information into a cohesive whole, involving the standardisation of terminology, estimation and reporting procedures, the development of policy implications of existing work and the establishment of policy priorities for the future. Responsibility for this should be either explicitly delegated to the NBST or taken on by the Department of Energy.

There is no existing institutional framework which is ideally suited to the carrying out of private land rental/leasing for tree growing. The various options should be examined in some detail, so that the best approach can be quickly acted upon when it is appropriate to do so.

If the results of the demonstration, marketing and institutional studies prove to be sufficiently promising – as we suspect will be the case – an integrated energy crops/conventional forestry programme should be designed and implemented, with appropriate specified targets and implementing procedures.

Given the coincidence of interest in Northern Ireland and the Republic in this area, we feel that there is merit in attempting to mount an integrated demonstration phase embracing both parts of Ireland. If the results are appropriate, it would also be logical to continue this co-operation into programme implementation.

Chapter 1

OBJECTIVES AND METHODS

In this chapter we present our objectives for the study. We provide a brief discussion of the definitions concerning energy crops, conventional forestry and the region, and then outline the methods used in the study, dealing successively with: the estimation of productivity, management strategies, costs and prices; the investment appraisal approaches used; the identification of landowners' socio-economic circumstances, and attitudes to energy crops and conventional forestry; and the manner in which the results are being presented to policymakers.

Here we present only a summary of the approaches adopted, with the purpose of giving the reader an overall feel for the methods employed. We take up more detailed and more technical discussion of specific topics later in the report.

Objectives

In undertaking this study we had two primary objectives:

(i) To estimate the net financial returns which investment in energy crops might be expected to yield to the nation under Irish cost, price and productivity conditions, and to compare these with returns to agriculture and conventional forestry.

(ii) To determine what the impact on regional welfare might be of an investment programme in energy crops, and of a combination of energy crops and conventional forestry.

We also had a number of subsidiary objectives. These included:

(iii) To examine how most effectively to get investment in relatively long-term projects such as tree growing (energy crops or conventional forestry) underway on privately-owned land.

(iv) To identify the agencies which might be mobilised to this end, and discuss possible sources of investment funds.

(v) To outline opportunities for cross-border co-operation.

(vi) To present the relevance of our findings for regional revitalisation elsewhere in the European Economic Community.

(vii) To trace the implications of investment in energy crops for Irish energy policy.

Definitions

Energy Crops

Through the photosynthetic process, any growing plant matter converts energy from the sun into organic matter. This energy can be made available through combustion, or, if eaten, can be converted into usable energy by the ingestors. Thus all crops are "energy" crops. In the sense in which we use the term, we intend it to embrace only those crops grown with the intention of utilising them primarily as a fuel, either burned directly, or converted into another fuel such as methanol.

Much of the land of Ireland has (or could have) a high biological productivity for the production of straw. However, in current economic circumstances the use of straw directly as a source of energy is likely to be a subsidiary and supplementary outlet to its primary market for animal feed and bedding. In Irish conditions, tree species comprise the most promising energy crop. Most deciduous trees sprout new shoots if the stems are cut off near ground level. For those species which combine this trait with the ability to grow rapidly in early years, it is logical to think of a management regime which involves periodic and relatively frequent harvests, beginning as soon as is economically optimal after crop establishment; the first felling might take place 5 years after planting, with subsequent harvests being taken every 5 years thereafter. This type of cropping system is also known as short rotation forestry (SRF), and the cutting and re-sprouting process is termed coppicing.

Conventional Forestry

Conventional forestry in Ireland has in recent decades concentrated on two coniferous species – Sitka spruce and Lodgepole pine. These are typically planted in straight lines with 2 metres (6.5 feet) between each plant, so that there are 2,500 plants per hectare. A group of trees of the same age, species or with other distinguishing characteristics is known as a *stand.* After 15 or 20 years, the stand is thinned, which usually involves extraction of small dimension and poorly formed material. Thinning is undertaken at regular intervals – e.g., every 5 years – until the time of clear-felling, which typically occurs 35-45 years after planting. The bulk of the early thinning material consists of small dimension, low-valued stems useful for pulping or chipping; this wood comprises the raw material for paper, chipboard and fibreboard. Later thinnings have a higher proportion of large dimension material suitable for sawing, while the clear-felling crop consists primarily of such material. The sawing process requires "squaring" the log; the slabs thus produced comprise about one-third of the total volume and this material is also suitable for pulping or chipping.

The Region

We selected a region comprising the contiguous counties of Cavan, Leitrim and Monaghan (see Map 1) as a focal point for our analysis, for the following reasons:

(i) The scale allowed us to conduct a survey within the designated budget which provided landowner and land-use data which could be generalised to the three county area as a whole.

(ii) While much of the land in the three counties produces very modest net returns from agriculture, it is among the most productive in the temperate world for tree growth. As such, the region is representative of other Western and Northern counties with large areas of wet mineral soils.

(iii) The three counties suffer from relatively low incomes and high unemployment, so that any shift in land-use which improved incomes and/or increased employment would be of benefit. Again, they are representative of other counties in this respect. In Appendix 1, a detailed discussion of socio-economic characteristics are presented.

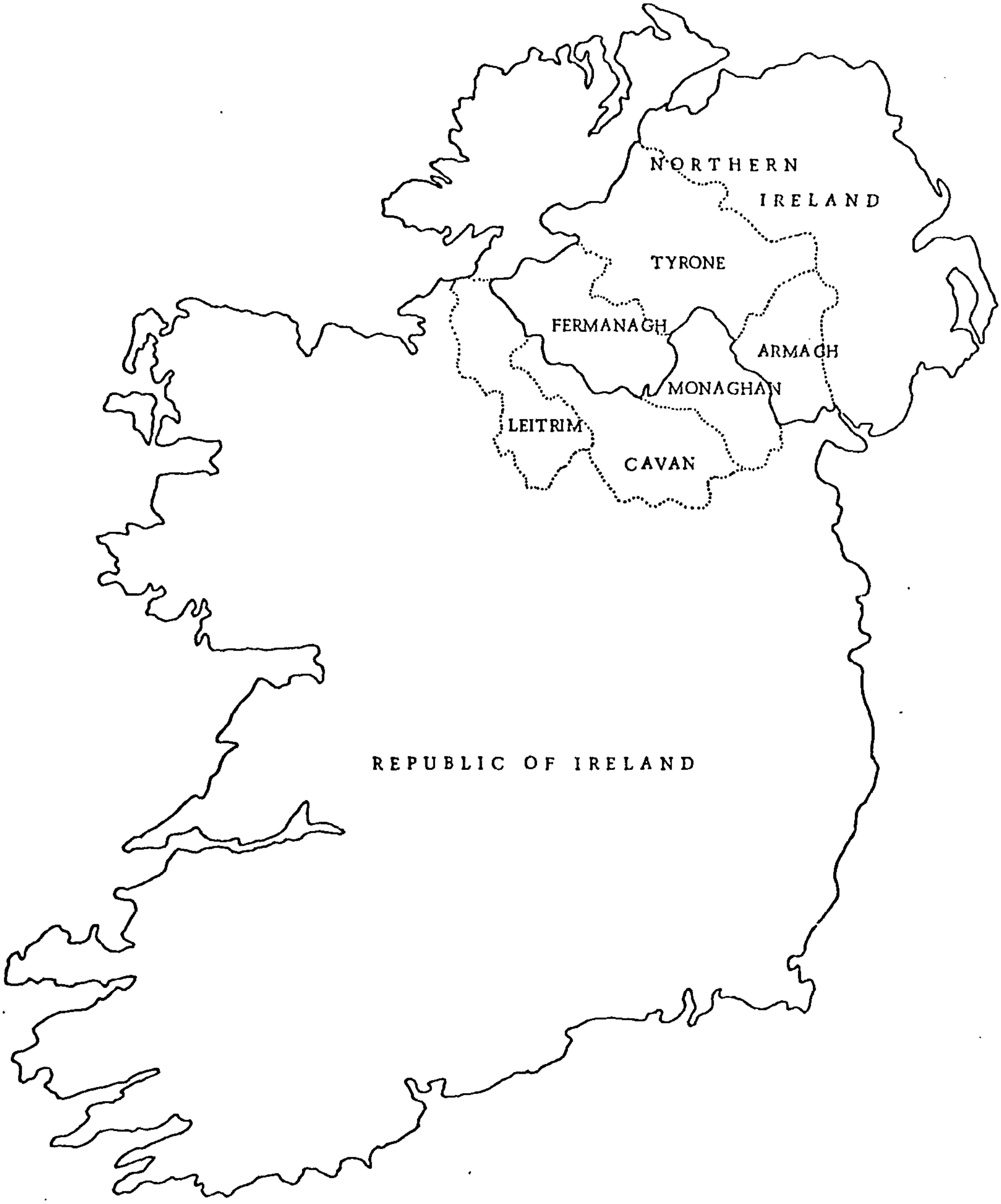
(iv) Each of three counties has a border with Northern Ireland. The contiguous areas in Northern Ireland share both the soil productivity and the socio-economic characteristic of their neighbours to the South. The Northern Ireland Horticulture Centre at Loughgall, Co. Armagh was the first research unit in Ireland to establish (in 1973) productivity trials for coppicing species. If energy crops and/or conventional forestry hold some promise for improving net incomes and/or employment, this potential applies to both sides of the border. A programme designed to capture such potential would be an obvious candidate for cross-border co-operation.

Methods

Productivity, Management Strategies and Costs

The relative advantage which Ireland seems to have for energy crop production has resulted in a considerable expenditure on research to assay the possibilities in this regard. Most of this work has been encouraged and co-

Map 1: *Study Area Counties in the Republic of Ireland and Adjacent Counties in Northern Ireland*



ordinated by the National Board for Science and Technology and embraces the following topics: short rotation forestry production, optimal management strategies, harvesting, utilisation and systems analysis of short rotation energy plantations. This work is summarised in Table 1.

Partial funding (roughly 50%) for this research was provided by the Research Development + Education Directorate General (DGXII) of the EEC, except for the systems analysis work at Trinity College which was financed by the International Energy Agency (IEA). The remaining funds (50%) were supplied by the Irish Government. A pilot demonstration project, funded by the Energy Directorate (DGXVII) of the EEC, is now underway. This incorporates short rotation forestry production through to combustion in electricity generating plants of the Electricity Supply Board (ESB). Bord na Móna are the main contractors, although the project involves the Forest and Wildlife Service, the Agricultural Institute and the Electricity Supply Board with the National Board for Science and Technology functioning as co-ordinators.

Northern Ireland is also involved in SRF production research, with experimental plots at Newtown Butler and Castle Archdale in Co. Fermanagh and at Loughgall Horticultural Centre, Co. Armagh, from where the research is co-ordinated. We have met with researchers involved in each of these efforts, and our work will review and incorporate their results.

These studies provided us with a major portion of our information on production, management strategies and costs. Most of this work is still in progress and results in some cases have yet to be published. We convened a one-day workshop in which most of the nation's experts generously participated. We discussed productivity, management strategies and costs. We complemented this cost and productivity data by undertaking a land-use survey in our three county sub-region (see discussion later of this survey), wherein we did an on-the-ground survey of candidate areas for energy crop production.

From these costings and productivity data, from the workshop deliberations and the published literature, we distilled the cost and input/output data on energy crops and conventional forestry which underpin our analyses.

For estimates of the returns to agriculture, we depended on four data sources: the annual Farm Management Survey conducted by An Foras Talúntais, broken down appropriately; estimates of land-rental prices for land of different quality, provided by the responses given in a survey we undertook of auctioneers and land-valuers who are active in the three-county area; information on rentals currently received by the landowners surveyed; and net returns specified by landowners as being the minimum necessary to get them to allocate land to tree-growing.

Table 1: *Summary of research on short rotation forestry for energy in Ireland*

Area of research	*Organisation*	*Status of research*
1. Short rotation forestry production on:		
(a) drumlin soil at Swanlinbar, Co. Cavan	FWS	Year 4 yields recorded; research ongoing
(b) raised bog at Tullamore, Co. Offaly	FWS	Year 4 yields recorded; research ongoing
(c) cutover raised bog at Clonsast, Co. Offaly	AFT	Various trials at different stages; research ongoing
(d) blanket bog at Glenamoy, Co. Mayo	AFT	Experiment on potted plants completed; spacing trial ongoing
(e) blanket bog at Ross, Co. Galway	FWS	Year 4 yields recorded; research ongoing
(f) mineral soil at Oak Park Research Centre, Co. Carlow	AFT	Year 4 yields recorded; research ongoing
(g) mineral soil at Kilfinane, Co. Limerick	FWS	Year 4 yields recorded; research ongoing
2. Development of SRF harvesting machine	BnM subcontracted to Irish Sugar Co.	Prototype harvester
3. Review of transportation options	AFT	Research completed and reported
4. Storage of wood chips	AFT	Research ongoing
5. Utilisation –		
(a) fuel value of wood	AFT	Research completed and reported
(b) development of domestic-sized solid fuel boiler (with automatic stoking)	AFT, NBST	Design completed and patented
6. Systems analysis of SRF energy plantations	AFT	Research ongoing
7. Systems analysis of biomass energy	TCD	Research ongoing

FWS = Forest and Wildlife Service
AFT = Agricultural Institute
BnM = Bord na Móna
NBST = National Board for Science and Technology
TCD = Trinity College, Dublin

Prices

The ESB is (September 1981) paying £15 per tonne for chips delivered (at 55% moisture content) to its generating stations at Cahirciveen, Co. Kerry, Allenwood, Co. Kildare and Lanesborough, Co. Longford.[2] This provided our "baseline" price data. We then modified the price payable to take cognisance of the possible building of new wood-burning units. Price payable was defined in relation to competing fuels, with appropriate adjustments being made to compensate for differences in burning efficiencies and costs of plant conversion and operation.

We discuss other markets for the wood, including usage directly for domestic, institutional and factory heating and as a furnish for the manufacture of gas (methanol), and then present the price implications of these outlets, to the extent that it is possible to do so usefully.

Investment Appraisal

Using the input/output, cost and price data developed as indicated above, the present net worth and annual equivalent return to investment in energy crops and conventional forestry were estimated for a range of costs, prices and productivities using a US Forest Service computer programme (IMPACT) adapted for the purpose by Lyons at An Foras Talúntais, Oakpark, Co. Carlow.

Landowners' Socio-Economic Circumstances and Attitudes to Energy Crops and Conventional Forestry

Close to 1,000 landowners — 3.7 per cent of the total — in the region were interviewed. The sample was taken from a list of landowners who have 5 acres or more and was chosen such that a representative sample of the land in the three-county area was selected. Owners were asked questions concerning their socio-economic status, current land-use and interest in growing their own energy crops and/or leasing or selling their land for this purpose. This information provided us with a description of the landowning population in the region and allowed us to see whether there was any statistically significant relationship between landowner characteristics and willingness to participate in energy crop production. A sub-sample of those who expressed interest was selected, and the productivity and costs of energy crop production and conventional forestry, respectively, were estimated for the candidate land suggested by the owners. (The use to which these data are put is described above.)

2. In April 1982 the ESB stopped accepting supplies of wood chips. The continued stagnation in electricity consumption has combined with the availability of natural gas to diminish the desirability of maintaining in operation small, relatively high-cost units.

Policy Level Involvement

We explained what the study entailed to the members of the County Development Teams in each of the counties in the region and we have benefited from their advice and help. We have sought and received assistance from personnel in all of the principal government departments and agencies concerning the manner in which our results might most effectively be utilised. Their advice is reflected in the shape and content of our recommendations. However, responsibility for these rests with us alone.

Chapter 2

THE ENERGY POLICY CONTEXT

Consumption and Supply

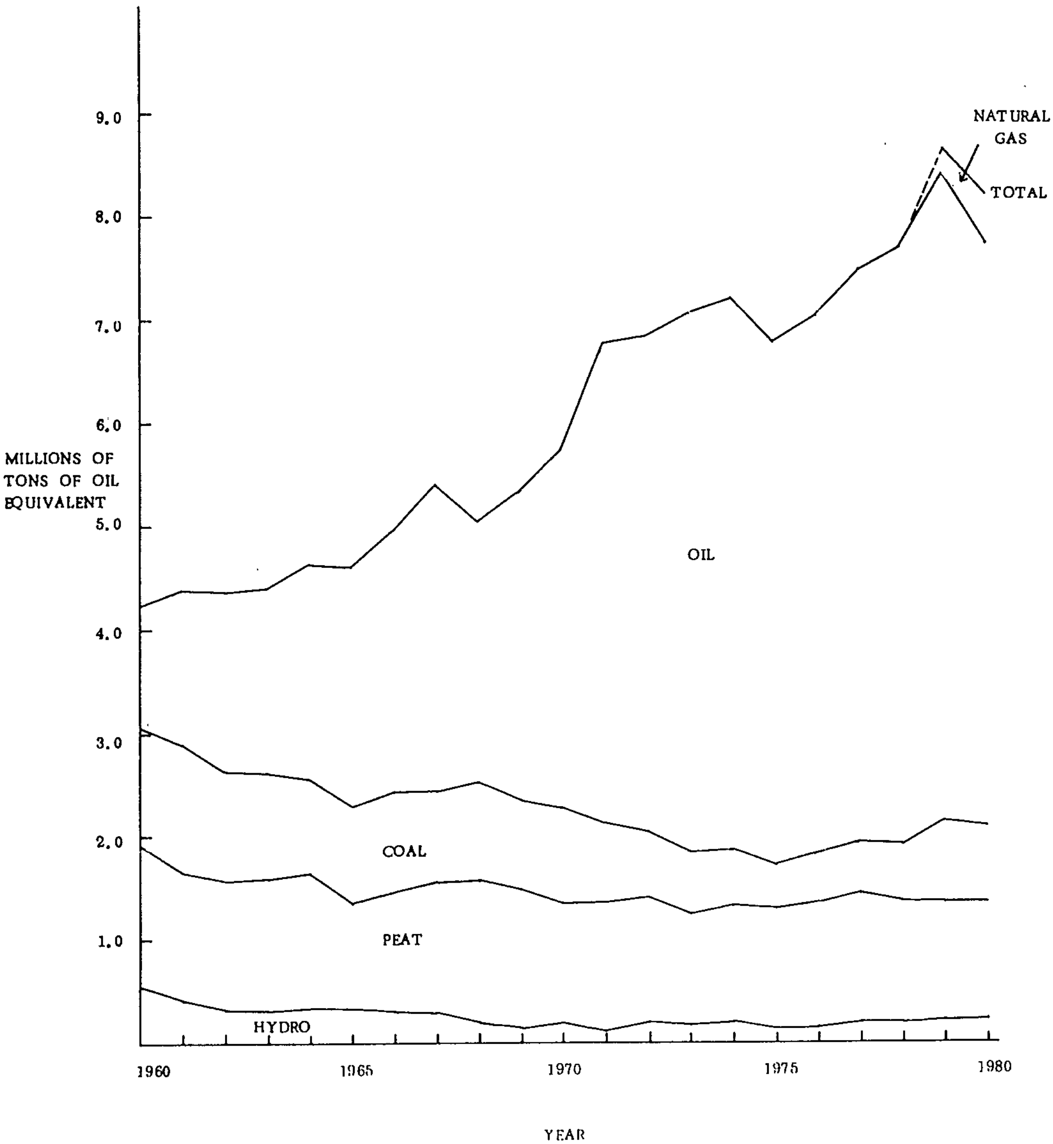
In common with almost all other countries, during the past two decades Ireland has rapidly increased its consumption of energy, and oil has supplied the bulk of the increase. In Figure 1 can be seen the pattern of intake since 1960. Up to 1979, peat and hydro comprised the country's only indigenous energy sources, so that dependence on imports increased sharply over the period. Domestically produced energy, as a share of the total, fell from close to 50 per cent in 1960 to 18 per cent in 1978. However, in 1979 natural gas from the Kinsale field began to make a contribution; as a consequence, in 1981, the indigenously produced share of energy consumption increased to 28 per cent.

The position of peat in the Irish energy budget is of particular interest. Over two-thirds of the peat production in Ireland is harvested by Bord na Móna, the government-sponsored agency which has been established and given statutory authority for this purpose. A major outlet for the production of the Board is the Electricity Supply Board (ESB) which burns peat at 9 generating stations, ranging in capacity from 90MW to 5MW; total peat-fired electricity generating capacity amounts to 447.5MW, comprising in 1979/80, 15.6 per cent of total ESB capacity, and generating 15.8 per cent of total output in that year.

Of the two types of peat-fired stations, sod and milled peat, sod peat stations can be much more readily adapted to burning wood than can milled peat units. To be used in the milled peat stations, wood chips would need to be reduced nearly to the size of sawdust, the cost of which would be prohibitive.

It is estimated that the bulk of the bogs now being exploited will be worked out within 25 years, and some will be so in less than a decade. This land, which will become available as the surface peat is cleared away, is known as cutaway, and can be used to grow energy crops. This coincidence of interest has quite properly resulted in an initial concentration on the potential of cut-over boglands to grow energy crops. However, even if all of this cutaway were devoted to this purpose, the production would meet only about one-quarter of the energy now supplied annually in the form of peat

Figure 1: *Primary Energy Consumption in Ireland, 1960-1980*



Source: Appendix Table 2.

to the existing peat-burning units. This assumes an annual yield from energy crops of 20 dry tonnes/hectare, which translates into 7.5 Tonnes of Oil Equivalent[3] (TOE)/hectare/year, as compared to a 33 TOE per hectare/year yield from milled peat. Thus, regardless of what takes place on Bord na Móna land, there is a potential market in electricity generation for wood grown on privately owned land. This and other marketing issues will be discussed in a later chapter.

Price

The viability of the energy crops concept depends fundamentally on the dramatic upward movement in energy prices which has occurred since 1973. This is captured in the trend in the import price of residual fuel oil and coal shown in Table 3 and Figure 2. We can see that the real (net of inflation) price of residual fuel oil (that which is burned in base-load oil-fired generators) in 1981 is more than five times what it was in 1972. Some part of the recent increase is due to the devaluation of the Irish pound *vis-à-vis* the US dollar since oil is purchased in US dollars. The real price increase in the case of coal has been much more modest, amounting to 68 per cent from 1972 to 1981.

It is difficult to predict future energy prices. Much depends on the extent to which economic growth re-commences and supplies respond. In 1978, Saudi Arabia, Kuwait, Iran, Iraq and the United Arab Emirates together supplied 31 per cent of the world's oil supply. A major Middle Eastern war which interrupted these supplies, occurring simultaneously with significant world economic growth, would result in sharp real growth in oil prices. However, with a stagnating or very slowly growing world economy and a continuation of the existing patterns of supply (including a substantial inventory) real oil prices (in dollars) could decline, at least in the short to medium term.

Many observers feel that real long-term growth in oil prices of the order of 2-4 per cent per annum can be anticipated – residual fuel oil import prices in Ireland have grown in real terms in 1972-1981 at an annual compound average rate of 20 per cent – but what actually happens depends on prospective geo-political considerations which are highly volatile. It also depends in part on the conservation response of energy users. It appears as if a significant conservation response to higher prices is developing which will dampen the surge in consumption associated with economic growth.[4]

3. A tonne of oil equivalent contains the energy found in a tonne of oil.

4. We took as our basic assumption that current (1981) prices would obtain in the future. This assumption is not as restrictive as it may appear, because three market outlets are examined, and they provide a very wide spread of prices, ranging from £3 to £22 per dry tonne standing [see Chapters 5 and 6.]

Electricity

Table 4 lists the existing generating capacity of the ESB and what is expected to be in place in 1987/88. Major expansions in both gas and coal-fired capacity will take place, reducing the dependence on oil from 59 to 41 per cent of capacity.

This expansion represents an average annual compound growth rate of just over 6 per cent. However, this may exaggerate available capacity, because some of the ESB's natural gas assignment may be allocated to Dublin, while some of the older oil-fired units could be closed down if growth in consumption is not as rapid as anticipated. Annual electricity sale (Gigawatt hours, or GWH) by the ESB since 1974 have been as follows:

Table 2: *Electricity sales by the ESB, 1974-80*

	Sales (GWH)
1974	6239
1975	6076
1976	6633
1977	7190
1978	7741
1979	8578
1980	8546

Over the 1974-1980 period this represents an average compound annual growth rate of 5.5 per cent. The absence of growth from 1979 to 1981 has continued into 1982. The stagnant sales record since 1979 is a product of the recession, and growth in real electricity prices (and the conservation which that induces). If economic recovery in the 1980s matches growth rates achieved in Ireland in the 1970s, and it proves possible to dampen or eliminate the real growth in prices, then the ESB could find itself towards the end of the 1980 decade in its accustomed situation of having a capacity-constrained system. If there is little growth, then there will be significant excess capacity and the response is likely to be to "prematurely" terminate generation at the higher cost oil-fired units and perhaps subsequently convert them to coal-burning units.

Conclusions

Peat production from Bord na Móna bogs is now used to generate over

Table 3: *Current and constant (1968 £) import prices of residual fuel oils and coal 1972-81 (£ per tonne)*

	Residual fuel oil		*Coal*		*CPI (1968 = 100)*
	Current	*Constant*	*Current*	*Constant*	
1972	7.1	5.2	10.1	7.5	135.4
1973	9.1	6.0	11.2	7.4	150.8
1974	30.5	17.3	18.3	10.4	176.4
1975	31.3	14.7	21.6	10.1	213.2
1976	39.2	15.6	24.1	9.6	251.6
1977	46.8	16.4	30.4	12.1	285.9
1978	43.3	14.1	33.5	10.9	307.7
1979	63.3	18.2	37.6	10.8	348.4
1980	86.5	21.0	48.8	11.8	411.9
1981	121.5	24.5	65.0	13.1	496.0
1982[1]	126.1	23.0	71.4	13.0	548.7

[1] February.

Sources: December issues of *Trade Statistics of Ireland* for years 1972 through 1981.

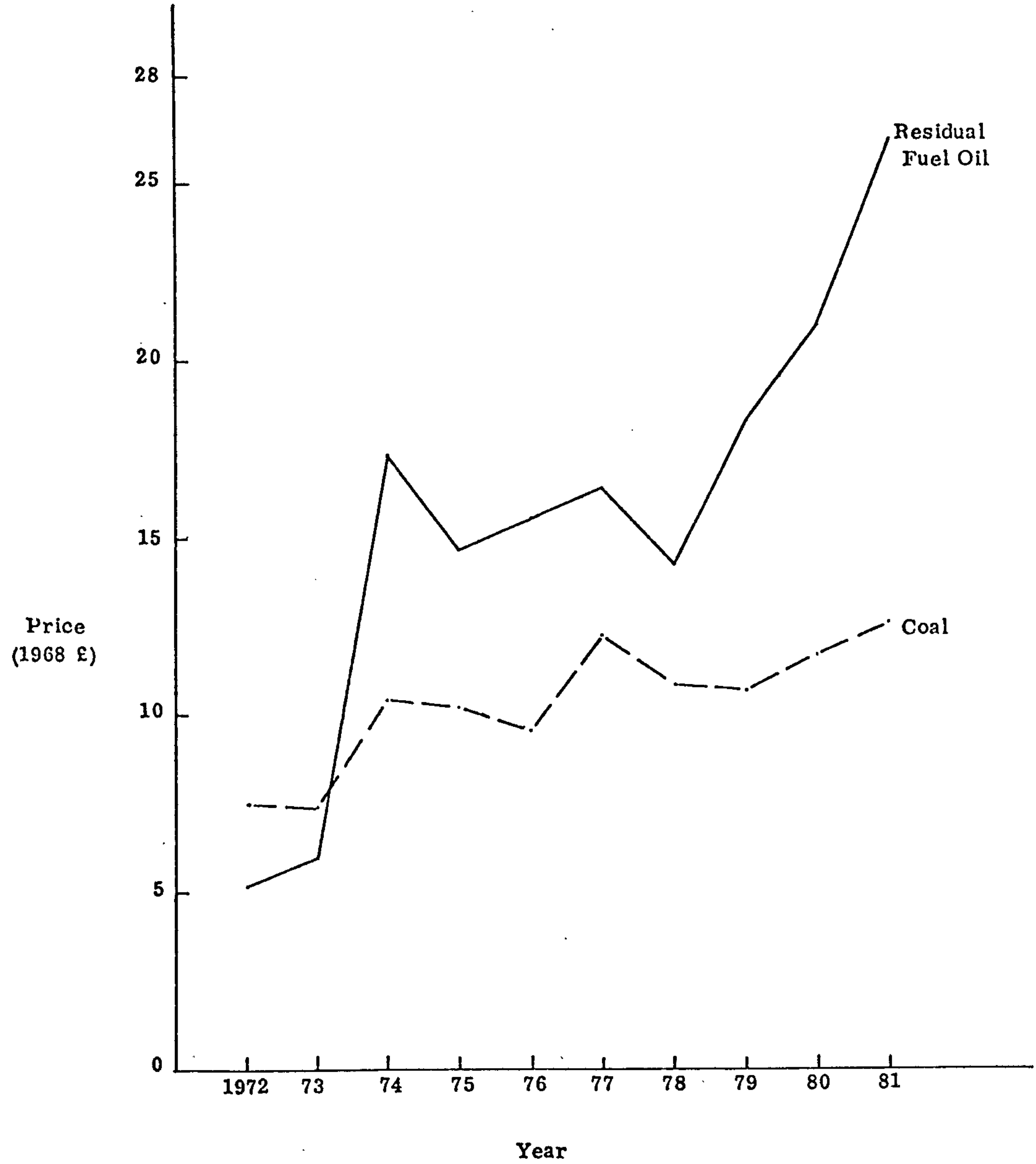
Table 4: *ESB generating capacity in 1979/80 and 1987/88, by fuel type*

	1979/80		*1987/88*	
Fuel	*Capacity (MW)*	*%*	*Capacity*	*%*
Hydro	511	18	511	11
Oil	1,684	59	1,884	41
Peat	447.5	16	527.5	11
Gas	205	7	730	16
Coal (Domestic)	15	1	60	1
Coal (Import)	—	—	900	20
Total	2,862.5	100	4,612.5	100

Source: Electricity Supply Board.

15 per cent of the ESB's electricity output. These bogs will be cutaway over the next two decades, and there is an obvious logic in examining the potential of these cutaway areas for growing a replacement energy supply. However, even if these lands were totally devoted to energy crops — an unlikely prospect — they will only supply about a quarter of the energy now provided for electricity generation by peat extraction. There is some logic, therefore, in also examining the potential of private land for energy crop production.

Figure 2: *Real Import Prices per Tonne of Residual Fuel Oil and Coal, 1972-1981, Deflated using CPI 1968 = 100*



Source: Table 3.

We assumed that current (1981) energy prices would obtain in the future. Sensitivity analysis was accommodated in this regard by examining returns from sales in different energy markets, which showed wide variations in "willingness to pay" for wood.

Chapter 3

ENERGY CROPS: PRODUCTION AND COSTS

Since energy crops have not been established commercially in Ireland, we do not have a firm basis of experience for the estimation of costs and production potential such as we can draw on in the case of conventional forestry. However, as we noted earlier, there has been a large volume of research activity from which useful information can be gleaned.

Energy is available in both coniferous and deciduous tree species. Wood grown as a conventional forest crop can be utilised directly for its energy content. For reasons touched on below, we have concentrated our attention on deciduous coppicing species. However, because the bulk of our commercial tree growing experience in Ireland is with conifers – mainly Sitka Spruce and Coastal Lodgepole Pine – and because they have inherent interest as potential energy crops, we address some attention to these species also.

Conifers

The Sitka Spruce plantations now being established in Ireland by the Forest and Wildlife Service have an average annual output of 14 cubic metres/hectare which, assuming $1.1M^3$/tonne, works out at 12.73 tonnes of green matter of *commercial* size timber per hectare. Assuming an average of 55 per cent moisture content, this yields 5.73 tonnes of dry matter per hectare per year. On the best Sitka Spruce sites, the dry matter yield of commercial timber (the stem up to 7 cms. top diameter) will average 10.64 tonnes of dry matter per hectare per year. Carey and O'Brien (1979) estimated that only half of the dry matter production in a 33 year old stand of Sitka Spruce was in the stem; roods (13%), branches and needles (22%) and the forest floor (14%) comprised the remainder. In the stand examined, average annual dry matter production *in toto* came to 13.073 tonnes per hectare.

Three difficulties arise in considering the use of conventional forest production for energy purposes:

(i) The production listed is an average annual output over the life of the crop; the rotation length for a forest crop is 35 to 40 years and with normal spacing, much of the growth occurs in the latter half of this period, so that the availability of wood for energy must be deferred if the full growth potential of the species is to be realised.

(ii) Coniferous species grown in Ireland have no proven ability to be successfully coppiced. Coppicing is the process of cutting certain deciduous species when they are young and allowing shoots to sprout from the stumps, which are in turn cut after a time. This allows frequent periodic harvests of the total crop without the expense of having to re-plant.

(iii) As forest trees approach saw log size, they become very valuable for sawn timber. Even in the current (1981) depressed state of the lumber market, saw log size material still standing in the forest is fetching about £20 per tonne; it would take a dramatic shift in energy prices to warrant paying this price for wood for energy before harvesting.[5]

It was considerations such as these that have led researchers to examine the potential of deciduous species such as willow, poplar and alder for energy crop production. Before reviewing their experience, we enter a few caveats *vis-à-vis* the conclusions concerning conifers. If some conifers, such as Sitka Spruce and Lodgepole Pine, are spaced very closely together, early yields can be very high. McCarthy (1981) reports that a nursery bed of Sitka Spruce plants spaced 12 cms. apart on a peaty gley site in Co. Leitrim produced above-ground dry matter yields of 40 tonnes per hectare after 3 years, the usual spacing is 200 cms. On another acid brown earth site in Co. Wicklow, closely spaced Sitka Spruce produced 88 and 90 tonnes of above-ground dry matter per hectare after 3 and 4 years respectively, i.e., an average annual growth of 29 and 23 tonnes, respectively. These plots were created by accident; the cost of plants for this spacing would be prohibitive. However, they do demonstrate that very high yields from Sitka Spruce on very short rotations are possible. The second caveat concerns coppicing. It has been noted that Sitka Spruce does coppice if cut off at about waist height above the lowest whorl.[6] However, the feasibility of doing this periodically over a cycle, and the ages at which it is feasible, have not been determined.

Deciduous

The first scientific investigations in Ireland of the yield potential of coppicing deciduous species were initiated in Northern Ireland in 1973 by personnel based at the Horticulture Centre, Loughgall, Co. Armagh. Willow was the chief species investigated. On a surface water gley soil in County Fermanagh, such as is commonly found in Cavan, Leitrim, Monaghan,

5. The ESB has been paying £15 per tonne for chips *delivered* to the generating station.

6. The point on the main stem from which lateral branches grow.

Longford, Roscommon, Clare and Kerry, mean dry matter yields of *Salix Aquatica Gigantea* (Willow) at two experimental sites were as follows:

	Newtown Butler	*Castle Archdale*
Mean annual yield (3 year cycle) (tonnes of dry matter per hectare)	15.8	13.5

The sites were ploughed and lime was applied at a rate of 7.4 tonnes of ground limestone per hectare to bring up the pH to a satisfactory level; willow will not root in low pH. Half a square metre per plant was allowed, so that there are 20,000 plants/hectare.

In the Republic, An Foras Talúntais (AFT) initiated species trials in 1977 on mineral soils in Carlow, followed by experimental plots laid out on cutaway basin peats at Clonsast, Co. Offaly and on improved blanket peat in Glenamoy, Co. Mayo. Under subcontract to AFT, the Forest and Wildlife Service (FWS) also established species trials in 1977, on blanket bog, drumlin and old red sandstone sites. Some of the yields from the AFT and the FWS plots are presented in Table 5. Although we now have quite a wide spread of plots established on a variety of site types, the data available for any particular site type are very limited. However, the known productivity of conventional forest crops, combined with the preliminary data we do have, indicate that there are grounds for optimism in this regard.

It is not easy to reconcile the wide discrepancy between the productivity data for Northern Ireland and the Republic. The following factors are relevant: the Northern Ireland plots have been established for 4 years longer than those in the Republic; they are on better, lower elevation wet mineral soil sites, which have also proved to be highly productive for conventional forestry.

Bord na Móna in 1980 initiated a major energy crops demonstration project at Clonsast on cutaway bog. The first phase of 80 hectares has been completed, and they plan eventually to establish 400 hectares of coppice deciduous trees. Although production on the plots established in the Republic does not yet match those achieved in Northern Ireland – the former were established 4 years after the latter – recent unpublished measurements of some of An Foras Talúntais plots indicate high current growth rates (14-16 dry tonnes per hectare per annum).

The Border Region: The land surveyed in the border region was classified as either good, medium or poor for deciduous coppicing species, based on site characteristics including elevation, exposure, aspect, soil type and soil acidity. A more refined estimate of productivity potential was not possible,

Table 5: *Short rotation forestry yield data (incomplete listing)*

Location	*Soil type*	*Species*	*Total yield (dry tonnes/ha)* 1 yr	2 yr	3 yr	4 yr
Castle Archdale Co. Fermanagh	drumlin	*Salix aquatica gigantea*			47.40	
Newtown Butler Co. Fermanagh	drumlin	*Salix aquatica gigantea*			40.50	
Oak Park Research Centre Co. Carlow	mineral	*Salix aquatica gigantea*		0.40	5.30	
Oak Park Research Centre Co. Carlow	mineral	*Populus trichocarpa*		8.40	24.50	
Swanlinbar Co. Cavan	drumlin	*Populus trichocarpa dettoides*		3.79	8.10	11.18
Clonsast Co. Offaly	cutover raised bog	*Salix aquatica gigantea*	1.18	1.74		
Kilfinane Co. Limerick	podzol	*Pinus contorta*		0.82	1.14	
Ross Co. Galway	blanket bog	*Pinus contorta*		0.64	1.84	3.09
Tullamore Co. Offaly	raised bog	*Pinus contorta*		1.37	5.60	10.94

Sources: Department of Agriculture, Northern Ireland (1979), Neenan and Lyons (1980), McCarthy (1981).

given the total lack of experience in growing these species commercially. The hectares classified in this tripartite fashion are presented in Table 6: over two-thirds of the land surveyed was classified as good for deciduous production. This included almost all of the good mineral and gley sites and some of the peaty gley areas. The poor sites (19 per cent of the total) are concentrated on the peat lands, where high acidity would make deciduous cultivation difficult.

Given that 81 per cent of the land surveyed is classified as good or medium for deciduous energy crop production, what are the costs of such production likely to be?

Table 6: *Acres classified as good, medium and poor for hardwood production in the land-use survey, border region.*

	Land-use survey		*Regional level*[1]	
	Acres	*% of total*	*Acres*	*% of total*
Good	617	69	59243	69
Medium	110	12	10303	12
Poor	172	19	16314	19
Total	899	100	85860	100

[1] Based on a land-base of 1.06 million acres, with 8.1% of this being "available".
Source: Appendix 3.

Costs

The Forest and Wildlife Service has a Work Study Unit which estimates the costs of the gamut of conventional forest operations, from planting to harvesting. This can be done on the basis of historic costs or direct costing of current operations. The sites, species and associated input-output mixes chosen and managerial patterns adopted are well established and reasonably predictable. In evaluating conventional afforestation investments, therefore, the weakest datum is the price at which the wood can be sold. Even in this case, we do have time-series price data, while the development of intermediate markets for immature plantations can also provide useful price information.

In the case of short rotation forestry, or what we have termed energy crop production, all of these ingredients are missing. The technology of production and the output to be expected are hardly defined; the costs of alternative input-output mixes are unknown; the costs of harvesting and transport are likewise not known, while the price at which the output can be expected to sell can be estimated only very imperfectly. Nevertheless, in order to evaluate the desirability of proceeding with the energy crops programme, it is necessary to make some estimate of the financial viability of investment in this area. Lyons and Vasievich (1981) have conducted a careful analysis of the costs and returns which might be expected to be associated with short rotation forestry for energy in Ireland. They focus on the cutaway bog area, and present high, medium and low costs for land acquisition, site preparation, drainage, fencing, access, planting, plant replacement, fertilisation, maintenance, regeneration, harvesting and transportation. They applied these costs to willow planted at 4 alternative densities – 6,666, 10,000, 13,333 and 20,000 stems per hectare – and alternate harvesting cycles of 2, 3, 4, and 5 years.

We have one actual costing of an energy plantation. The Forest and Wildlife Service established a 40 hectare plantation of Lodgepole Pine at Bellacorick, Co. Mayo in 1979/80. The costs were recorded by the Work Study Section. The crop was planted at a density of 40,000 plants per hectare; it is now thought that a planting density of 13,333 (150 X 50 cms.) stems per hectare would be sufficient to produce an adequate crop, so that we have adjusted the number of original plants and planting costs to reflect this density. The site was totally ploughed. In Table 7 we present the Lyons and Vasievich and the Forest and Wildlife Service cost estimates. They are not really comparable, because they were prepared for different sites and purposes. The FWS data apply to just one blanket bog site, planted with Lodgepole Pine, while the Lyons and Vasievich data apply to cutaway sites in general, planted with willow. These latter authors conducted comprehensive sensitivity analyses.

Since the Forest and Wildlife Service data are based on actual field experience, we use their establishment costs in our analysis.

The Lyons/Vasievich data apply to cutaway midland bog, while the Forest and Wildlife estimates apply to blanket bog. How appropriate are these data for other sites, notably the drumlin and related sites?[7] These areas are typically well roaded and quite fertile, so that the fertiliser cost need not be incurred, while the cost per hectare of providing roads can be reduced to £100. There is a school of thought which feels that ploughing on these sites is also not necessary. However, since there is some ambiguity on this score, we leave this cost in. Thus, incorporating the adjustments noted, we estimate that the costs per hectare of energy crop establishment will amount to £1090.20 on the drumlin and related soils sites.

We assume that average annual maintenance costs will amount to £25 per hectare on all sites and that extraction of the roots at the end of the rotation (25 years) will cost £100 per hectare. Potentially, a method for using the energy content in the rootstock is likely to be developed, but for the current situation we include this cost in our calculations.

Conclusions

Because the land to which our analysis is primarily addressed is the relatively low-lying wet mineral (drumlin) soils, we use the Northern Ireland productivity data as our primary source of information *vis-à-vis* output potential of energy crops. In our appraisal we take outputs of 7, 10, 15 and 20 dry tonnes per hectare as representing the likely range of production from energy crops. In doing so, we are fully cognizant of the frailty of the

7. Mainly wet mineral soils.

Table 7: *Two estimates of the direct costs (excluding land purchase) of establishing an energy plantation with 13,333 plants per hectare (£/ha)*

		FWS		*Lyons and Vasievich*
Ploughing:	£14.50/plough-hr X 10 hrs/ha	145.00		
	£ 3.70/man-hr X 5 hrs/ha	18.50		
		163.50		100.00
Drainage:	£14.50/plough-hr X 1.5 hrs/ha	21.75		
	£ 3.70/man-hr X 0.75 hrs/ha	2.78		
		24.53		100.00
Planting:	Plants – £32/1000 (LP) X 13,333/ha	426.66		
	Pl. distrib. – £11/muskeg-hr X 0.9 hrs/ha (incl. labour)	9.90		
	£6/tractor-hr X 2 hrs/ha (incl. labour)	12.00		
	Trenching – £3.70/man-hr X 4 hrs/ha	14.80		
	Planting – £3.70/man-hr X 80 (6 man-hrs/ 1000)	296.00		
		759.70		1123.00
Fertiliser:	£90/tonne of rock phosphate X 1.25 tonnes/ha	112.50		
	£105/tonne of muriate of potash X 0.15 tonnes/ha	15.75		
	£3.70/man-hr x 6.25 hrs/ha (labour)	23.13		
	Application – £3.70/man-hr X 14.2 hrs/ha	52.54		
		203.92	(0)	81.00
Fencing:	£0.90/metre X 71.11 m/ha.	64.00		150.00
Roads:	£3.71/metre (road improvement) X 30 m/ha	111.30	(100)	150.00
Total		1326.95	(1111.73)	1704.00

Notes: (1) The costs per unit and the amounts apply only to the Forest and Wildlife Service estimates. The FWS and the Lyons and Vasievich estimates are for October 1980 and January 1981, respectively.
Numbers in parentheses are adjustments made for crop establishment on wet mineral soils – fertiliser cost reduced to 0, road cost reduced to £100.
(2) The FWS estimates apply to Lodgepole Pine; the Lyons/Vasievich apply to willow.

basis for this critical assumption. We make recommendations in this regard later on. We use the costs which are based on the Forest and Wildlife Service (FWS) experience (Table 7).

Chapter 4

CONVENTIONAL FORESTRY: PRODUCTION AND COSTS

Production

Since before the foundation of the State, afforestation has been carried out by the government. The forest area in State ownership now amounts to 295,415 hectares (730,000 acres); it is administered by the Forest and Wildlife Service. There is, in addition, 80,936 hectares (200,000 acres) of privately owned woodland.

The State now has over 60 years' experience of forestry, involving land purchase, selecting the tree species most appropriate for the site, establishing and managing the crop and harvesting the timber. Data gathered systematically over decades are available from which to draw in arriving at the most appropriate mix of inputs. If well-established management practices are followed, production can be predicted with reasonable assurance.

Forest crops are classified by a productivity index termed *yield class*. The yield class designation indicates the annual average commercial wood production per hectare in cubic metres (M^3) to be expected from a fully stocked stand if final harvest is made at the age at which average annual growth is maximised. Thus a Sitka Spruce plantation of Yield Class 16 will produce an average annual output of 16 cubic metres per hectare per annum under the conditions listed above. Based on soil type, drainage, elevation and aspect, an experienced forester can assign a bare field to a particular yield class, indicating a reasonable estimate of output which it would produce if it were afforested. There are yield tables available which show the volumes of wood in the pulpwood, boxwood and sawlog categories which will be harvested with a specified management regime.[8]

As can be seen in Table 8, the forests of Ireland have an estimated average annual net production per hectare of 6.91 cubic metres, which is almost twice the average for the EEC, and 2.6 times the average for the Nordic countries. This figure of 6.91 is a current estimate, and may be an understatement of potential annual net[9] production, since an abnormal percentage of Irish forests are in an immature stage. The Sitka Spruce plantations now

8. *Forest Management Tables* (Metric) Booklet No. 34, Forestry Commission, 1971.

9. Net of losses due to insect and disease damage, windblow, etc.

being established have an average yield class of 14. Yet Ireland has the lowest percentage of tree covered land in Europe. This seeming incongruity between high productivity and low tree cover has led some observers, on these grounds alone, to call for bringing the forested land-share in Ireland up to the European norm. However, two considerations are germane: the Nordic countries and our EEC partners have their forests; they do not have to allocate funds to create them. In maintaining their forests, these countries do, of course, carry a very substantial opportunity cost, but this does not enter the public finance and political calculus with anything like the force of "new" expenditure. In addition, much of this forest is on land where the opportunity cost – what is forgone – of using the land for tree-growing is negligible.

In Ireland we must consider the costs, including the forgone land-use opportunities.

Based on the land-use survey,[10] the areas which owners were willing to consider for energy crop production (and forestry) and their productivity levels, are shown in Table 9. It is clear that the candidate land is highly

Table 8: *Forest area and annual net production, EEC and Nordic countries, 1977*

	Forest as % of total land area	*Forest area per capita (hectares)*	*Annual net production per hectare*
Belgium	20	0.06	4.3
Germany	29	0.12	4.82
Denmark	11	0.09	5.9
France	25	0.26	3.14
Great Britain	8	0.03	3.49
Italy	21	0.11	2.12
Ireland	4	0.10	6.91
Luxembourg	32	0.24	4.87
Netherlands	7	0.02	4.35
N. Ireland	5	0.05	– *
EEC	20	0.12	3.5
Finland	74	4.03	2.98
Norway	29	2.23	1.88
Sweden	64	3.04	2.69
Nordic countries	52	3.14	2.67

*Included in the estimate for Great Britain.
Source: Convery (1979), p. 39.

10. The form used in this land-use survey is in Appendix 3.

productive for tree growth. Over 70 per cent of the area is of Yield Class 20 or better; this compares with an average productivity for State Sitka Spruce plantations in State forests of Yield Class 14. Factoring up the sample land to the total three county area, we find that owners in the region would be willing to consider allocating 34,800 hectares, comprising 8.1 per cent of the total land area.

The candidate areas for each soil type, and the associated costs, are presented in Table 11. In lay person's terminology, good mineral soil consists

Table 9: *Productivity and crop establishment costs for conventional forestry, the border region, 1981 £*

Yield class	*Area available*		*%*	*Average costs of establishment (1981 £)*[3] *(per acre)*
	Area surveyed[1] *(acres)*	*Total regional area*[2]		
12	3	859	1	180
14	49	4293	5	352
16	121	11162	13	307
18	84	7727	9	321
20	66	6010	7	288
22	276	26617	31	217
24	282	26617	31	264
26	19	1717	2	104
	900	85860[2]	100[2]	264

[1]*Source:* Survey and assessment of typical parcels of land available in the 3 counties (Appendix 3).

[2]*Source:* Table 10. It is assumed that all of the crop and pasture land, and rough grazing land in use, is included in the total land-base considered, together with 50,000 acres of "other land" – the latter amounting to 30 per cent of total "other land" in the 3 counties – to yield a total potential land-base of 1,060,000 acres (to the nearest thousand).

In response to the questionnaire, landowners indicated that they would be willing to make 11.4 per cent of the total area surveyed available. However, when a subsample of the land was actually mapped, it was found that of the 1,264 acres "offered", only 900 were available (71.2 per cent), due to inaccessibility, change of heart, and/or initial over-estimation of area by the owners (mainly the latter). Thus 8.1 per cent (11.4 X 0.712) of the total potential land base is estimated as being "available".

[3]*Source:* Cost estimates were derived from the land evaluation survey (Appendices 3, 4, 5), which was an on-site examination of land parcels potentially available for ECP in the 3 county study area. Specific requirements (fencing, roads, fertiliser, ploughing, drainage, etc.), for crop establishment on each parcel were estimated based on estimates developed by FWS through actual experience.

Table 10: *Land area and use in the border region, 1975*
(Acres)

	Total corn, root and green crops and fruit	*Hay*[1]	*Pasture*	*Total crops and pasture*	*Rough grazing in use*	*Total crops pasture and rough grazing*	*Other land*[2]	*Total area*
Cavan	4629	109325	281564	395518	18263	413781	53381	467162
Leitrim	2245	68691	197275	268211	35513	303724	73040	376764
Monaghan	8297	75863	197156	281316	11063	292379	26606	318985
	15171	253879	675995	945045	64839	1,009,884	153027	1,162,911

[1] Including grass for silage.
[2] Including woods and plantations, turf, bog, marsh, water, roads, etc.
Source: Central Statistics Office (1978), pp. 68-69.

of well drained, fertile, easily worked, brown soil. Gleys are wet mineral soils which are associated with the drumlins, and are colloquially called "daub" – they have a high clay content and tend to compact under persistent pressure, leading to poor drainage, a trait which is exacerbated by a tendency for an "iron-pan" to form which further impedes drainage.

Table 11: *Candidate areas, total establishment cost and cost per acre, by soil type, conventional forestry*

Soil type	*Area (acres)*	*% of total*	*Total cost (1981 £)*	*Cost per acre (1981 £)*
Gley	287	32	68345	238
Peaty gley	56	6	14354	256
Peat	213	24	65323	307
Good mineral	268	30	64599	241
Swamp	75	8	24330	324
Total	899	100	236951	264

Source: Appendix 3.

A peaty gley is a gley which has an associated organic (peat) component in the upper layer. Because of their physical characteristics, these soils are difficult to work for agriculture, but often have quite a high level of inherent fertility. Peats, of course, are the familiar organic soils with a high moisture content, low bearing capacity and often (but not always) low fertility. Swamps are areas with persistent surface water.

Gardiner and Radford (1980) estimate that 73 per cent of the land in the three-county region is classified as marginal for agricultural purposes. (The marginal land estimate ranges from 97 per cent for Co. Leitrim to 44 per cent for Co. Monaghan). In light of this, it is interesting that 30 per cent of the land suggested by landowners as being potentially available is classified as good mineral soil. The evidence, therefore, does not support an hypothesis we entertained at the outset of the study, namely, that landowners would only consider allocating waste land to this new use.

Costs[11]

As indicated above, average costs per acre of crop establishment were estimated for the 900 acres examined. From Table 9 we can see that the most and least productive sites – Yield Classes 12 and 26 – have the lowest average

11. The costs on which the estimates in this section are based are presented in Appendix 5.

crop establishment costs per acre – £180 and £104 respectively – while average per acre costs peak on the relatively low yield site category of Yield Class 14. However, there were very few acres (3 at Yield Class 12 and 19 at Yield Class 26) at these productivity extremes. The average per acre costs associated with Yield Classes 24 and 22 (£264-217) and Yield Classes 14 and 16 (£352-307) provide a more representative sense of the pattern. The lower average costs on the better sites are to be expected, as they would have better road access, less site clearance requirements and lower fertiliser requirements.

This pattern is also borne out when average establishment costs are categorised by site-type (Table 11). Average costs per acre on good mineral soils and gleys amount to £241 and £238, respectively, while on the peat and swamp sites they increase to £307 and £324, respectively.

Economies and Diseconomies of Scale

In Table 12 we present the distribution of parcel sizes surveyed and the associated establishment costs. The data imply that there are no economies of scale; indeed they show that there are diseconomies of scale. This is a product of the manner in which our data (of necessity) were collected. The field inspector mapped the area, did a productivity assessment and estimated the quantities of inputs – ploughing, drainage, fencing, fertiliser, planting, etc. – that were required. The format used in gathering these data is presented

Table 12: *Size distribution of land parcels surveyed, and average cost per acre of crop establishment (conventional forestry)*

Size of parcel (acres)	*Frequency*	*% of total parcels*	*Total acres*	*% of total area*	*Average cost per acre*
1	27	25	27	3	166
2	14	13	28	3	200
3	13	12	39	4	179
4	10	9	40	4	177
5	6	6	30	3	261
6-10	14	13	102	11	423
11-20	10	9	148	16	219
21-40	7	7	206	23	248
41-60	3	3	143	16	226
61-80	2	2	135	15	282
Total	106	100	898	100	264

Source: Derived from Appendix 3.

in Appendix 4. An average cost per unit was then applied to these inputs; it was not possible to adjust the unit cost to take cognizance of scale effects. The unit costs applied are listed in Appendix 5. Furthermore, on the smallest parcels, ploughing was not recommended because of the small size, and some of these areas did not require full fencing, and this also "discriminated" against the large units. Finally, the costs listed only include on-the-ground outlays; no adjustment has been made to cover overhead and general administration. Clearly, these would be higher per hectare on smaller than on larger units.

The ignoring of overhead costs is legitimate only to the extent that it is a fixed cost, and that this "capacity" would remain unutilised if the planting in question were not undertaken. Counterbalancing this tendency to understate cost is the fact that the outlays and productivities assumed are those actually incurred and achieved respectively by the Forest and Wildlife Service. We feel that it is likely that private individuals and firms will in many cases be able to reduce unit costs and increase output above the levels experienced by the government service.[12]

In spite of the above caveats, we feel that the cost estimates derived, based as they are on site visits to 106 parcels, provide a reliable cost basis for the conventional forestry option, and that the productivity estimates are likewise robust. The details in these respects concerning each parcel examined are provided in Appendix 3.

It can be seen in Table 12 that if it were felt to be desirable to limit participation to parcel sizes of 5 acres or larger, then 14 per cent of the area would be eliminated, representing 59 per cent of the parcels offered.

Conclusions

The land of those owners who were willing to consider tree growing was surveyed and classified by production potential (yield class). Over 60 per cent of the area had a productivity of 22 cubic metres per hectare per annum or greater. Costs per acre of crop establishment was estimated by yield class ranging from £104-£352. These productivity and cost data were used in the investment appraisal.

12. Unfortunately, we have no evidence available to sustain or reject this hypothesis.

Chapter 5

ENERGY CROPS AND MARKETS

Three outlets for energy crops can be envisaged: the first and, perhaps at this stage, the most speculative outlet is as a supply for processing into gas and/or liquid fuels, or to animal feed. The second is as a source of energy for domestic, institutional or industrial facilities. The third is as a fuel for conversion into electricity.

Gas and/or Liquid Fuels; Animal Feed

The distillation of wood to produce chemical fuel (methanol) is being persued in a number of countries. This is technically feasible, but it is a highly capital intensive process; the end product cannot yet compete in terms of price with conventional fuels. In addition, there are substantial investments already being made in coal gasification and liquefaction. This implies that those investing feel that the payoff in these areas is likely to come sooner than it will in the case of wood. However, the technological advances which are likely to be achieved with coal may well have some application to wood.

In the US, major emphasis has been placed on encouraging the displacement of gasoline by ethanol.[13] It is hoped to encourage the production of fuel alcohol from biomass equal to at least 10 per cent of total US gasoline consumption by 1990, implying an annual production of 10 billion gallons of fuel alcohol. To achieve this, exemption from federal and state (25 states) excise taxes – amounting respectively to 40 and 54 cents per gallon of alcohol contained in fuel – is provided, together with investment tax credits and grants, loans and guarantees. The ethanol is produced from corn and other feed grains. In explaining why the US has chosen to emphasise the production of ethanol rather than methanol, Sanderson (1981) notes that a blend of 10 per cent ethanol and 90 per cent regular gasoline – the combination is called gasohol – can be burned in conventional car engines with only a slight loss in miles per gallon and a slight gain in octane rating. Methanol, on the other hand:

13. Since the Reagan Administration took office in the US (1980), government support for ethanol has diminished considerably.

> . . . can be produced more cheaply (from wood and other cellulosic materials, and even more cheaply from coal), but it has major drawbacks as a motor fuel extender. In particular, whereas a 10 per cent ethanol gasoline blend can be used in the family car, admixtures of methanol require extensive modifications. Compared with ethanol, methanol has a low Btu content (only half that of gasoline and 20 per cent less than ethanol), more severe phase separation problems, more starting problems in cold weather, more serious corrosive effects on metals and plastics, and high toxicity. (p. 2)

He observes that it is conceivable that methanol could become acceptable in engines especially adapted to its use, notably in the form of pure alcohol. More widespread use of such vehicles is planned in Brazil. However, he argues that if methanol has a future in the US, it is likely to be as a feedstock for synthetic gasoline, and that the economics will favour methanol from coal over methanol from biomass.

We conclude that the use of wood as a supply for the production of gas or liquid fuels on a commercial competitive basis remains a long-term possibility only. While current developments provide a basis for guarded optimism concerning future prospects, there is insufficient substantive data available to underpin an investment appraisal using these outlets as the primary markets. The same applies to the use of wood as a source of pelletised animal feed. There are some promising portents from preliminary work in Northern Ireland, New Zealand and elsewhere, but much remains to be done before commercial viability is demonstrated.

Domestic, Institutional and Industrial Uses

Wood has been used for millenia as a source of energy in houses, in institutions (schools, hospitals, etc.,) and industrial premises. As such it heats, provides energy for cooking and raises steam for industrial processes. In the developing world it still comprises the primary source of energy. However, in the developed world it has been replaced first by coal and latterly by oil and natural gas. In Ireland, our indigenous forests were largely exhausted by the early 18th century. The substantial area of private woodland planted by the more long-established landlord class during the 19th century provided fuel for the manor house, but in the main its use did not extend to the peasantry. The latter depended on peat as their main source of heat and cooking fuel. Thus, in most rural areas in Ireland there is not a long established tradition of wood use as the primary fuel for domestic purposes, such as one finds in parts of the North Eastern United States and Central Europe.

The demise of wood as a domestic fuel resulted for a variety of reasons. First among them, perhaps, is the low value per unit of volume, which makes it relatively expensive to transport and space-using to store and burn. Second is the labour-intensive nature of the traditional functions of splitting, preparing and loading logs for the fire. Third is the heterogeneous nature of the product, both in terms of moisture content and the combustion properties of different species; this demands more knowledge on the part of the wood consumer than does the purchase of either machine turf or coal. Fourth, in parts of Ireland there has been a near absolute unavailability of wood.

In terms of comparisons, it is clear that coal and turf provide the most appropriate comparisons in terms of market opportunities. The average annual import price for domestic coal from 1972 to 1981 can be seen – in current and real (1968 £) terms – in Figure 3. Overall, in the 1972-1981 period the real price rose by 68 per cent; this compares with a rise in the price of heavy fuel oil of 500 per cent over the same period.

Of more direct relevance is the retail price per tonne of coal and turf. Since September 1978, Bord na Móna has been collecting information on retail prices for domestic coal, machine turf and briquettes, by quarter. These data are presented in Table 13 and Figure 4. It is notable that the gap between the price of coal and turf (machine turf and briquettes) has widened over the period:

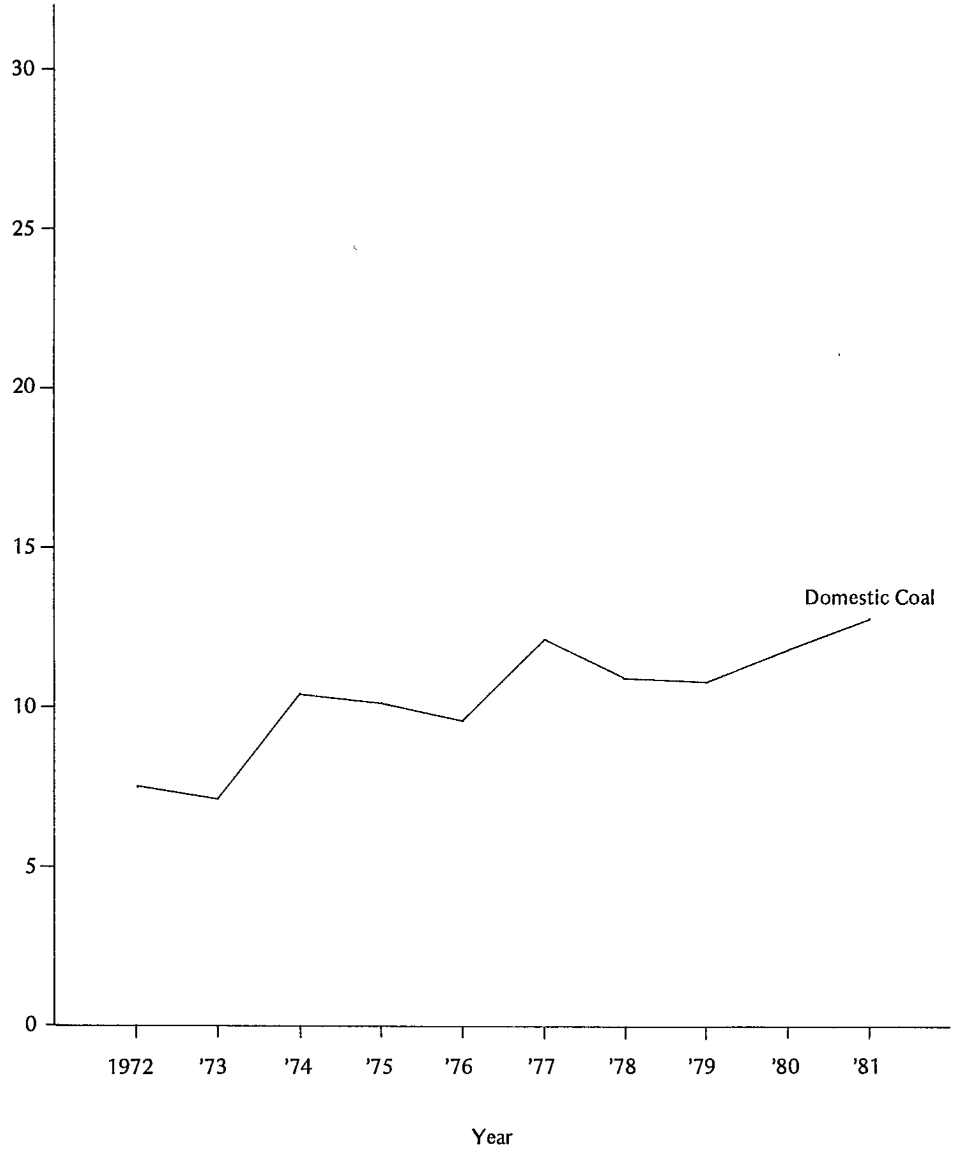
Difference in retail price (1968 £) per tonne of coal and:

	Machine turf	*Briquettes*
September 1978	13.1	9.5
June 1981	15.0	11.5

In each case the price difference over the period has increased by about £2 (1968 £) (or £9.59 per tonne in June 1981 £). This results because the price of both machine turf and briquettes is kept below the market-clearing level; non-price rationing must be used to allocate supplies. The price of coal is, of course, also controlled, but unlike turf, it must perforce be allowed to achieve the international level or supplies will not be forthcoming. Thus, in terms of providing a sense of the willingness to pay of Irish consumers, the price of coal provides a more market-determined guide than does the administratively-set price of turf. However, in terms of such matters as the ratio of value to volume, Btu and moisture content, etc., wood is more like turf than coal. Thus, we derive price equivalents for both fuels. In doing so we are cognizant that differences in utilisation costs and burning efficiencies will warrant adjustment of these prices; they will be discussed briefly later on.

Wood when freshly felled (green timber) has a high percentage of moisture,

Figure 3: *Real Import Prices per Tonne of Domestic Coal, 1972-1981, deflated using CPI 1968 = 100*



Source: Table 3.

Table 13: *Retail prices per tonne of coal (bulk), machine turf (bulk) and briquettes (baled), 1978-1981, by quarter. (Prices in current and constant (1968 £) Irish pounds.)*

Year and quarter	*CPI (1968=100)*	*Machine turf*		*Coal*		*Briquettes*	
		Current	*Constant*	*Current*	*Constant*	*Current*	*Constant*
1978							
September	312.5	15.0	4.8	55.9	17.9	26.3	8.4
December	317.1	17.3	5.5	56.2	17.7	29.8	9.4
1979							
March	330.3	17.3	5.2	57.0	17.3	29.8	9.0
June	340.8	17.9	5.3	58.4	17.1	29.8	8.7
September	354.9	21.4	6.0	65.7	18.5	29.9	8.4
December	367.7	22.8	6.2	75.4	20.5	37.7	10.3
1980							
March	381.5	22.9	6.0	76.4	20.0	37.2	9.8
June	409.7	none	—	80.8	19.7	37.8	9.2
September	421.8	25.9	6.1	87.9	20.8	41.1	9.7
December	434.7	25.2	5.8	91.7	21.1	41.3	9.5
1981							
March	461.6	25.9	5.6	95.1	20.6	41.3	8.9
June	479.6	25.9	5.4	98.0	20.4	42.8	8.9

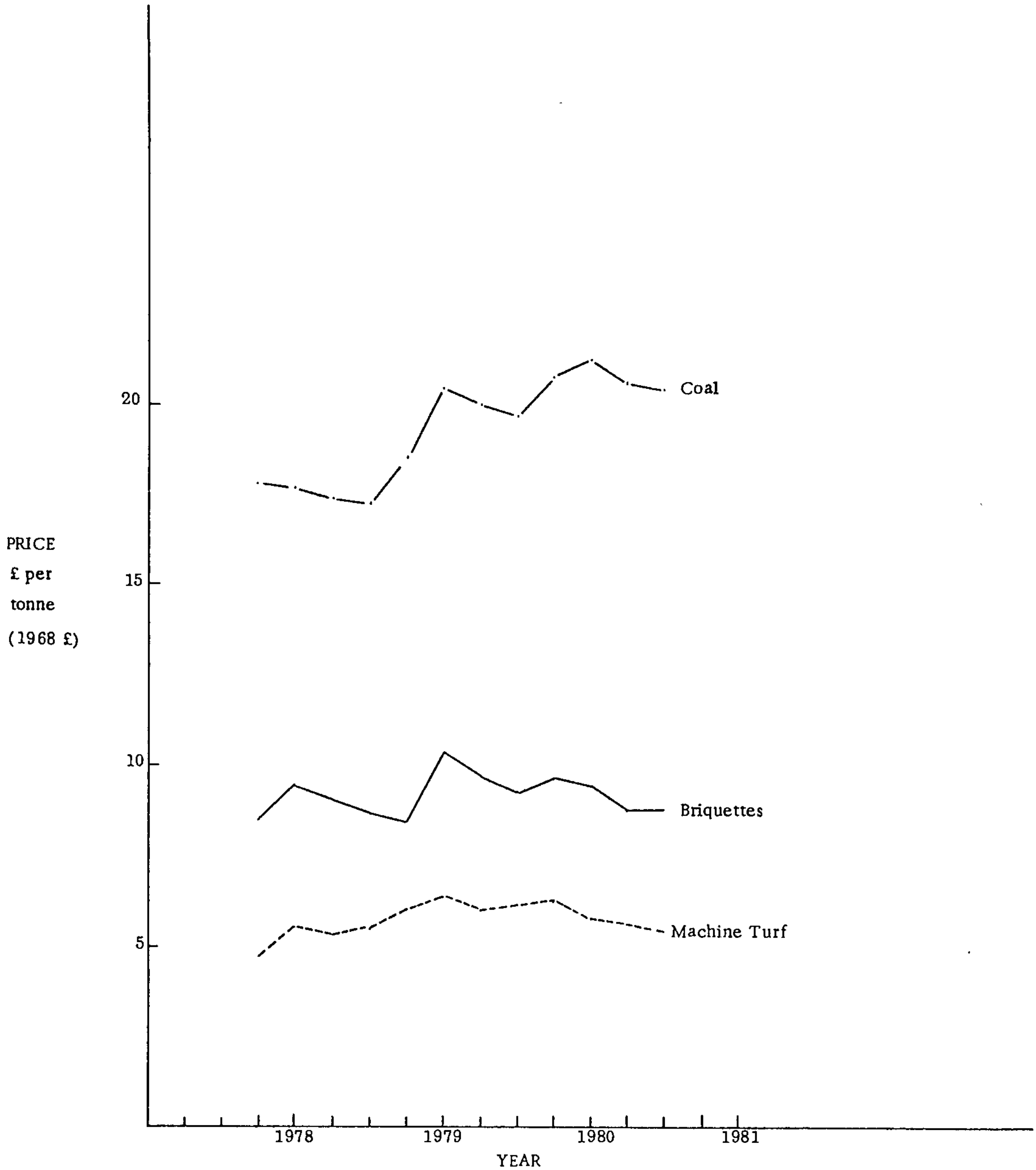
Source: Bord na Móna.

ranging from 62 per cent in the case of Sitka Spruce to 32 per cent in the case of ash.[14] In the dormant (winter) season, an average figure for conifers would be 55 per cent, while for deciduous species the norm would be in the low 40s. After felling, the moisture content of the wood can be reduced by air drying. Stacking so as to facilitate air circulation in spring and summer, followed by transfer to a covered, ventilated area in autumn and winter, will achieve considerable drying. Coniferous woods treated in this fashion will dry to 20-35 per cent moisture content in 12 months; deciduous woods may take somewhat longer.

When comparing wood with other fuels such as oil, gas and coal, it is usual to talk of tonnes of dry matter, i.e., wood with zero moisture content. Fuels are often also expressed in tonnes of oil equivalent (TOE), i.e., the number of tonnes of the fuel in question which it takes to be equivalent in energy content to a tonne of oil. In Table 14 can be seen the tonnes of oil equivalent in coal, machine turf and briquettes, together with the price per TOE for

14. Moisture content (%) = $\frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \times 100$, i.e., wet weight basis.

Figure 4: *Retail Prices of Coal (Bulk), Briquettes (Bales) and Machine Turf (Bulk), by Quarter, 1978-1981 (1968 £) CPI 1968 = 100*



Source: Table 13.

Table 14: *Energy equivalent prices per tonne of dry matter for wood, at retail prices of coal, machine turf and briquettes obtaining in June 1981*

	Coal equivalent price	*Machine turf equivalent price*	*Briquettes equivalent price*
Initial fuel price per Tonne (June 1981 £)	98	25.9	42.8
Tonnes of oil equivalent (TOE)	1.504	3.195	2.257
Price per TOE	147.4	82.8	96.6
Equivalent price per dry matter tonne of:			
Deciduous wood[1]	56	31	37
Coniferous wood[2]	61	34	40

[1] 2.63 tonnes of dry matter per TOE at 35% moisture content derived as follows:
Gross calorific value (GCV) = 8000 (1 – 0.35)
= 5200 Btu/lb.
Net calorific value (NCV) = 5200 – 1055 (0.35 + 9 (0.039))
= 4460 Btu/lb.
4460 Btu/lb. ÷ 0.43 = 10372 KJ/Kg ÷ 3.6 = 2881.14 kWh/tonne as fired
1 TOE = 11,630 kWh → 4.04 as fired tonnes/TOE: 4.04 X 0.65 = 2.63 tonnes of dry matter/TOE
2.63 TDM = 11,630 kWh: 1 TDM = 4422 kWh

[2] 2.41 tonnes of dry matter per TOE at 35% moisture content:
GCV = 8600 (1 – 0.35)
= 5590 Btu/lb.
NCV = 5590 – 1055 (0.35 + 9 (0.039))
= 4850 Btu/lb.
4850 Btu/lb. → 3133.36 kWh/tonne → 3.71 as fired tonnes/TOE, or 2.41 tonnes of dry matter/TOE.

these fuels. Since we know the number of tonnes of wood dry matter it takes to be equivalent in energy terms to a TOE, we can derive the energy price per tonne for wood when the price is based on coal, machine turf and briquettes. The bases on which equivalences are derived are presented under Table 14. For deciduous species this price per tonne of dry matter ranges from £56 when it is based on coal to £31 for machine turf. In the case of coniferous species these numbers increased to £61 and £34, respectively.

In order to arrive at a standing timber value based on these equivalents, it is necessary to deduct harvesting and transportation costs. For the energy equivalent wood prices examined below, we assume a transport distance of 25 miles[15] and that the wood will be transported (by truck) at 55 per cent

15. The availability of markets is considered later.

moisture content (worked back to dry matter tonnes). It is likely that wood chips will be dried to about 30-35 per cent mc (moisture content) before transport since added moisture increases weight, and thus makes transport costs higher, but this factor might not be terribly significant, because the cost of wood transport is linked more closely to the volume of a load rather than the weight, and volume does not vary much with changes in moisture content, whereas weight does. Also, the fuel value of wood increases with decreasing moisture content and so would probably be dried to 35 per cent before combustion anyway. The estimated transportation costs per tonne for various distances are listed in Table 15. These are for conventional forestry.

Table 15: *Wood transportation costs (1981 £)*

Distance (miles)	*Haulage rates (£ per tonne)*	
	Wood (55% moisture)	*Wood (dry matter)*
10-25	2.52	5.6
26-30	3.09	6.9
31-35	3.19	7.1
36-40	3.56	7.9
41-50	3.82	8.5
51-60	4.06	9.0
61-70	4.38	9.7
71-80	4.52	10.0
81-90	5.08	11.3
91-100	5.27	11.7

Source: P. McMahon, Road Haulier, Scariff, Co. Clare. Based on transport of pulpwood and chips, by truck.

Estimates of harvesting costs are highly speculative at this stage. Harvesting machines are being developed both at Loughry College of Agriculture and Food Technology, Co. Tyrone, Northern Ireland, and by the Irish Sugar Company in the Republic, the latter being under contract to Bord na Móna. However, they are still — especially the latter — at the prototype stage. Harvesting (felling and extraction) costs in the Forest and Wildlife Service are listed in Table 16. The costs listed indicate the economic difficulties involved in using early thinnings as a source of energy. For the first thinning, the felling and extraction costs — totalling £34.3 per dry tonne — alone bring the costs above the energy equivalent retail price per tonne of dry matter (deciduous) for machine turf (31.00). This arises because thinning involves selectively taking out small, poorly formed and widely dispersed stems. In

Table 16: *Average costs per tonne for harvesting conventional forestry crops (1981 £)*

Crop	Wet weight (55% moisture content) Felling	Extraction	Total	Dry matter Total
		£		
1st thinning	10.97	4.46	15.43	34.3
2nd thinning	7.14	4.46	11.60	25.8
3rd thinning	5.06	4.46	9.52	21.2
Clearfelling			5.75[1]	12.8

[1] Total includes felling and extraction.
Source: Forest and Wildlife Service.

later thinnings, as the average size of the individual stems increase, the unit costs fall. Line thinning, which is cheaper per unit, is becoming more common. At clearfelling, all of the remaining trees, which will of course be the largest, are removed, and costs per tonne fall sharply, to £12.8 per dry tonne. With energy crops it is anticipated that the total crop of deciduous trees will be harvested every 5 years, and that this will be accomplished in a fashion more akin to the harvesting of agricultural grain crops than conventional forests. We estimate that such harvesting will cost £5.00 per wet tonne, or £11.1 per dry tonne, which is slightly below current clearfelling harvest costs for conventional forests. In doing so we are aware of the speculative nature of this estimate; harvesting is the least substantiated of our cost estimates.

Deducting harvesting and transportation costs, respectively of £11.1 and £5.6, respectively (totalling £16.7) from the retail energy equivalent prices estimated earlier, we arrive at the corresponding stumpage prices for deciduous wood:

	Coal Equivalent Price	*Machine Turf Equivalent Price*	*Briquettes Equivalent Price*
Stumpage price per tonne of dry matter (1981 £)	39	14	20

Which, if any, of these prices is most appropriate to apply to the output of energy plantations? Since seasoned (20-30 per cent moisture content) wood is about twice the volume of coal per unit weight and half the calorific value, it means that storage requirements need to be up to four times the size required for coal. This ratio does not necessarily hold through all considerations. For example, turf burning cookers are not significantly larger than coal burning ones, but, other things being equal, the frequency with which the fire must be fed is greater with wood than it is with coal. Both machine turf and briquettes are similar to wood in their storage requirements and burning characteristics. For these reasons, a comparison with turf prices seems the more appropriate. However, as we noted above, the prices of these are set below the market-clearing level. What would the equilibrium prices be if prices were decontrolled, and turf was allowed to flow to willing buyers including those in Northern Ireland (there is an embargo on turf sales from Bord na Móna to the North) and all demand were satisfied at the prices prevailing? The current (June 1981) prices per tonne of machine turf and briquettes are £25.9 and £42.8, respectively. Discussion with individuals in the trade led us to tentatively conclude that the market-clearing prices for these would be about £32 and £50, respectively. Converting these in turn to equivalent prices per tonne of deciduous dry matter, in the manner indicated in Table 15, we find that for machine turf it is £39 and for briquettes it comes to £43. Since machine turf is more akin than briquettes to what we envisage being the end-product of energy crops, we take £39 per tonne of deciduous dry matter as our reference retail price in the analysis of domestic, industrial and institutional uses. This is 70 per cent of the current energy equivalent price for coal. Deducting harvesting and transportation costs totalling £17 we derive a standing wood value of £22 per dry matter tonne.

There are no reliable wood market data available against which to check these values. In addition, the discussion of coal as an alternative has focused on domestic coal. Major industrial users have the option of burning steam coal, which at present has an import price about 70 per cent that of coal. In this respect, an important consideration would be distance from port, reliability of supply and price, and scale of enterprise. It is notable that a brick works in Co. Tyrone is examining the possibility of meeting its energy needs from energy crop plantations. This is an outcome of the trials conducted out of the Loughgall Horticulture Centre, Co. Armagh.

As part of our central analysis, we did not use equivalent prices for oil and natural gas in estimating willingness to pay for wood. These fuels have such compelling cost advantages over wood in terms of transportation, storage, handling and combustion that direct comparison would be irrelevant, and adjusting appropriately for all of the differences in use costs would be very difficult. However, in the very short term, in electricity generation, output from wood-fired (formerly) sod-peat burning stations can be regarded as substituting for the output from oil-fired units, under three very restrictive conditions: that the sod-peat burning stations will be closed down if wood is not used; that the system is capacity-constrained, so that there is no "surplus" non-oil fired (i.e., gas and coal) generating capacity in the system; that all non-fuel costs are fixed. Under such circumstances, it can be appropriate to value wood in relation to oil, adjusted for conversion efficiency. Electricity generation is discussed in the next chapter. However, we are evaluating the attractiveness of a major, long-term investment in wood for energy. Given this circumstance, it is clear that wood should be compared with the best available alternative in the long run.

Chapter 6

WOOD FOR ELECTRICITY GENERATION

Existing Stations

Wood can be burned by the Electricity Supply Board (ESB) at the sod peat burning stations listed in Table 17 and presented in Map 2. The table also shows the capacity in MW of these units, their existing efficiencies and the expected overall efficiency of new plant of similar size. The total potential wood-burning capacity in these units amounts to 117.5 MW, comprising 3.8 per cent of existing ESB installed capacity, and only 2.5 per cent of total capacity expected to be in place by 1987/88. Wood chips "manufactured" from sawmill waste are being burned at these units, in combination with coal slack. In addition to its inherent thermal properties, the chips give "body" to the slack, thereby allowing the latter to be burned. The ESB is paying £15.00 per tonne delivered for chips of 55 per cent moisture content, or £33.33 per tonne of dry matter.[16] In the case of Lanesborough this works out at 3.45p per kilowatt (kWh) of electricity produced with the existing chaingrate.[17]

The generating capacity of the ESB in 1980/81 and expected capacity in 1987/88 are presented in Table 4 (on page 14). Capacity is measured in terms of megawatts (MW). Each megawatt has the capacity to produce 1000 kilowatts of electricity per hour, called kilowatt hours (kWh) or simply units The number of units generated depends on the load factor, i.e., the percentage of the time during which the station is operational. For a given intake of fuel, the amount of electricity produced depends on the conversion efficiency, i.e., the percentage of the energy in the fuel which actually gets converted

16. The ESB recently discontinued this practice.

17. There are 2,881 kWh/tonnes of wood (see note 1, Table 14). Assuming an expected efficiency of 21.8 per cent (existing grate, NCV-based): 2881 x 0.218 = 628 kWh/tonne. The ESB pays £15/tonne at 55 per cent moisture content; this equals £21.67/tonne at 35 per cent mc (£15/0.45 tonnes dry matter = £x/0.65 tonnes dry matter; x works out at £21.67). So, £21.67/tonne ÷ 628 kWh/tonne = 3.45 pence/kWh.

Note: When calculating the price (£/tonne) payable for wood (standing), we use the ESB figure of £15/tonne at 55 per cent moisture content, worked back to the appropriate moisture content. For example, above we calculated the price at £21.67/tonne at 35 per cent mc. The ESB pays a "bonus" of 30 pence/tonne for each moisture content below 55 per cent (and vice versa); at 35 per cent mc, this works out at £21/tonne. So, in fact, the pricing system appears to discourage wood sellers from drying their wood below 55 per cent mc to gain the maximum price per tonne. Because of this anomaly, we are assuming a direct conversion from £15/tonne at 55 per cent mc to the relevant moisture content.

into electricity which is sent out from the station. In 1980/81 the average plant load factor was 37 per cent and the thermal efficiency of conversion of primary (fuel) energy to electricity was 32.4 per cent for all ESB units.

The major expansion in capacity over the next five years will take place in coal, with 900 MW capacity to be installed at Moneypoint, Co. Clare, using imported steam coal. Since capacity at this site can be further expanded and it appears to be the least-cost option available, this source provides the long-run marginal cost estimate for electricity production with which to compare alternatives – in our case wood-fired capacity.

The peat-burning stations are of two types: those which burn sod peat (117.5 MW) and those which burn milled peat (330MW). The sod peat units tend to be high-cost stations, of a small scale, with low load factors and inefficient conversion. In part this is due to the fact that the boilers in the sod peat stations were originally designed to burn coal and not peat. Modifications for peat were made, but the resulting boiler was too large, inefficient and has high maintenance costs. Also, the boilers are run at very low pressures, leading to a greater fuel demand per unit output. Low load factors also contributed to make the non-fuel costs per unit of output relatively high.[18] The stations can readily be used to burn wood, and have already been used this way in combination with coal slack, as noted above. The milled-peat units are larger and more efficient, but cannot readily be converted to burn wood, unless it is in the form of sawdust.

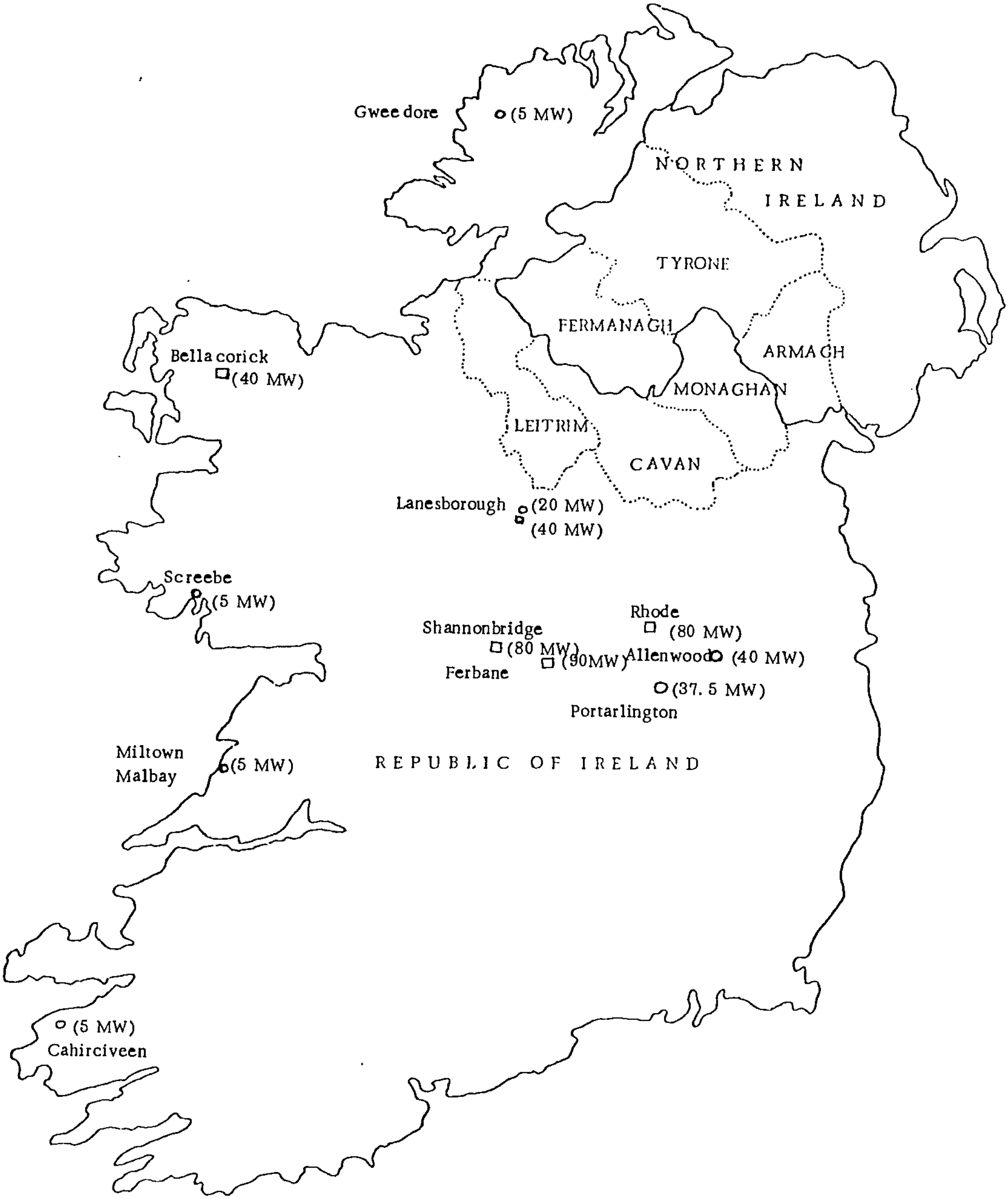
Table 17: *Capacity, current efficiency and expected efficiency of new plant sod peat stations*

Unit	*Capacity MW*	*Current efficiency*[1] %	*Efficiency of new plant* %
Lanesborough	20	21.8	27
Allenwood	40	19.8	25
Portarlington	37.5	19.8	25
Screebe	5	18.2	23
Miltown Malbay	5	18.2	23
Cahirciveen	5	18.2	23
Gweedore	5	18.2	23
	117.5		

[1]Net Calorific Value
Source: Electricity Supply Board.

18. However, having regard to their design and age, load factors and performance today (1982) are regarded as remarkably good.

Map 2: *Peat-burning Power Stations*



□ Milled Peat Power Stations
○ Sod Peat Power Stations

The long-run marginal cost of increments in electricity output produced by the ESB amounts to 3.2p per kWh (unit) sent out; this is the estimated cost in 1980/81 of units to be produced at the major (900 MW) coal-fired capacity currently being installed at Moneypoint. However, the Moneypoint plant is still under construction, and so the analyses presented below which focus on this 3.2p per kWh (sent out) will need to be reworked in light of the actual (as opposed to the ESB's projected) cost per kWh, once the station is operating. Since the wood above is costing 3.45p per unit sent out, this means that even before (non-fuel) operating costs are added in, wood is more expensive by 0.25 pence per unit. The capital costs of the peat-fired units are sunk and so are irrelevant to the decision as to whether to continue their operation or expand the coal-fired capacity. The non-fuel and non-capital costs – listed as operating, maintenance and local charges by the ESB – for the sod-peat and milled peat using stations are listed in Table 18. The most interesting results are summarised below:

	*Costs per unit**
Sod-peat (machine)	1.63
Sod-peat (hand-won)	4.53
Milled-peat	0.83

*Excluding capital and fuel costs.

It is clear that at all stations, given the price paid for wood, adding in the additional costs which must be incurred in order to produce electricity will result in a higher cost per unit than that which can be produced with the new coal plants. This is especially true in the case of the hand-won sod peat using stations. These are very small (5 MW capacity) plants which suffer greatly from diseconomies of scale, low efficiencies and low utilisation. With a total average cost per unit of 7.98p (3.45 + 4.53) for wood-fired output, this amounts to 2.49 times the cost of output from a "new" coal-fired unit. The machine sod-peat fired stations have a much lower cost, because they are larger, more efficient and more fully utilised. Nevertheless, the unit cost of 5.08p (1.63 + 3.45) is 59 per cent higher than the projected cost of a kWh produced at Moneypoint.

The sod-peat (both hand-won and machine) using stations can be utilised for the burning of wood and slack with minor alterations. However, the stations using milled peat would require major alterations, as they are designed to burn a fuel of powdery consistency. Sawdust may prove suitable for these stations but reducing the wood output of energy crops to this form does not seem to be economically feasible at present. The milled peat stations

Table 18: *Operating, maintenance and local charge costs of peat burning electricity generating stations 1980/81*

Station	*Costs (£)*				*Units sent out (millions)*	*Cost per unit*[1] *p*
	Operating	*Maintenance*	*Local charges*	*Total*		
Sod peat (machine)						
Portalington	588378	549223	107871	1244472	65.3	1.90
Allenwood	852418	695791	121549	1669758	118.4	1.41
Lanesborough[2]	487946	291699	63106	842751	47.0	1.79
Total	1928742	1535713	292526	3756981	230.7	1.63
Sod peat (hand won)						
Cahirciveen					8.5	
Gweedore					11.8	
Miltown Malbay					2.4	
Screebe					2.5	
Total	568312	488862	84900	1142074	25.2	4.53
Grand total	2497054	2024575	377426	4899055	255.9	1.91
Milled peat						
Bellacorick	628209	1468278	147381	2243868	126.3	1.78
Ferbane	1116436	2094229	252065	3462730	278.7	1.24
Rhode	926887	1261563	168279	2356729	398.5	0.59
Shannonbridge	752604	1249790	156731	2159125	329.3	0.66
Lanesborough[2]	275453	297853	52058	625364	169.4	0.37
Total	3699589	6371713	776514	10847816	1302.2	0.83

[1] Excluding fuel and capital costs.
[2] Lanesborough has both sod and milled peat burning units.
Source: Electricity Supply Board *Annual Report* for year ended 31 March 1981, pp. 36, 46.

are large and more efficient than the sod-peat using units. Assuming an average exported efficiency of 23 per cent, the wood costs per unit sent out works out at 3.17p leaving only 0.3p to cover other costs, which would bring the total relevant cost per unit up to that of coal (3.2p). The additional costs per unit in 1980/81 for milled peat came to 0.83p, so that the total costs per unit (making no allowance for capital costs of plant conversion) amount to 4.00p (3.17 + 0.83) per unit, which exceeds the coal-fired costs per unit by 25 per cent. The total generating capacity of the milled peat stations amounts to 330 MW, comprising 11 per cent of existing total capacity, and 7 per cent of anticipated capacity in 1987/88. Milled peat supplies for these will be successively depleted over the next 15-25 years, so that these stations clearly comprise a major potential market for the output of energy crops. However, since the feasibility and costs of conversion are as yet unknown, we cannot derive a precise willingness-to-pay estimate for wood in this use.

On the basis of all of the foregoing, we conclude that the price being paid currently for wood is at the maximum level justifiable based on the alternatives available. The following are among the reasons why the ESB was willing to pay a premium for wood chips.

(i) It acts as a convenient medium for allowing the burning of inexpensive coal slack. This consideration is not included in the above discussion.

(ii) With the diminishing of supplies of sod-peat available to the ESB, the options are to close these units down, or burn the wood/slack mixture. If the ESB takes the view that closure is unacceptable, then the non-fuel outlays for operation, maintenance and local charges are fixed costs. The wood price, at 3.45p per unit, is in this event only slightly above the alternative cost (coal at 3.20p/unit).

(iii) In the short run, in a supply constrained system, a reduction in output must be replaced by burning either more oil or natural gas. In this event the willingness to pay will be the energy equivalent price for oil/gas adjusted downwards for differences in efficiency of conversion and operating/maintenance costs. This price will be higher than that which is based on the long-run marginal costs.

(iv) The agency can use the experience gained with the burning of chips to make decisions concerning the long-run potential use of this resource.

(v) Wood is more environmentally benign than coal, and also, being indigenously produced, is less susceptible to supply interruptions.

(vi) The wood chips being used are mainly coniferous and they have a higher energy content per dry tonne than deciduous species. We have used deciduous species in our analysis because the energy crops planted are likely to be of this type.

Thus far, we have discussed the case where wood is delivered to existing peat-using stations; the capital costs of plant construction are sunk. It was suggested to us that a relatively minor level of capital investment in existing stations would increase conversion efficiencies, and that the value of the additional output resulting thereby would be more than sufficient to cover the investment costs. However, the ESB tells us that because of material and thermodynamic limitations, no significant improvement can be achieved in the efficiencies of existing units.

We turn, therefore, to the final outlet for wood in electricity generation, namely the construction of a new, custom-built plant.

New Plant

In 1981 it was estimated by the ESB that such a new unit would cost £850/kW of capacity for a 40 MW extension on an existing station site. If the plant were to be built on a new site, 8 per cent (£68/kW) should be added to the cost. The following is a breakdown of these costs:

	Capital per kW of capacity (1981 £)	*Per cent of total*
Civil works (Inch site)	212.50	25
Boiler	204.00	24
Turbined generator	110.50	13
Other mechanical plant (incl. fuel handling)	63.75	7.5
Electrical plant	63.75	7.5
Site services	25.50	3
Head office/site staff (and interest during construction)	170.00	20
	850.00	100

For a 40 MW station, capital costs therefore would amount to £34 million. The ESB estimates operating and maintenance costs at £0.96 million annually, and annual output – with 29.5 per cent conversion efficiency and 70 per cent load factor – is expected to amount to 226 million units.

Assuming a plant life of 25 years and a real (net of inflation) interest rate of 7 per cent,[19] the annualised capital and non-fuel operating costs amount to (1981 £):

19. In analysing investments, one can express everything in either nominal or real terms. In the former case, actual outlays and revenues – which include inflation – are included. In the latter case, all costs, revenues and the interest rate are expressed in net of inflation, i.e., real terms. In conventional financial analyses it is usual to use nominal values, as this tells the investors the actual cash flows expected to obtain. However, the use of "real" costs, revenues and interest rates simplifies analysis and for this reason we use it here. All costs and revenues are in constant 1981 £. Seven per cent was chosen because this was the rate used in arriving at the cost of a unit sent out by a new coal-fired plant.

Capital	= 2,917,200	£34 million x 0.0858 = £2.9172 million
Non-fuel operating	= 960,000	
	3,877,200	

This works out at 1.72p per kWh produced.[20] This means that the ESB could afford to pay up to 1.48p per kWh (3.20-1.72) for wood delivered, and break even with the cost of electricity produced from coal, i.e., pay up to a total of £3.3448 million for wood delivered to the plant. The estimated conversion efficiency is 29.5 per cent, so that there are 1,308 kWh produced per tonne of dry matter;[21] 172,783 tonnes of dry matter (226,000,000 ÷ 1,308) are required per annum. The ESB could afford to pay up to £19.36 per tonne (£3,344,800 ÷ 172,783) and still break even with coal. Achieving this price is contingent upon air drying the wood down to 35 per cent moisture. If it remains at 55 per cent (as at present), then conversion efficiency falls to 29 per cent, and output remains at 226 million units per annum. In this case, the maximum price payable per dry tonne works out at £17.02.[22]

This result underlines the great importance of reducing the moisture content of the wood before burning. If this is done at the forest level, transporta tion costs will also be reduced. Substantial diseconomies of scale are incurred if smaller stations must be built, as is clear from the data in Tables 19 and 20. The maximum ability to pay for wood falls from over £19 per dry matter tonne for a 40 MW unit to near zero with a 10 MW station.

The sod and milled peat generating stations together sent out 1,558.1 million units in 1980/81. Since one new 40 MW station is expected to send out 226 million units per annum, it follows that seven such stations could supply the output now supplied by peat. It is interesting to examine the area of energy crops required to meet this demand (Table 21). The area required ranges from 427,000 to 149,000 acres, depending on the produc-

20. 3,877,200 ÷ 226,000,000 = 0.0172.

21. 4,460 Btu/lb. ÷ 0.43 = 10,372 KJ/kg ÷ 3.6 = 2881 kWh/tonne
2,881 x 0.295 = 850 kWh/ash fired tonne
850 ÷ .65 = 1,308 kWh/TDM
226,000,000 ÷ 1,308 = 172,783 TDM required
3,344,800 ÷ 172,783 = £19.36 per TDM

22. At 55% mc: GCV = 8,000 (1–0.55)
= 3,600 Btu/lb.
NCV = 3,600 – 1,055 (0.55 + 9 (0.027))
= 2,763 Btu/lb. → 1,785 kWh/tonne.
1,785 kWh/tonne x 0.29 = 517.65 kWh/tonne
517.65 ÷ 0.45 = 1,150.33 kWh/TDM
226,000,000 ÷ 1,150.33 = 196,465.36 TDM required
3,344,800 ÷ 196,465.36 = £17.02/TDM.

Table 19: *Capacity and costs of new extensions of wood-fired generating units*

Capacity MW	Capital costs Total 000s £	Capital costs Annualised 000s £	Operation and maintenance 000s £	Total non-fuel annual costs £	Units sent out (millions)	Non-fuel costs per unit (p)
40	34000	2917.2	960	3877.2	226	1.72
20	22000	1887.6	750	2637.6	112	2.36
10	14000	1201.2	580	1781.2	56	3.18
5	9000	772.2	500	1272.2	27	4.71

Notes: Capital costs are annualised at a real interest rate (i) of 7 per cent over 25 years (n), where the annual equivalent (A) of a capital sum (P) is derived as follows:

$$A = P \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right] \text{, i.e., } A = P\ (0.0858)$$

Output is based on a 70 per cent load factor. Moisture content of wood is 35 per cent.

Table 20: *Estimated maximum willingness to pay per tonne of dry matter delivered to custom-built wood-burning stations, by capacity*

Capacity MW	Units sent out millions	Total maximum willingness to pay for wood[1] per kWh (p)	Total maximum willingness to pay for wood[1] Total (million £)	No. of tonnes of dry matter required[2] No.	Willingness to pay per tonne £
40	226	1.48	3.3448	172,783	19.36
20	112	0.84	0.9408	85,627	10.99
10	56	0.02	0.0112	42,813	0.26
5	27	–	–	20,642	–

[1]Maximum willingness to pay per kilowatt hour is derived by deducing the non-fuel costs per unit (from Table 19) from 3.20p; the latter is the estimated cost of producing a unit from the coal-fired units at Moneypoint.

[2]1308 kWh per dry tonne of 35% mc wood, based on 29.5 per cent conversion efficiency; units sent out ÷ 1308 = No. of tonnes of dry matter required.

tivity per unit area assumption. These area requirements should be increased by 10-15 per cent to allow for roads, firelines, etc. Bord na Móna has 22 production centres covering 130,000 acres of bog, from which it supplies the power stations, the domestic market for briquettes – on an energy equivalent basis this accounts for about 15 per cent of the Bord's output – and a substantial domestic and export market for peat moss. It is clear, therefore,

Table 21: *Area of energy crops required to supply an amount of electricity equal to that which is currently supplied by sod and milled peat, by productivity*

Productivity tonnes of dry matter/hectare	*Wood requirement (tonnes)*	*Area required hectares (acres)*[1]
7	1,209,481	426,947
10	"	298,863
15	"	199,242
20	"	149,431

[1] Excluding requirements for roads, firelines, landing stages, etc.

that even under the most optimistic assumptions concerning productivity, when the land owned by Bord na Móna is cut-away, even if it is fully devoted to growing energy crops, it will be insufficient of itself to supply the energy now supplied by peat. Furthermore, if the performance standards assumed in the generating plants — 29.5 per cent conversion efficiency and 70 per cent load factor — are not met, the area requirements will expand further. There is a compelling logic in growing wood for generating electricity as close as possible to the power plants. Other things being equal, the cutaway areas will have a comparative advantage over other areas in this regard. However, in terms of our three county region, it is clear from the above that there could be a residual market for wood in electricity generation from this region if the existing potential cut-over areas prove insufficient as a source of fuel. If a 40 MW generating plant (or plants) were built within the region, this would, of course, provide a direct outlet. However, building a station on a green-field site would incur additional capital costs (8 per cent) per megawatt, which would reduce the maximum amount payable per tonne from £19.36 to £18.05.

It is interesting to compare these estimates with the energy equivalent price for steam coal, which is the fuel utilised in coal-fired generating plants. At present (October 1981) steam coal is priced (delivered) at £43.75 per tonne. With 1.504 tonnes of coal per tonne of oil equivalent (TOE) this works out at £65.80 per TOE. With 2.63 tonnes of wood dry matter per TOE, this means that the steam-coal energy equivalent price per tonne of dry matter is £25.02. Thus our estimated price for wood is 77 per cent of the steam coal energy equivalent price. The discrepancy exists because the capital costs per megawatt are lower with coal than they are with wood-fired capacity, while conversion efficiencies for coal are higher, being 37-38 per cent, as compared with 29.5 per cent for wood.

Many experts expect real growth in the price of steam coal over time, which would, other things being equal, increase the maximum price payable for wood. Wood, in addition, has positive environmental, security of supply and regional development attributes which are not reflected in the price estimates.

A radius of 25 miles from the peat-using electricity generating plant at Lanesborough includes potential energy crop producing areas. A new green-field plant would presumably have most of its wood grown within a 25 mile distance, so we assume that transport costs amount to £5.60 per dry tonne for both the existing and new plant. Harvesting costs are assumed (as before) to amount to £11.1 per dry tonne. The per tonne residual stumpage value of wood used in existing stations is therefore 33.33 – 16.70 = 16.63 (rounded up to £17). For new stations (extensions and green-field), the residual stumpage value per tonne is 19.36 – 16.70 = 2.66 (rounded up to £3).

Price Summary

In analysing investment opportunities in energy crops, we use the following output prices per tonne (standing wood, i.e., before harvest and transport):

Market	*Price per dry tonne (£)*
Domestic, institutional and industrial	22
Electricity generation – existing stations	17
Electricity generation – new capacity	3

Chapter 7

FOREST PRODUCTS' MARKETS

It is usual in analysing Irish forest products' markets to classify the outlets as being for pulpwood, boxwood or sawlogs. The pulpwood market is for small-dimension material; this wood is normally disintegrated to provide the primary raw material for the pulp and paper industry, and for the chipboard and fibreboard manufacturers. Boxwood is small-dimension sawlog-size material; pallets comprise a major outlet for this wood. Finally, the sawlogs *per se* comprise the raw material for the larger-sized sawnwood. Let us examine briefly the past history and prospects in each of these markets. The ultimate purpose of so doing is to derive output price ranges to apply to future forest products' output. Which output prices for energy crops are expressed per dry tonne, price per tonne in the case of conventional forestry applies to "green wood" i.e., wood including moisture.

Pulpwood

A decade ago, Ireland had quite a prosperous pulpwood-using sector. There were four pulpwood users in the Republic – a groundwood pulp plant in Clondalkin, chipboard factories in Waterford and Scarriff and a fibreboard plant in Athy – and one chipboard plant in Coleraine, Northern Ireland. Now all but the Scarriff and Coleraine units are closed and even these are thought to be economically marginal. The reasons for the decline are various: most pulpwood-using processes are very energy intensive and the rapid escalation in these costs after 1973 impaired their competitiveness. Many of the major pulpwood-using industries internationally are integrated operations, whereby the "waste" from the sawmilling sector is fed to the pulpwood-using unit and this reduces both their transportation and wood raw material costs. There have been significant improvements in end-product quality in recent years and it has been difficult for the small Irish units to keep abreast of such developments. Finally, until recently, all wood was transferred to the plants under the sealed tender system, this involved a substantial investment of plant management time and resources in acquiring wood raw material supply.

With regard to the future, the Medford Corporation (USA) is planning to open a large medium-density fibreboard plant in Clonmel. It is expected that the plant will be operational by mid-1983 and will absorb 200,000 cubic metres (M^3) of roundwood per year initially, increasing to 350,000 M^3 – 400,000 M^3 by 1986. The intake of this plant, together with that of the chipboard mill at Scarriff, is likely to absorb most of the pulpwood becoming available from State forests in the coming decade. Pulpwood sales from this source in 1980 amounted to 259,000 M^3. By 1990 it is expected that volumes available will have increased to 690,000 M^3; the difference equals about what Medford anticipates taking. However, there will, in addition, be available a substantial volume of residue from sawmills.

Medford plans to overcome the constraints faced by the earlier pulpwood-using firms by generating most of its energy requirement by burning bark; having a contract with the Forest and Wildlife Service which puts the onus on the agency to make specified quantities of wood available at a pre-arranged price; having a large production unit, achieving thereby substantial economies of scale; and producing a high quality product which is in great demand in the European market. It remains to be seen how successful the company will be in these respects, but it does seem as if some, at least, of the disabilities which hindered the earlier firms are likely to be overcome.

The strong downward trend in the real price for pulpwood since 1974 which can be observed in Table 22 and Figure 5 reflects the adverse market conditions noted above. (The terms stumpage and standing timber are used interchangeably throughout the text.) The price formula which is to be applied to the wood intake to Medford is confidential. We gather that it

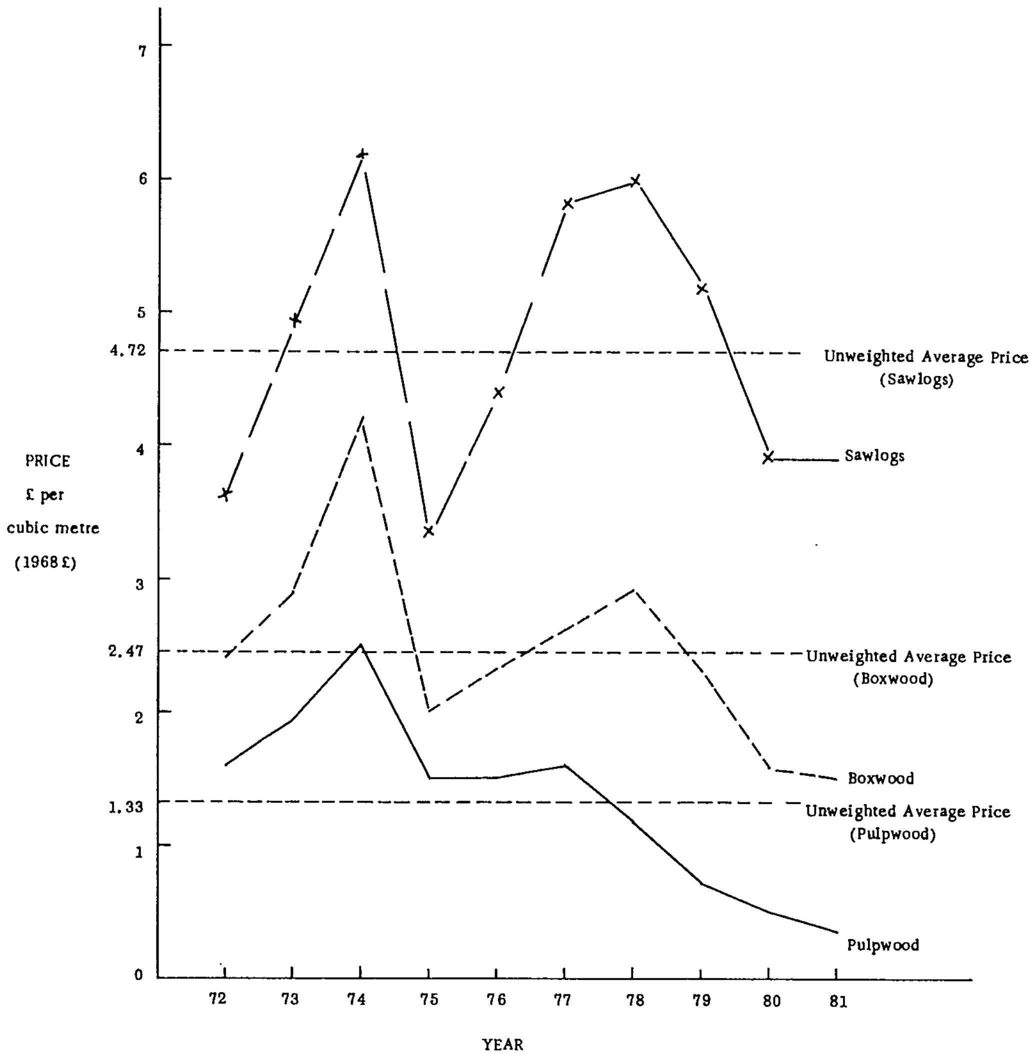
Table 22: *Average wood prices for pulpwood, boxwood, sawlogs, 1972-1981, current and constant (1968 £), stumpage per M^3*

Year	CPI 1968=100	Pulpwood		Boxwood		Sawlogs	
		Current	Constant	Current	Constant	Current	Constant
1972	135.4	2.2	1.6	3.2	2.4	4.9	3.6
1973	150.8	2.9	1.9	4.3	2.9	7.4	4.9
1974	176.4	4.4	2.5	7.4	4.2	11.0	6.2
1975	213.2	3.2	1.5	4.2	2.0	7.1	3.3
1976	251.6	3.7	1.5	5.8	2.3	11.0	4.4
1977	285.9	4.7	1.6	7.4	2.6	16.5	5.8
1978	307.7	3.8	1.2	8.9	2.9	18.4	6.0
1979	348.4	2.4	0.7	7.9	2.3	18.1	5.2
1980	411.9	2.2	0.5	6.6	1.6	16.0	3.9
1981[1]	479.6	1.25	0.3	7.0	1.5	18.5	3.9

[1]May 1981.

Source: Forest and Wildlife Service.

Figure 5: *Average Price per Cubic Metre for Stumpage Sold from State Forests, 1972-1981 (1968 £): CPI 1968 = 100*



involves a low initial price, with escalator clauses provided which are keyed to the final product price. We feel that the existing general average price level (£1.25/tonne) is at the lowest end of what investors might plan on in looking to the future. (A tonne in this context is a tonne of standing timber, which is, of course, "green".)

Boxwood and Sawlogs

The consumption of lumber (this term refers to wood after it has been sawn; it is inclusive and applies to both boxwood and sawnwood) in 1979 can be seen in Table 23. Imports comprise 79 per cent of consumption. In Table 24 can be seen the various outlets for sawnwood in Ireland in 1977, and the share of each held by native timber. It is clear that the construction market, where native wood in 1977 only captured 13 per cent of the total, is the major potential growth area. The bulk of this market could technically be served by Irish timber, but it must be able to compete with the product of well-established exporters in Scandinavia and North America.

Softwood sawnwood imports over time, by value and volume, are shown in Table 25. The pattern in terms of average annual real price per tonne is shown in this table and also in Figure 6. From the peak achieved in 1974, the average price declined for two years, staged a slight recovery in 1977, but fell again in 1978; in 1979/1980 the real price grew slightly but in 1981 it fell to its lowest level since 1978.

Sweden, Finland and Canada together supply almost 90 per cent of Ireland's lumber imports. The former two tend to supply the higher priced material, while Canadian lumber competes in the lower price ranges. In

Table 23: *Apparent softwood lumber consumption, imports and domestic production, 1979*

	Apparent lumber consumption 1979	
	Roundwood volume, '000s M^3	*% of total*
Imports	1001	79
Domestic		
State	232	18
Private	35	3
Total	267	21
Grand total	1268	100

Source: Industrial Development Authority.

Table 24: *Irish market for sawn softwood timber, 1977 000s M^3 of roundwood equivalent*[1]

End use	Total apparent consumption	% of total	Native timber Quantity	% of total	Share of market held by native timber
Construction	725	72.5	97	44	13
Pallets and packaging	67	6.7	53	24	79
Fencing	62	6.2	48	22	78
Furniture	39	3.9	2	1	6
DIY	25	2.5	2	1	9
Miscellaneous	82	8.2	18	8	21
Total	1000	100	220	100	22

[1]The original IIRS/FWS data are converted to roundwood equivalents by multiplying by 2; this is misleading for some end-users, but facilitates comparison with data in Table 51.

Source: Institute for Industrial Research and Standards and Forest and Wildlife Service Study of the Irish sawmilling industry.

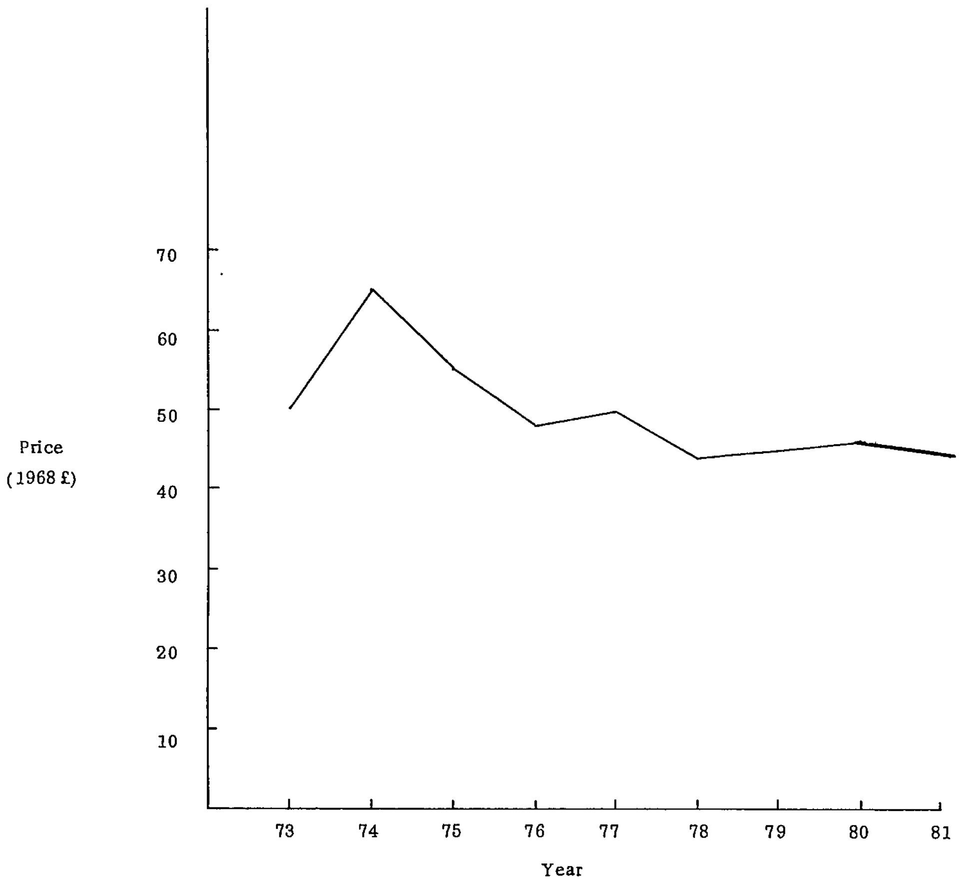
Table 25: *Imports of coniferous sawnwood, 1973-1981*

Year	Quantity (metric tons)	Value/tonne (current £) ('000)	Value/tonne (current £)	CPI (1968=100)	Value/tonne constant (1968 £)
1973	168,766	12,761	76	150.8	50
1974	232,492	26,511	114	176.4	65
1975	121,793	14,334	118	213.2	55
1976	190,242	23,239	122	251.6	48
1977	190,629	27,377	144	285.9	50
1978	223,113	30,214	135	307.7	44
1979	270,423	42,844	158	348.4	45
1980	211,662	40,500	191	411.9	46
1981	209,801	44,730	213	496.0	43

Note: 1 tonne - 1.85M^3 of sawnwood.

Source: *Trade Statistics of Ireland*, successive December issues.

Figure 6: *Average Price per Tonne of Imported Sawnwood. (Constant 1968 £)*



Source: Table 25.

Table 26 and Figure 7, it can be seen that for the past four years Canadian wood has been priced significantly below its import competitors.

Stumpage market for sawlogs and boxwood

The only information available comes from the average annual stumpage prices received since 1972 by the Forest and Wildlife Service. These are presented in Table 22 and Figure 5. The two price peaks for sawlogs and boxwood in 1974 and 1978 are divided by price troughs and we are again in one at present (1981). This volatility is a product in part of the residual nature of the stumpage market; most of the change in end-product price

Table 26: *Major sources of sawn coniferous imports, by volume and value (1968 £), 1977-1981*

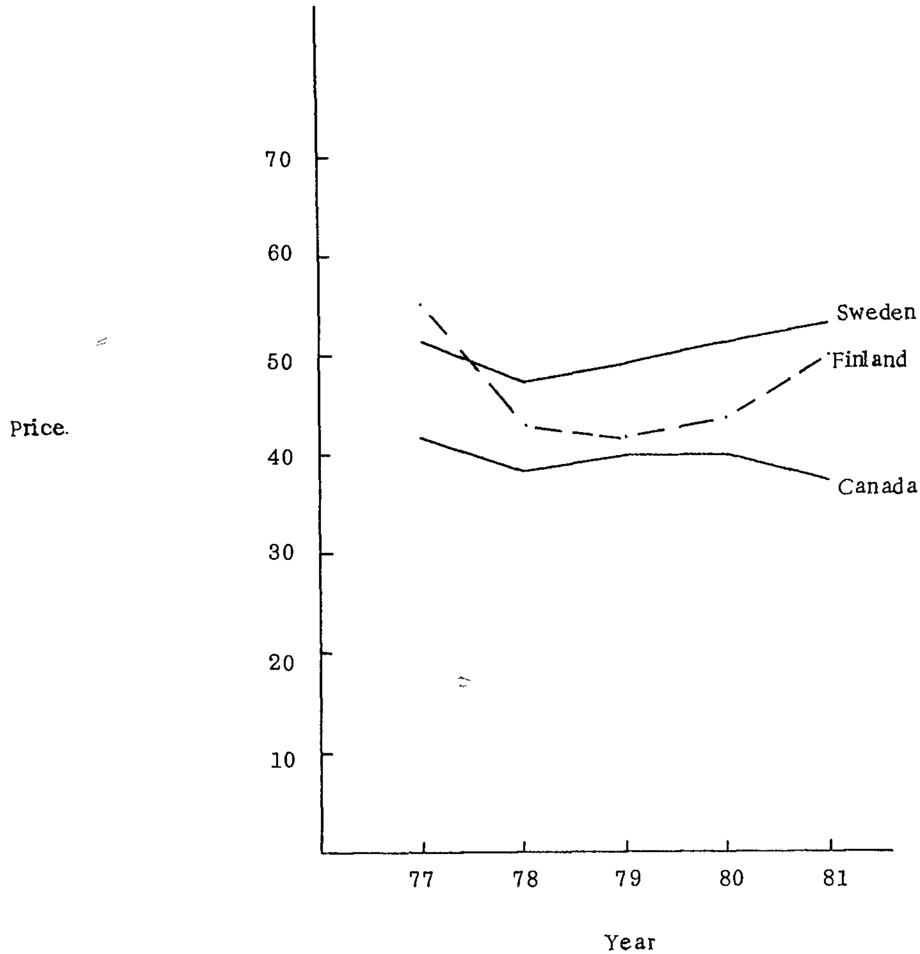
		Sweden	*Finland*	*USSR*	*Canada*	*Total*	*Grand total*
1977 CPI = 285.9	Volume (tonne)	57513	57777	10663	57685	183638	190614
	Value (000s £)	8424	9147	1690	6766	26027	27370
	Value/tonne (current £)	146	158	158	117	142	144
	Value/tonne (1968 £)	51	55	55	41	50	50
	Percentage of grand total (by volume)	30	30	6	30	96	
1978 CPI = 307.7	Volume	68229	95351	13535	33435	210550	222450
	Value	9948	12577	1652	3946	28123	30103
	Value/tonne	146	132	122	118	134	135
	Value /tonne	47	43	40	38	44	44
	Percentage of grand total (by volume)	31	43	6	15	95	
1979 CPI = 348.4	Volume	74906	107157	15406	53762	251231	270423
	Value	12680	15900	2425	7476	38481	42844
	Value/tonne	169	148	157	139	153	158
	Value/tonne	49	42	45	40	44	45
	Percentage of grand total (by volume)	28	40	6	20	93	
1980 CPI = 411.9	Volume	50870	86483	12565	46108	196026	211662
	Value	10650	15754	2708	7602	36714	40500
	Value/tonne	209	182	216	165	187	191
	Value/tonne	51	44	52	40	45	46
	Percentage of grand total (by volume)	24	41	6	22	93	
1981[1] CPI = 461.6	Volume	13390	20343	1845	16590	52168	577513
	Value	3275	4654	463	2833	11225	12513
	Value/tonne	245	229	251	171	215	217
	Value/tonne	53	50	54	37	47	47
	Percentage of grand total (by volume)	23	35	3	29	90	

[1]January to April.

Note: 1 tonne = $185M^3$ of sawnwood.

Source: Successive December issues of *Trade Statistics of Ireland* and the April 1981 issue.

Figure 7: *Average Price per Tonne of Imported Sawnwood from Sweden, Finland and Canada. (Constant 1968 £)*



Source: Table 27.

gets shifted back to the stumpage market, so that the proportionate change on this smaller base is greater than it is at the final product level.

Example (highly simplified)

Final product price (1981 £ per M^3 of roundwood)	=	58.1*
Payment for stumpage (1981 £ per M^3 of roundwood)	=	18.5
Conversion costs (including normal profits)		39.6

*Price per tonne of Canadian sawnwood = £215; there are 1.85 M^3 of sawnwood in a tonne, and 2 M^3 of roundwood per M^3 of sawnwood. Thus: 215/1.85/2 = 58.1.

If now the final product price increases by £10 – a 17 per cent increase – and this gets passed through to the stumpage (as it will in competitive market conditions), the standing timber price will increase to £28.5, a 54 per cent increase.

This highly simplified example also illustrates another important point, namely, that the costs of harvesting, transportation and processing can rise/fall and reduce/increase thereby, the amount accruing to stumpage. *A priori*, we would expect to be able to reduce unit harvesting, transportation and mill costs in Ireland in the future. The large increase in wood volumes becoming available should allow economies of scale to be achieved in all phases of production. However, the rapid domestic price and wage inflation we have had in Ireland in recent years has far exceeded that experienced by our competitors in Canada, Sweden and Finland. Since the ceiling as to what can be charged for Irish lumber is set by these producers, it is clear that unless significant productivity gains are achieved in Ireland, the residual available to pay for stumpage is likely to diminish over time.

The Future

The foregoing discussion illustrates the difficulties which attend making stumpage price forecasts. Stumpage sales of sawlogs and boxwood in 1980 from State forests amounted to 151,000 M^3, and 120,000 M^3, respectively; it is estimated that, by 1990, output will have increased to 524,000 M^3 and 405,000 M^3, comprising rises of 347 per cent and 337 per cent in sawlog and boxwood availability. This will require, in turn, a major expansion in the industry, and will make Ireland virtually self-sufficient in those sawnwood uses for which Irish wood is technically suitable. Thereafter, Irish lumber will have to capture domestic market share now held by non-timber structural materials, and/or export into the British market; Britain imports over 90 per cent of its sawnwood requirements. It is into this highly competitive market that the output of any "new" Irish forest plantations will have to sell. However, if there were a very rapid increase in per capita consumption of wood in Ireland, then this would defer the necessity to export.

We have argued elsewhere that an umbrella organisation – we give it the title of Forest Products Development Board – be established with responsibility for developing and implementing wood utilisation plans, for deciding on wood sale methods, for sponsoring product research and development and for market development (Convery, 1979; Convery, 1981). This unit would function as a complement to existing market forces. The case for the Board can be made as follows:

(i) The State in a real sense makes the market for stumpage (standing trees); within wide limits the Forest and Wildlife Service can move this stumpage price up (and down) by contracting (expanding) the volume of wood on offer. Since the Government is one of the primary determiners of market price, it behoves it to know and be capable of evaluating the full implications for downstream activity of its marketing choices.

(ii) The price of standing wood is a residual – what is left after the costs of processing, transport and harvesting have been netted out of the product sale price. It follows that it is in the State's immediate (commercial) interest to encourage the achivement of both premium prices for mill output and reductions in cost of harvesting and processing; much of the benefit resulting therefrom will be reflected in stumpage price.

(iii) The competition – Sweden, Finland and Canada – all have the benefit of strong experienced marketing organisations, backed by a base of State-supported research (basic and applied) and development work. This also applies to a lesser extent to domestic substitutes for wood. For example, the recently published *Roadstone Book of House Design* provides a very attractive and sophisticated vehicle for selling the use of various materials in house construction; native timber does not feature prominently therein.

Thus far, not only has such a unit not been established, but the modest volume of timber product research and development work which had been conducted at the Institute for Industrial Research and Standards had been substantially reduced, but is now partially restored. In what follows, we assume that such negligence will be temporary, and that the supporting resources and actions necessary to ensure that native timber achieves maximum feasible economic market penetration, will be forthcoming.

With regard to future prices, we work with three alternative outlooks:

(i) Current (1981) prices, which we assume comprise the lowest likely long-term trend;

(ii) 1974 prices (expressed in 1981 £) which we assume are the highest likely to occur in the future;

(iii) the unweighted average prices over the period 1972-81 for pulpwood, boxwood and sawlogs, all expressed in 1981 prices.[23] This comprises our medium or "normal" price projection.

Thus, in comparing alternatives, we used the following alternative price projections (prices in 1981 £ per cubic metre of standing timber).

	High	*Medium*	*Low*
Sawlogs	29.9	22.6	18.5
Boxwood	20.1	11.8	7.0
Pulpwood	12.0	6.4	1.25

23. Thus for sawlogs the average unweighted price achieved over the 1972-81 period is £4.72 (1968 £), or £22.6 (1981 £). The equivalents for boxwood are £2.47 (1968 £) and £11.8 (1981 £), and for pulpwood – £1.33 (1968 £) and £6.4 (1981 £).

Chapter 8

NET RETURNS: ENERGY CROPS AND CONVENTIONAL FORESTRY

In previous chapters, we have examined the production costs and markets which are likely to obtain for conventional forestry and energy crops. In this chapter we draw this material together to provide an estimate of the net returns to be expected from the two land-uses. Although, in doing so, we focus on the three-county region, the results are widely applicable, and especially so in those counties which have a significant proportion of their land which is marginal for agriculture.

Interest Rate

In the case of both conventional forestry and energy crops, the bulk of the costs are incurred at crop establishment, while the returns accrue in the future. In order to compare alternatives, it is necessary to adjust for the differences in time of occurrence of costs and revenues. This is done by discounting the expected cash flow back to the present at a rate of interest which reflects the rate of return which would be yielded by the best alternative investment, other things (risk, etc.,) being equal. In the case of public sector investment, it is usually argued that society's rate of time preference – the rate at which society as a collectivity discounts the future – is the appropriate interest rate to use. In this latter regard, the assumption is usually implicit that individual consumers and producers are "myopic" about the future, and that the collective rate of time preference will be lower than the average of the individual discount rates.

Unfortunately, in Ireland we do not know what the rate of return is in the best alternative investments. Still less do we know what the collective rate of time preference might be. With regard to the former, some of the larger companies use a real rate of 10 per cent in evaluating proposals, but few firms are yielding a before-tax real (net of inflation) rate of return of this order. Although it is difficult to estimate, primarily because of the prospective impact of exchange rate changes, the real cost of foreign borrowing by the Government is probably in the range of 0-5 per cent. The real rate of return earned on some (purportedly commercial) State investments seems to be negative.

We evaluate investments in conventional forestry and energy crops using real rates of 2, 4, 7 and 10 per cent to give the reader a sense of the sensitivity of results to changes in this regard. We feel that the real long-term rate of return at the margin from investment in Ireland is probably within the 2-4 per cent range and we focus our discussion on the estimates derived using these numbers.

We express everything in *real* terms which nets out the effects of inflation. Thus, if the real rate of interest is 4 per cent, and the rate of inflation is 15 per cent, the nominal (money rate) of interest which would be equivalent to a real rate of 4 per cent, is 19.6 per cent.[24] All costs and revenues are also expressed in real terms. If prices are expected to grow or decline in real terms over time, this should be included. We assumed constant costs and returns for a range of outputs and prices.

Criterion

Discounting the net cash flow back to the present, yields the present net worth of the investment in question. If mutually exclusive investments have the same time horizon, and if all the capital required can be made available at the interest rate specified, then the one yielding the greatest present net worth should be chosen, if the latter is positive. When alternatives do not have the same time horizon, they can be made comparable by estimating and comparing their annual equivalents. The annual equivalent is defined as the amount, occurring annually over the life of the investment which would, if discounted to the present, yield a sum equal to the present net worth. Rational investors, therefore, would be indifferent between receiving the present net worth sum now, or the annual equivalent amount each year over the relevant time horizon; if they had the former, they could use it to generate the latter.

In terms of energy crops and conventional forestry, the annual equivalents per acre tell us the amounts which investors could afford to pay for the use of an acre of the land in question and still cover all of their non-land costs — labour, capital, materials and interest charges. As such, they can be compared with equivalent net returns per acre per annum yielded by agriculture.

Energy Crops

The annual equivalents per unit area yielded by investment in energy crops on mineral and peatland soils, respectively, with a range of interest rates, production levels and output prices, are presented in Appendix 5B. Some of

24. Derived from 1.04 x 1.15 =1.196.

these results are summarised in per acre terms in Table 27. Based on available estimates of possible production, we assume outputs of 15 and 10 dry tonnes per hectare on mineral and peatland soils, respectively. Given these assumptions, the following annual equivalents per acre would be yielded at real interest rates of 2 and 4 per cent.

Price per tonne (£)	*i = 0.02* Mineral	*i = 0.02* Peatland	*i = 0.04* Mineral	*i = 0.04* Peatland
3	–17	–27	–23	–34
17	65	27	55	18
22	94	47	83	37

Source: Table 27.

At the low price level, which is what we estimated a new ESB power station could afford to pay, it can be seen that the return to land would be negative on both peat and mineral soils.

However, if the users were willing to pay the price currently being paid by the ESB for wood chips (£17 per dry tonne standing), then, on mineral soils, an investor would be able to pay landowners in the range of £65-55 –

Table 27: *Annual equivalent returns per acre yielded by investment in energy crops, at various production levels and output prices (in 1981 £)*

Production dry tonnes per ha	*i = 0.02* *Price per tonne (£)* 3	17	22	*i = 0.04* *Price per tonne* 3	17	22
A. MINERAL SOILS						
7	-26	12	25	-32	4	18
10	-23	32	51	-29	23	42
15	-17	65	94	-23	55	83
20	-11	98	137	-17	87	125
B. PEATLAND SOILS						
7	-34	7	21	-38	-1	12
10	-27	27	47	-34	18	37
15	-21	60	89	-29	50	78
20	-15	93	132	-23	82	119

Source: Appendix 6B.

depending on the real interest rate – per acre per annum over the 25 year investment cycle for the use of their land for tree growing. If energy crop output prices and costs keep pace with inflation, then these rentals for the use of the land can be maintained constant in real terms. The corresponding annual equivalents on peatland fall in the range of £27-18.

If the price achieved is at the level payable by domestic, institutional and some industrial users (£22) per tonne, then investors could pay landowners £94-83 per acre on mineral soils and £47-22 per acre on peatland areas.

Market Prospects

As we shall see in a subsequent section, the returns yielded with both current ESB wood chip and domestic/institutional/industrial prices are very attractive when compared with the returns currently available on many of these sites with agriculture. However, in the vicinity of the three county region, the market available at these price levels appears to be limited. With regard to energy generation, the ESB indicated that the scope for further wood-chip intake to existing sod-peat burning units within haulage range was confined to Lanesborough. The units generated, and associated wood and area requirements, if all of the output in 1980/81 at this station were to be generated from wood grown on mineral soils, are presented below:

	Units (millions of kWh)	*Wood requirement*[1] *(tonnes)*	*Area*[2] *acres*
Sod peat (20 MW)	47	48,755	8,032
Milled peat (40 MW)	169.4	175,726	28,950
Total (60 MW)	216.4	224,481	36,982

[1]4422 kWh per tonne of dry matter (see Table 14, note 1).
4422 x 0.218 = 964 kWh per TDM

[2]Assuming 15 tonnes of dry matter per hectare or 6.07 TDM per acre per annum.

About 8,000 acres of energy crops would meet the annual wood requirements of the sod-peat burning component of the station. If the milled peat unit could be converted to burn wood, then a further 29,000 acres would be required. However, it is not clear yet if such conversion would be feasible, and, if so, what the costs might be. Incurring conversion costs would, of course, reduce the amount payable for the wood. Furthermore, the cutaway peatland (State owned) in the immediate vicinity of the plant would probably be used to grow some of the required wood. While we cannot look, therefore, to existing turf-burning stations as major users of wood grown in the three county region, there is some potential there if conversion of the milled-peat unit proves to be technologically and economically feasible.

Although we estimated that the domestic/institutional/industrial markets could pay a premium price for the wood, the prospects for a large volume of sales to these outlets from the region appear to be modest for the following reasons:

(i) There are no major centres of population and/or industry within easy haulage distance.

(ii) Based on the responses in our landowners survey, it was estimated that 80 per cent of landowners would not be interested in growing energy crops for their own fuel use. The heating system and fuel use now in operation in the area can be seen in Table 28. Wood is already used by 63.6 per cent of landowners, although less than 6 per cent use more than 10 tonnes annually. Over 60 per cent of landowners are already using solid-fuel stoves as their main cooking method (Table 29). Almost 22 per cent of landowners who are not interested in growing their own say that they have enough already (Table 30).

(iii) For major industrial users, steam coal is an option, and it is priced at about 70 per cent of the domestic coal price. With the start-up of 900 MW of coal-fired capacity in Moneypoint, the ESB will be major importers of steam coal and bulk purchase by industry is also likely. This will tend to lower the maximum which some industrial energy users would be willing to pay for wood.

However, there are grounds for some optimism in the longer term. First, the estimated price payable by these outlets is so high – £22 per dry tonne standing – that it leaves a considerable margin to cover additional transportation (beyond the 10-25 miles assumed) costs and still provide a good return to the land. Secondly, 20 per cent of landowners are interested in growing their own wood for energy, and there is a prospect that if it is demonstrated that this is an easy and profitable thing to do, this percentage could grow in the future. Thirdly, some industry might be attracted into the area if there was an assured supply of competitively priced energy.

For a new 40 MW wood-fired plant, it is assumed that conversion efficiency would be 29.5 per cent and that 226 million units would be sent out annually. Using the computational procedures employed earlier in the analysis of existing plants, we estimate that the annual wood requirement would

Table 28: *Landowner heating systems and domestic fuel use, border region, 1980*

		% of total population
1. Heating system		
Full central heating		13.6
Partial central heating		6.4
Localised heating		79.6
No response		0.2
		100.0
2. Fuel use (units/year)		
Timber (tons):	0	36.4
	0.1 - 10	57.1
	11 - 20	2.6
	21+	0.1
	NR	3.8
		100.0
Coal (tons):	0	30.5
	0.1 - 2	35.2
	3 - 5	28.1
	6 - 10	5.5
	NR	0.9
		100.0
Oil (gallons):	0	87.4
	1 - 500	7.3
	501 - 1000	4.4
	1000+	0.5
	NR	0.4
		100.0
Gas (bottles):	0	56.1
	1 - 10	26.2
	11 - 20	13.4
	21 - 50	3.4
	51+	0.4
	NR	0.9
		100.0
Electric fires (no.):	0	63.7
	1	26.3
	2	6.2
	3 - 5	3.1
	6 - 8	0.7
		100.0
Electric heaters (no.):	0	80.4
	1	14.4
	2	2.5
	3 - 5	2.0
	6 - 8	0.8
		100.0
Electric radiators (no.):	0	87.2
	1 - 10	11.4
	11 - 50	1.3
	51 - 100	0.1
	101+	0
		100.0
Turf (tons):	0	54.9
	0.1 - 10	38.5
	11 - 20	5.3
	21+	0.6
	NR	0.7
		100.0

Source: Land-owner survey.

Table 29: *Cooking method. Landowners in the border region, 1980*

Cooking method	*% of total population*	
	Main method	*Secondary method*
None	0.2	28.8
Solid fuel stove	60.9	15.2
Oil fired stove	5.1	1.0
Electric cooker	5.0	8.4
Gas cooker	24.6	41.0
Open fire	4.0	5.5
NR	0.2	—

Source: Landowner survey.

Table 30: *Interest in growing energy crops for own use. Landowners in the border region, 1980*

"Would you be interested in growing energy crops for your own fuel use?"

	%
Yes	20
No	80
	100

Why not?	%	*Excluding no response*
Enough already	21.7	28.1
Too old	17.0	22.0
Too busy	15.1	19.6
Too small	6.1	7.9
Dirty	0.2	0.3
Use turf	9.5	12.2
Long wait	4.3	5.5
Other	3.1	4.1
NR	22.8	—
	100.0	100.0

Source: Landowner survey.

amount to 173,313[25] dry tonnes, or 4333 TDM per MW of capacity. Assuming an annual production of 15 tonnes per hectare (6.07 TDM per acre) per annum on mineral soils and 10 tonnes (4.05 TDM per acre) on peatland soils, this would require 28,552 acres under energy crops on the former, or 42,793 acres on the latter. Since it would take seven such units to supply all of the output now provided by peat-fired units, total land requirements for this purpose under the assumptions stated would amount to almost 200 thousand acres (mineral) or 300 thousand acres (peatland). While the potential market in this outlet is large, if it were financed on commercial terms it probably would not be sufficiently lucrative for landowners to induce the necessary change in land-use. If energy costs grow in the future in real terms, then commercial viability might be achieved.

Conventional Forestry

The average annual equivalents per hectare for all yield classes[26] are estimated in Table 31 and the same is done by site type in Table 32. With an average yield class over all sites of about 22, the annual equivalents at the three price levels are as follows (1981 £):

Interest rate	*High*	*Medium*	*Low*
0.02	83	49	25
0.04	50	25	8

Thus, if we expect the medium price range to obtain, we find that landowners, on average, could be paid in the range of £49-25 (1981 £) per acre per annum for the use of their land for conventional forestry, depending on the interest rate obtaining. At that price, investors could cover all of their non-land costs, including interest charges, at the rates specified. As is to be expected of an enterprise with long deferred returns, the results are very sensitive to the interest rate applying. They are likewise sensitive to price and productivity levels, with the annual equivalent on the average site falling from £83 to £25 (i = 0.02) depending on whether the output price is high or low. As one goes from swamp to good mineral sites (medium price, i =

25. $226 \times 10^6 \div 4422 \times 0.295$.

26. Yield class is a measure of potential forest productivity; it specified the per hectare average annual production (in cubic metres) of commercial wood to be expected if the trees are allowed to grow to the age when the mean annual production is maximised.

Table 31: *Average annual equivalent per acre (1981 £), by yield class, conventional forestry*

Yield Class	*% of Total*		*i = 0.02* High	*i = 0.02* Medium	*i = 0.02* Low	*i = 0.04* High	*i = 0.04* Medium	*i = 0.04* Low
12	1		33	15	2	13	1	–8
14	5		42	21	6	16	1	–11
16	13		45	21	4	19	2	–10
18	9		58	30	11	27	8	–5
20	7	71	74	43	21	39	17	2
22	31		83	49	25	50	25	8
24	31		97	58	32	59	31	11
26	2		105	65	36	73	42	20
	100							

Source: Appendix Table 6A.

Table 32: *Average annual equivalents per acre (1981 £), by site type, conventional forestry*

Site Type	*i = 0.02 Price* High	*i = 0.02 Price* Medium	*i = 0.02 Price* Low	*i = 0.04 Price* High	*i = 0.04 Price* Medium	*i = 0.04 Price* Low
Swamp	44	20	3	18	2	–11
Peat	58	31	12	28	9	–5
Peaty gley	75	44	22	41	19	3
Gley	82	48	24	49	24	6
Good mineral	98	59	33	60	32	12

Source: Appendix Table 6A.

0.02), the annual equivalent payable per acre increases from £20 to £59. As in the case of energy crops, all annual equivalents are in 1981 £; if wood prices (and costs) keep pace with inflation, the payments to the landowner can likewise be kept constant in real terms.

The cost and productivity estimates for conventional forestry are quite firmly grounded, being based on over 50 years of field experience with land acquisition and planting by the State. The price series is, by comparison, quite short, and provides little guidance as to what is likely to obtain in the future in this respect. The existing forest estate is sufficiently large to meet the bulk of future domestic wood requirements, so that new plantations established now will in essence be selling into a market wherein a portion of Irish timber will probably have to be exported. Since Britain meets only about 10 per cent of its requirements from indigenous sources, there is a major adjacent market opportunity, but it remains to be seen to what extent we will successfully meet the challenge of exporting into this highly competitive market.

Chapter 9

NET RETURNS: AGRICULTURE

As a basis for comparison with the potential returns to investment in energy crops and conventional forestry, we now examine returns yielded by agriculture. We have four sources of data:

1. The Agricultural Institute's *Farm Management Survey*.
2. Average rental fees obtained on a cross-section of land types in the three counties in 1980.
3. Acres rented (and rental fee obtained) by those in our landowner survey.
4. Areas which landowners said they would make available for energy crops at various land rental levels.

Farm Management Survey

In Table 33 the average family farm income and management and investment income per acre are presented for those soil groups and farming systems relevant to the three county study area. The data are for 1978 and 1981 adjusted to 1981 £ to make them comparable with the returns yielded by energy crops and conventional forestry. We chose 1978 to compare with 1981 because the former is regarded as among "the best" years for Irish farming. Family farm income is defined as the value of gross output less direct non-labour costs and overheads. It represents the return available to pay family farm labour, management, the land and other fixed investment.

Management and investment income is family farm income less the value of family labour, costed at the prevailing agricultural workers' wage. As such, as the name implies, it represents the return available to reward management and land.

Conceptually, the annual equivalents per acre estimated for energy crops and conventional forestry are comparable with management and investment income per acre in agriculture; in each case, all costs, save land, are netted out. The labour costs involved in both energy crops and conventional forestry are valued at the wage prevailing for forest workers in the Forest and Wildlife Service. However, it is sometimes argued that for many landowners, there is little or no opportunity cost to their labour; if they were not engaged in the

Table 33: *Average management and investment income and family farm income per acre, 1978, 1981. Border region, in 1981 £*

	Management and investment income				*Family farm income*			
	1978		*1981*		*1978*		*1981*	
	Ireland	*Region*	*Ireland*	*Region*	*Ireland*	*Region*	*Ireland*	*Region*
Soil group[1]								
2	0	10	–41	–43	107	93	66	57
3	–45	–40	–60	–66	66	41	44	17
Farming system								
Mainly drystock (48%)[2]	–16	–25	–75	–51	87	42	64	20
Dairying and drystock (23%)	15	10	–26	–18	113	98	83	75

[1]Soil group 2 includes the wet mineral (gley) soils and some peaty gleys. Soil group 3 includes hill land; many peat and swampy areas would be included therein.

[2]Percentage of owners surveyed who said this was their farming system.

farming enterprise specified, they could not find other productive work on their farm, or off-farm, either on a neighbour's land or in non-agricultural employment. We feel that the case in this regard is often overstated; casual observation would indicate that on many Irish farms, additional labour input could be engaged and yield some return; it might indeed not be sufficient to match agricultural workers' wage level, but it would still be positive. Likewise, in some areas there appears to be a shortage of skilled agricultural workers at the wage prevailing, which implies a significant opportunity cost for labour "tied-up" on a farm.

If, indeed, the farm family's labour has zero opportunity cost, then family farm income, rather than management and investment income, is the appropriate measure of return to agriculture. If this is accepted, then the labour content in the energy crops and conventional forestry options should be also costed at zero, to provide the appropriate basis for comparison. However, since agriculture is more labour intensive per acre than the tree growing alternatives, "shadow pricing" family farm labour at zero would still give agriculture some relative advantage.

We feel that management and investment income per acre provides the best base-line data on average returns in agriculture, but that some upward adjustment to account for underemployed farm labour is likely to be warranted in many cases. We include family farm income per acre to define the upper bound of such adjustment.

From Map 3, it can be seen that Soil Group 2 holdings account for the bulk of the land in the region.[27] Such a broad classification inevitably embraces great qualitative variability. Almost all of the land which was classified in our land-use site survey as good mineral – comprising 30 per cent of the land area surveyed – (see Table 11) would be included in this category. This comprises an interesting example of how landowners do not define "good" land in any absolute sense; they judge it rather in relation to the quality of adjacent land.

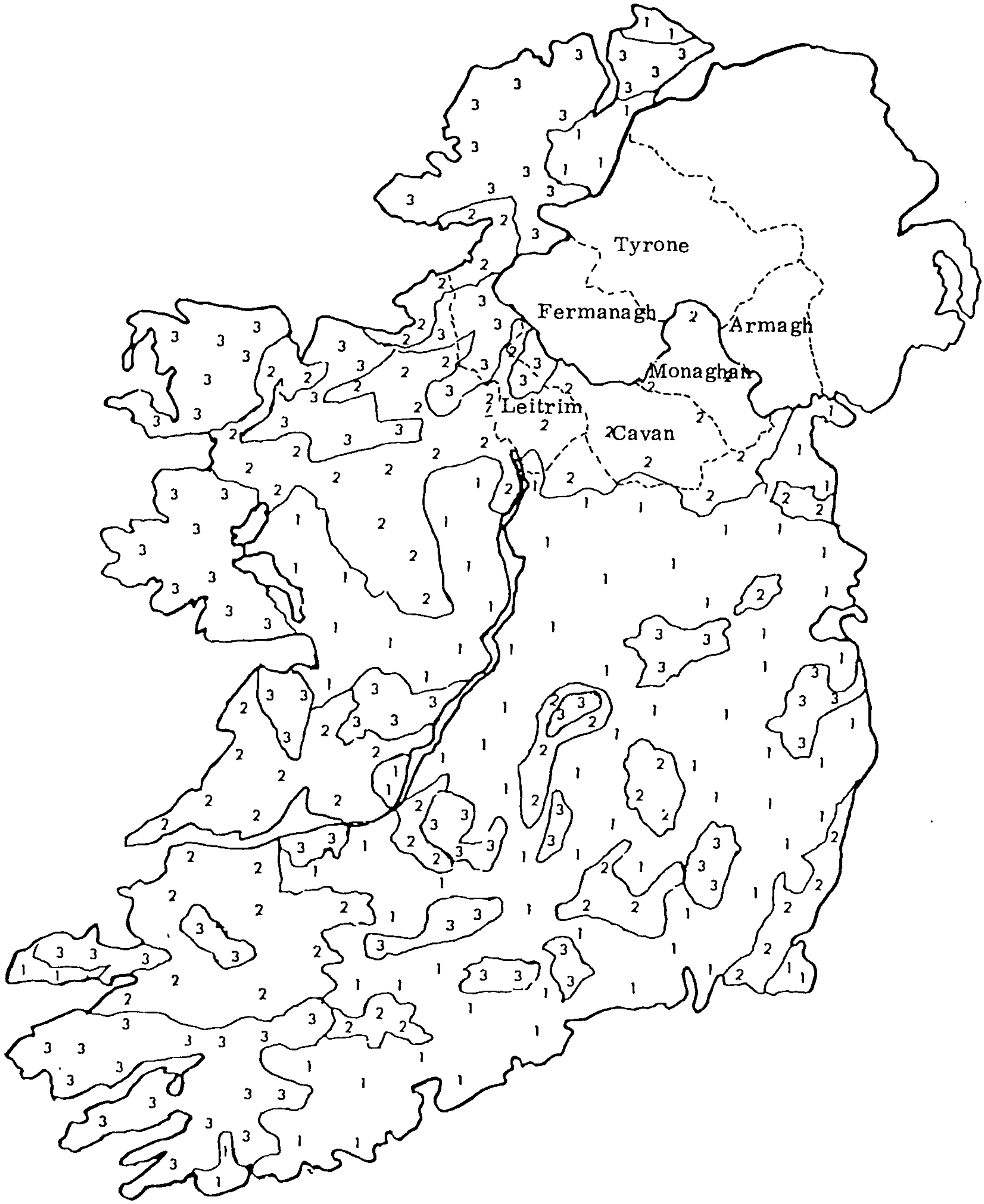
Average *Management and Investment Income* per acre on *Soil Group 2* sites has declined since 1978 (1981 £).

	1978	*1981*
Ireland	0	–41
Region	10	–43

Average per acre *Family Farm Income* on this soil type has also fallen.

27. The areas in Soil Group 1 comprise the most productive soils for farming. Soil Group 2 embraces those mineral soils – predominantly the wet mineral soils – which are marginal for agriculture, while Soil Group 3 consists of the uplands and peatlands.

Map 3: *Soil Categories in the Republic of Ireland*



Source: An Foras Talúntais.

	1978	*1981*
Ireland	107	66
Region	93	57

However, in terms of identifying opportunities for energy crops and/or conventional forestry, it is more interesting to examine the distribution of performance about the mean. The relevant data for 1981 are presented in Table 34. The contrast in performance in Ireland between the highest and the lowest 25 per cent is striking:

	Per Acre (1981 £)	
	Lowest 25 per cent	*Highest 25 per cent*
Soil Group 2		
Management and Investment Income	–125	47
Family Farm Income	4	129
Soil Group 3		
Management and Investment Income	–121	16
Family Farm Income	0	95

It can be seen that on the lowest 25 per cent, farming in 1981 did not yield sufficient return to make any contribution to farmers' own labour, which on the top 25 per cent returns were sufficient to pay farm labourers' wage and provide a "surplus" (£47 per acre on Soil Group 2 and £16 per acre on Soil Group 3) to reward management and the land and other investment.

From Table 33 we can see that the *average* management and investment income per acre in Ireland in 1978 amounted to £0 and £–45 (1981 £) respectively on Soil Groups 2 and 3 (1981 £). It therefore seems likely that, even if farming recovers to the relatively prosperous conditions obtaining in 1978, the lowest 25 per cent will be able to show little or any surplus to reward management and investment input.

Rental Fees in 1980

Local auctioneers throughout the three counties were visited and interviewed, and an estimate of the average rental and selling prices over the past year for each of the land types was obtained (Table 35). Annual rental fees vary from as little as £8/acre/year for rough grazing land in Co. Leitrim to £140/acre/year for cropland in Co. Monaghan. But since there is so little cropland in the three counties, a more realistic range of rental fees is between £28-£85/acre/year.

Table 34: *Distribution of family farm income and management and investment income per acre, by soil group, region and Ireland, 1981*

	Lowest			*Highest*
Distribution (%)	0–25	26–50	51–75	76–100
IRELAND				
Soil group 2				
Family farm income	4	46	75	129
Mgt. and invest. income	–125	–35	1	47
Soil group 3				
Family farm income	0	19	43	95
Mgt. and invest. income	–121	–41	–14	16
REGION				
Soil group 2				
Family farm income	–6	41	75	122
Mgt. and invest. income	–128	–33	6	49
Soil group 3				
Family farm income	–5	16	27	40
Mgt. and invest. income	–115	–38	–11	9

Source: Personal communication from Maurice Roche, An Foras Talúntais, Nov. 23, 1982.

Landowner Survey

Eight per cent of all landowners in the three counties let (rent out) land. Many of these do so in exchange for goods and services other than monetary payment – be it free milk, help around the farm, etc. Excluding the acres owned by these non-fee charging individuals, the average rental fee obtained in the three counties (across all land types) is £38/acre per year. Figure 8 shows the acreage let in each price category, while Figure 9 shows the accumulated area provided at each rental level.

Areas Made Available by Landowners at Different Prices

In our survey of landowners, each of those interviewed was asked what minimum rental he or she would accept in order to allocate a specified amount of their land to energy crop production. In our pilot survey, we tested the viability of asking landowners how much land they would make available at a schedule of prices. Unfortunately, this proved to be impractical; for each landowner it was only possible to get a point estimate of area available

Figure 8: *Acres of Land Let at Various Price Levels — Landowner Survey*

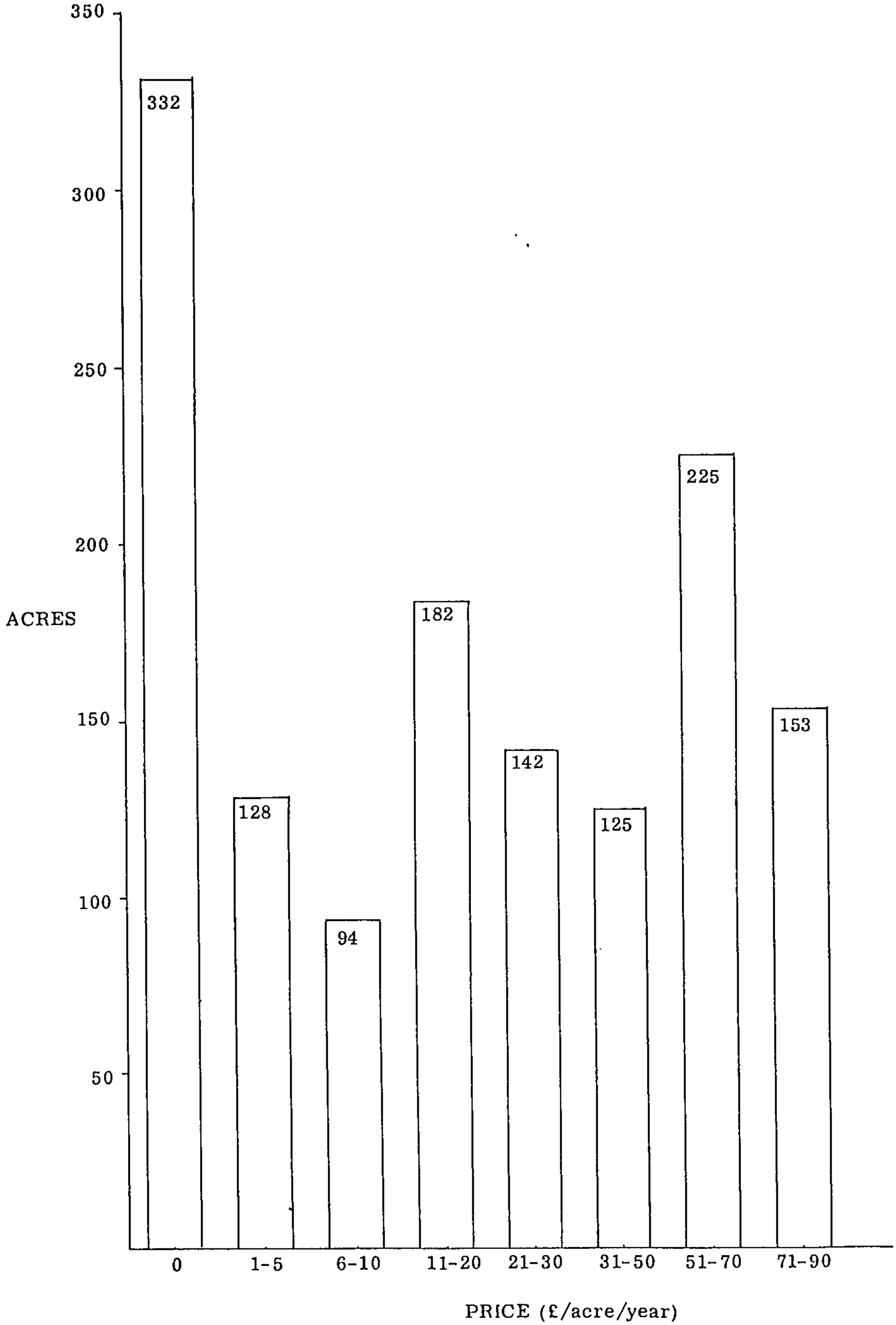


Figure 9: *Supply of Land Already Let by Landowners*

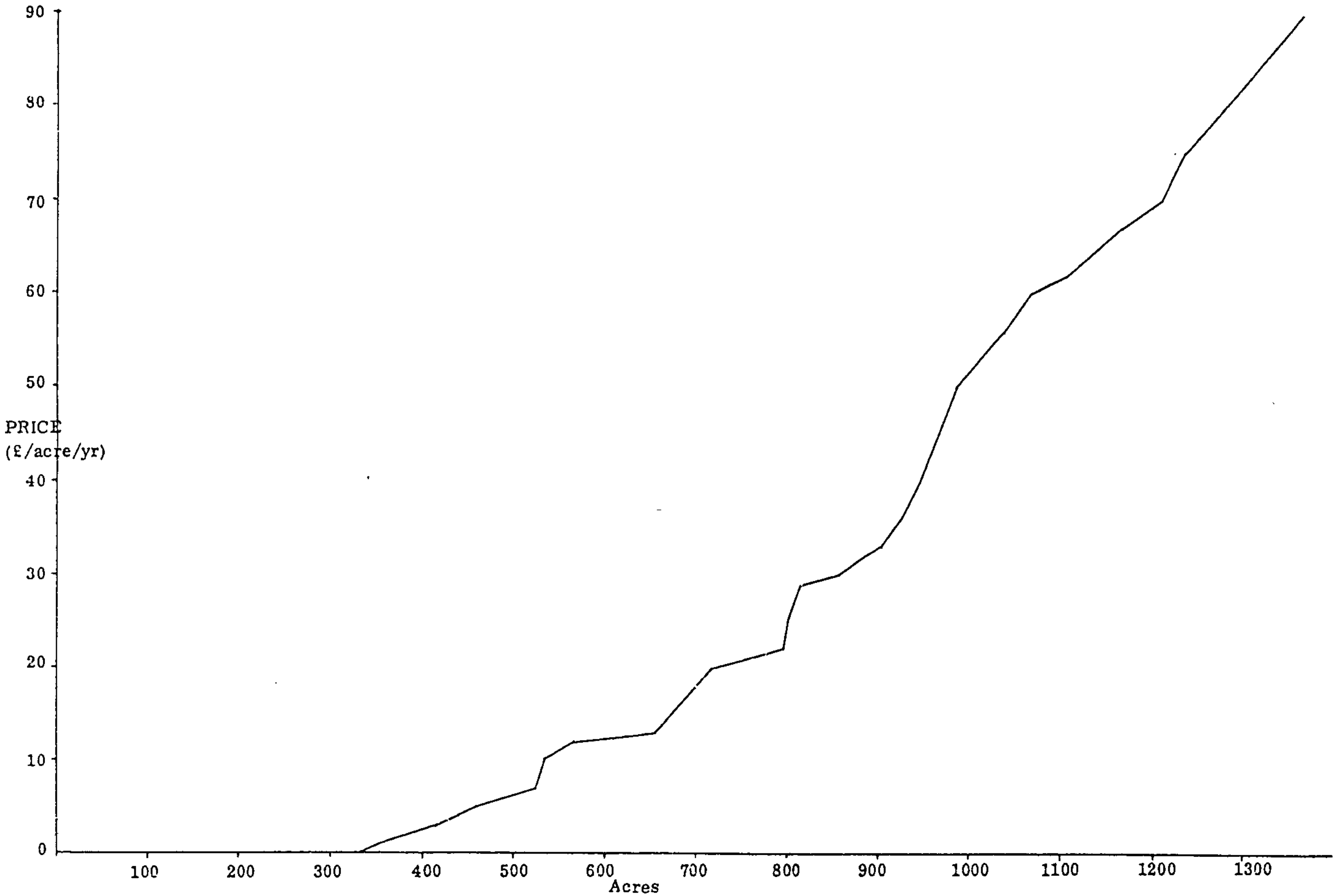


Table 35: *Average rental and sale values for land in counties Cavan, Monaghan and Leitrim, 1980*

		£/acre/year		
1. Average rental value for:	*Cavan*	*Leitrim*	*Monaghan*	*Total (Average)*
Cropland	120	–	140	130
Well drained grassland	90	80	85	85
Medium drained grassland	50	40	60	50
Poorly drained grassland	30	15	35	27
Rough grazing	25	8	35	23
Bogland	25	–	–	25
2. Average sale value for:		*£/acre*		
Cropland	1350	–	1550	1450
Well drained grassland	1300	1250	1350	1300
Medium drained grassland	1000	1000	1000	1000
Poorly drained grassland	600	600	750	650
Rough grazing	600	500	650	583
Bogland	250	200	–	225

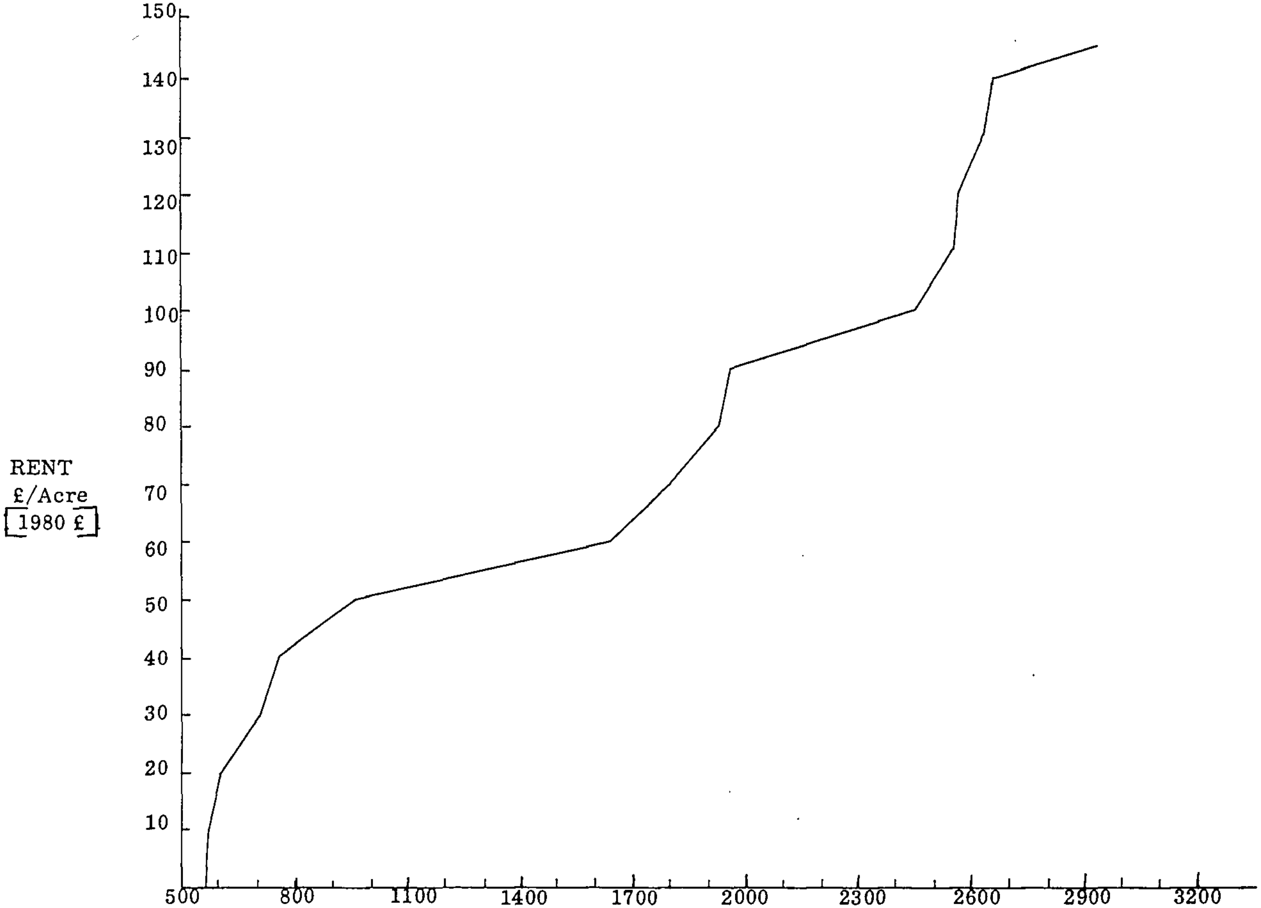
Source: Data obtained from interviewing 15 local auctioneers, December, 1980.

and minimum rental required for this area. However, by combining all responses, it was possible to derive a supply response, indicating the aggregate area which landowners would make available at a schedule of prices (Figure 10).

It is to be expected that respondents will exaggerate the amount which they would need to receive in order to allocate land to tree growing. Since no upper limit was specified, we anticipated that landowners would engage in strategic behaviour and tend to regard their initial "offer" as the opening bid in a rental negotiation. The responses seem to bear out this view.

The rents which landowners "demanded" tended to be significantly higher than those currently being received from renting and greater still than the average returns yielded from the landowners' own on-farm activities. A rental level of £60 per acre per annum would, if the responses represent actual behaviour, result in 1,639 acres being allocated to tree growing, representing only 46 per cent of the total area which the landowners interviewed said would be available for this purpose. The highest rental "requirement" – £999 per acre per annum – by a landowner represents an extreme manifestation of strategic behaviour.

Figure 10: *Acres offered for Rent for Energy Crop Production at a Range of Prices*



Source: Appendix 8.

Land-Use Activities Compared

Taking the four measures together of what landowners would have to forgo in terms of returns to agriculture in order to allocate land to tree growing, and comparing them with our estimates of annual equivalent returns to energy crops and conventional forestry, it appears to us that, conservatively, at least 10 per cent of the wet mineral and peatland soil areas could be converted to tree-growing at a considerable economic advantage to the landowners in question. The justification for this derives from the summary data which are presented in Table 36. Here are presented the "medium projection" returns per acre from investing in energy crops and conventional forestry, and the actual returns to agriculture on the 25 per cent wet mineral soils showing the lowest returns in this use.

Table 36: *Comparison of net returns (£ per acre per annum) energy crops, conventional forestry and agriculture, 1981*

	Interest rate	
	0.02	*0.04*
Energy crops[1]	65	55
Conventional forestry[2]	49	25
	Agriculture[3]	
	Lowest 25 per cent	*Average*
Management and investment income	–125	–41
Family farm income	4	66

[1]Assuming: Mineral soil; 15 tonnes dry matter per hectare per year; £17 per tonne price.
[2]Assuming: Yield class 22, medium price range.
[3]Soil group 2 (mineral soil); 1981.
Source: Table 34.

Note: The returns to both conventional forestry and agriculture represent what is being achieved in practice. The returns estimated for energy crops do not derive from field experience; they are based on cost, productivity and price assumptions which seem to us to be plausible but which have yet to be fully validated (see discussion in text).

It could be argued that this comparison is unfair to agriculture, because, with more efficient management, returns could be increased. The performance on the highest 25 per cent provides support for this view. However, we are talking of converting a maximum of 8.5 per cent of the marginal land area to tree growing (see discussion of this point in Chapters 10 and

12), so that there remains a large area of farmland on which improved management effort, if it materialises, can be focused. In addition, the returns to conventional forestry represent actual practice, i.e., what is being achieved today. A more salient objection would be that only progressive, well educated, relatively high income farmers would consider growing energy crops. For them, the opportunity costs, in terms of forgone farming income, might be high. We discuss this issue in the next chapter.

There is a very wide distribution of per acre income earning performance with farming. It is, therefore, difficult to estimate the net income advantage which would accrue from converting to tree growing without knowing which acres would be involved. It is made more difficult by the fact that there has also been great volatility in returns over time to farming; management and investment income per acre on Soil Group 2 fell from £0 in 1978 to £–41 in 1981 (1981 £). On the basis of these returns compared to those provided from tree crops, we assumed that if 8.4 per cent of farm land were converted to tree growing over 20 years, it would be possible, in so doing, to increase net income on average by £45 per acre (1981 £), fully cognizant of the uncertainties attending this estimate.

Chapter 10

WILLINGNESS OF LANDOWNERS TO PARTICIPATE

It is often argued that landowners who are old, poor and have only small holdings resist innovation, even when they could substantially increase their income thereby. In order to assess the actual willingness of landowners to participate in an energy crop production scheme, a survey of landowners in the 3 counties was conducted.

The Survey of Landowners

A sample of 1,000 landowners was chosen from the pool of landowners in the three counties with holdings of 5 acres or more.[28] The sample was selected using a stratified random method (with variable fractions) in order that we could generalise to all such landowners in the three counties. A questionnaire (Appendix 8) was developed and then reviewed by a panel within The Economic and Social Research Institute (ESRI) before it was tested on a subsample of 30 landowners. Based on the results from this pilot survey, changes were made to the questionnaire before the full survey began. A letter was sent to each landowner, explaining the study, its objectives and something about energy crops. The format used was a personal interview with each landowner by experienced personnel of the ESRI. Of the 1,000 landowners selected, 873 were successfully contacted.[29]

In addition to basic socio-economic questions, landowners were asked about their willingness to get involved in short rotation forestry production. Three options were presented: (1) renting land to a semi-state agency (unspecified) which would do the actual production work; (2) landowner EC (energy crop) production; and (3) selling land for EC production. Landowners were asked the price (£/acre/year for renting land and £/acre for selling land) it would take to convince them to allocate land to EC production, in an attempt to estimate the maximum area of land potentially available and its price. If landowners would not consider an option at any price, they were

28. In the 3 county area in 1975, there were 1,129 holdings in the 1-5 acre size range, amounting to 3,387 acres [Central Statistics Office (1978) p. 86] this comprises only 0.36 per cent of the total area of crops and pasture.

29. For a summary of the reasons no interview was held, see Appendix 9.

then asked to specify their reasons why not. Throughout this report, unless otherwise noted, "willing" landowners include all those who offered some of their land to one (or more) of the energy crop options presented, irrespective of the area and price they stated. As a result, very small (and probably uneconomic) parcels and exhorbitantly priced parcels are included. Table 37 is a summary of landowner willingness and acreage potentially available for energy crop production.

Landowner Interest

Nearly a third (31 per cent) of those contacted, owning 37 per cent of the land-area, indicated willingness to allocate land to at least one of the three options. On the one hand, this appears to be surprisingly high, since for most landowners our survey was their first contact with the "energy crops" concept. On the other hand, since to express interest cost them nothing, it could be argued that the proportion of candidate landowners was rather low.

Table 37: *Summary of landowner willingness and acreage potentially available for ECP*

	Population		*Total area owned*	
	Number	*%*	*Number*	*%*
Landowners interviewed	873	100	46,791	100
Willing landowners	267	31	17,482	37

Total area potentially available: 6,072–4,596 (13–10% of total) are surveyed.
Source: Landowner survey. See Table 45.

Column 2 of Table 38 lists the percentage of landowners within each category who are willing to allocate land for ECP. Most of the variables show no unambiguously clear relationship with willingness (excepting farm size), and as a result, are not very useful in predicting landowner willingness. A summary of the more prominent characteristics of the willing landowners follows.

Farm Size

As could be anticipated, landowners with small holdings (0-50 acres) are considerably less interested in ECP than the large landholders. The two categories of large holdings showed fairly similar responses, 40-45 per cent favourable, or almost double the willingness of the small owners.

Table 38: *General description of the total landowning population (of 5 or more acres) in counties Cavan, Monaghan and Leitrim and per cent within each category who are willing to consider ECP*

		% of total population	*% willing within each category*
Area of land holding (Ac.):	5 – 50	82	23
	51 – 150	17	40
	151+	1	43
Sex of landowner:	Male	88	27
	Female	12	15
Age	0 – 25	2	7
	26 – 35	10	31
	36 – 45	15	32
	46 – 55	21	33
	56 – 65	24	25
	66+	28	17
Marital Status:	Single	33	22
	Married	54	30
	Widowed	12	18
	Separated	1*	14
Number of dependants:	0	23	17
	1 – 4	61	28
	5 – 9	16	33
	10+	1	19
Education:	Primary	84	24
	Secondary	5	34
	Vocational	8	37
	Agricultural college	1	15
	Other third level	1	31
Principal occupation:	Farmer	81	24
	Professional-manager	2	40
	Clerical	1*	54
	Skilled-manual	4	33
	Unskilled or semi-skilled	6	40
	Self-employed	3	33
	Housewife	3	20
Farming system:	Mainly dairying	12	27
	Dairying & drystock	23	31
	Dairy, drystock & tillage	5	24
	Mainly drystock	48	22
	Drystock & tillage	3	28
	Hillsheep & cattle	3	28
Off-farm income: (£ annum)	£ 0 – 500	68	24
	£ 501 – 1000	1*	48
	£1001 – 5000	20	27
	£5001 – 10,000	7	42
	£10,001+	4	31
Trees already planted:	Yes	26	28
	No	73	25
	NR	1*	16
Resident?	Yes	94	
	No – but in this town	5	
	No – adjacent town	1	

*Less than ten observations.
Source: Landowner Survey (See Appendix 8).

Age

Since involvement in ECP would involve at least some effort (if only in terms of negotiations) and since the payoff is likely to extend 12 to 25 years into the future, one would expect young landowners to exhibit more interest than older ones. This appears to be the case, but not markedly so. Roughly a third of all landowners in each of the middle age groups (26-35, 36-45 and 46-55) indicated interest. Age, however, does not appear to be an overwhelming deterrent; 25 per cent of those 56-65 and 17 per cent of those over 65 expressed interest in getting involved.

Dependants

It is interesting to note that interest in ECP increases with number of dependants; only 17 per cent of all those living alone indicated willingness, where landowners with 5-9 dependants indicated twice as much willingness. This, in fact, appears to be a combined effect of age and number of dependants; 82 per cent of those living alone are over 45.

Education

As we had anticipated, willingness to participate is positively correlated with level of education. However, as with age, the association is not very strong. It is interesting to note that those with a vocational education indicated the most interest (37 per cent) and those educated through Agricultural College the least.

Off-Farm Income

Although there is a positive correlation between off-farm income and willingness, again, the relationship is not strong. Landowners with over £5,000/year indicated more interest than those with less than £5,000/year, but only by (at most) 18 per cent. Surprisingly, those in the highest income category (10,000+) are less interested than those in the £5,000-£10,000 bracket. Perhaps the high off-farm income may enable them to be less concerned about obtaining the maximum net return from their land.

In summary, willingness to consider ECP does appear to be positively correlated with farm size, education and income, and negatively correlated with age, but none of these associations are in any way emphatic. Also, these interpretations could be misleading; in fact they are only educated guesses. Effects that we attribute to one variable may instead or, in addition, be due to one or several other variables. For example, within education, those educated through vocational school appear the most interested in ECP. In reality, this may be due to the fact that more people with vocational educations would be working off the farm in businesses, etc., and thus might be more willing to risk a new enterprise on their land than those totally dependent on their land.

In order to assess these various effects, we conducted multiple regression analysis. For the variables which *a priori* one would expect to influence willingness,[30] we obtained one R^2 value of 0.07 indicating that only 7 per cent of the observed variation in willingness could be explained by these variables. Also, none of the variables individually made a statistically significant contribution to explaining willingness.

Since regression did not establish a clearly definable relationship between characteristics of landowners and interest in ECP, we utilised the simpler and more easily understandable cross-tabulations. Starting with farm size, we broke down each size category by each of the other variables. Table 39 lists the percentage of willing landowners within each farm size category for the entire population (top line) and this is then broken down by off-farm income, age, education, occupation and farming system. This is done for all possible two-way combinations of characteristics. To illustrate, 43 per cent of all landowners in the 51+ acres size class are interested in energy crop production (from Column (3)). From Column (1) we see that 48 per cent of all landowners with off-farm income in the range of £501-1,000 annually are interested. From Column (4), we learn that 46 per cent of those with both a primary education and farms of 151+ acres size are interested. The values within the tables are the percentages of willing landowners in each two-way combination of characteristics. A comparison between the percentage willing for the total population and the percentage willing in each category of the second variable should highlight the relative effect of each variable on landowner willingness and expose combinations of the most interested and disinterested landowners.

From Tables 39 to 43 the combinations of characteristics producing the greatest landowner willingness (over 50%) are:

Per cent		
77	:	£5000-10,000 per year/age 46-55
70	:	secondary education/age 26-35
66	:	£5000-10,000 per year/age 56-65
63	:	£5000-10,000 per year/non-farmers
62	:	vocational education/non-farmers
62	:	secondary education/dairying and drystock
60	:	£5000-10,000 per year/dairying and drystock
58	:	£10,000+ per year/50-150 acres
53	:	vocational education/age 56-65

30. These include farm size, age, marital status, number of dependants, education, off-farm income, occupation and farming system.

It is difficult to explain these effects; why *should* 77 per cent of those aged 46-55 with an off-farm income of between £5000 and £10,000 per year be especially interested in ECP? Also, the cross-tabulation of percentage willing for those aged 46-55 with off-farm income shows no obvious correlation between the two variables and landowner willingness.

The groups of landowners *least* interested in ECP (less than 15%) are:

Per cent		
5	:	aged 0-25/farmer
5	:	off-farm income of £10,000 + per year/dairying + drystock
8	:	aged 66+/mainly drystock
11	:	aged 56-65/£10,000+
12	:	aged 66+/mainly dairying
14	:	aged 66+/non-farmer
14	:	aged 66+/£0-500 per year

While we cannot identify any systemic pattern in the data, they do seem to indicate that the extremes of age and income – the very young and/or poor, and the very rich and/or old – are least interested; those in the middle are most likely to get involved.

However, the combinations of characteristics associated with those who are most interested are those which are generally associated with "progressive" farmers, while those less enthusiastic are also those who are likely to be relatively inefficient farmers. This has two implications: the per acre farm income of many of the landowners who would consider taking up the wood-growing option will be relatively high, and a non-discriminating programme of support would tend to favour the already better off landowners. With regard to the former, it means that tree growing will have to compete in many uses with farm incomes which are above average. However, as we discuss in the next chapter, the maximum total area we consider for energy crops/conventional forestry amounts to only 8.4 per cent of the total marginal land area, or about 5 per cent of the total land area in the Western and Border areas, planted over 20 years, i.e., 0.42 per cent of the marginal land area being converted to tree growing annually. We feel that with this modest scale of conversion, it is unlikely that the highest yielding agricultural land would be used for tree growing; the comparative advantage in this regard even for "good" farmers will probably lie at the other end of the scale, although without direct comparison of returns for alternative uses on particular sites this remains to be proved.

Table 39: *Percentage of willing landowners, broken down by farm size with income, age, education, occupation, and farming system*

		Size of holding (acres)		
	(1)	(2) 0–50	(3) 51–150	(4) 151+
	Total pop	23	40	43
Off-farm income:				
£ 0–500	24	20	40	42
501–1000	48	52*	0*	–
1001–5000	27	25	37	48*
5000–10,000	42	42	43	50*
10,000+	31	27	58	–
Age:				
0–25	7	0*	19	0*
26–35	31	29	38	65*
36–45	32	28	44	20*
46–55	33	30	46	45*
56–65	25	22	40	69*
66+	17	16	29	0*
Education:				
Primary	24	22	40	46
Secondary	34	28	44	25*
Vocational	37	37	37	29*
Agricultural college	15	0*	29*	100*
Other third level	31	19*	68*	100*
Occupation:				
Farmer	24	20	40	37
Non-farmer	35	34	45	76*
Farming system:				
Mainly dairying	27	23	37	72*
Dairying and drystock	31	27	43	64*
Dairying, drystock and tillage	24	21	31	0*
Mainly drystock	22	19	41	28*
Drystock and tillage	28	26	42*	–
Hillsheep and cattle	28	18	46	32*

*Less than 10 observations.
Source: Landowner Survey.

Table 40: *Percentage of willing landowners, broken down by off-farm income with age, education, occupation, and farming system*

		Off-farm income (£)				
		0-500	*501-1000*	*1001-5000*	*5001-10,000*	*10,000+*
	Total pop.	24	48	27	42	31
Age:						
0–25	7	7*	–	0*	0*	18*
26–35	31	33	0*	27	19*	58*
36–45	32	30	57*	28	45*	68*
46–55	33	32	54*	21	77	45*
56–65	25	19	–	43	66	11
66+	17	14	72*	21	18	53*
Education:						
Private	24	23	59*	23	35	31
Secondary	34	28	–	41*	100*	17*
Vocational	37	26	0*	82*	64*	40*
Ag. College	15	13	–	40*	0*	–
Other third	31	22	–	0*	73*	–
Occupation:						
Farmer	24	22	39*	24	34	26
Non-farmer	35	28	100*	50	63	53*
Farming system:						
md	27	24	100*	17	46*	54*
d + dry	31	31	35*	31	60	5
d + dry + t	24	17	65*	43	20	29*
mdry	22	20	26*	17	38	50
dry + t	28	26	–	52*	0*	0*
hs + c	28	30	–	17	0*	100*

*Less than 10 observations
Source: Landowner Survey.

Table 41: *Percentage of willing landowners, broken down by age with education, occupation and farming system*

		Landowner age					
		0-25	*26-35*	*36-45*	*46-55*	*56-65*	*66+*
	Total Pop.	7	31	32	33	25	17
Education:							
Primary	24	0*	26	32	33	23	17
Secondary	34	12*	70	37	22*	37	0*
Vocational	37	13*	32	29	45	53	–
Ag. College	15	0*	42*	0*	0*	0*	–
Other 3rd level	31	0*	13*	52*	56*	14*	–
Occupation:							
Farmer	24	5	28	26	34	23	17
Non-farmer	35	16*	37	47	33	41	14
Farming system:							
md	27	0*	44	22	36	36	12
d + dry	31	8*	29	34	41	21	35
d + dry + t	24	0*	8*	31	40*	18	29
mdry	22	62*	33	33	29	20	8
dry + t	28	–	91*	18*	0*	41	0*
hs + c	28	0*	0*	47*	25	23*	26*

*Less than 10 observations.
Source: Landowner Survey.

Table 42: *Percentage of willing landowners, broken down by education with occupation and farming system*

		Education				
		Primary	*Secondary*	*Vocational*	*Agricultural College*	*Other 3rd*
	Total Pop	24	34	37	15	31
Occupation:						
Farm	24	23	34	21	12	64*
Non-farm	35	30	34	62	100*	19*
Farming systems:						
md	27	26	28	19	69*	39*
d + dry	31	29	62	48	4*	100*
d + dry + t	24	28	0*	0*	—	—
mdry	22	19*	33	39	7*	41*
dry + t	28	35	30*	14*	0*	—
hs + c	28	30	0*	12*	—	—

*Less than 10 observations.

Table 43: *Percentage of willing landowners, broken down by occupation with farming system*

		Occupation	
		Farmer	*Non-farmer*
	Total Pop.	24	35
Farming system:			
md	27	26	30*
d + dry	31	29	50
d + dry + t	24	24	20*
mdry	22	19	30
dry + t	28	17	100*
hs + c	28	27	34*

Note: md = Mainly dairying
d + dry = Dairying and drystock
d + dry + t = Dairying, drystock and tillage
mdry = Mainly drystock
Dry + t = Drystock and tillage
hs + c = Hill sheep and cattle

*Less than 10 observations

Source: Landowner Survey.

Landowner Option Preference

As previously noted, landowners were presented with three options of energy crop production: renting, selling or growing the crops themselves. In the way the questionnaire was designed, each option was presented separately to the owner. Landowners were first asked about renting, then landowner ECP,[31] and finally selling land. Landowners were not asked to specify whether the land they offered for the second or third option was the same land they had offered for the first option, a few questions previously. As a result, the precise area potentially available is not known. If we assume that for all the combined options (Table 44, nos. 4-7 in Column 1) the parcels of land offered are mutually exclusive – that is, there was no double counting of acres – then, the total area available would equal 6,072 acres, as listed in Column 6. If, on the other hand, we assume that double counting did take place – that the same parcel of land was offered for all the options agreed to – then at minimum we can assume that at least the *larger* of the 2 (or 3) areas offered by each owner is potentially available. In this case, the total would equal 4,596 acres, the total in Column 7. In actual fact, the true value probably lies somewhere between these two estimates.

It is interesting to note that the landowner ECP option rated lowest – both in terms of landowner preference and area offered – if we take acres where owners selected only one option, we find the following.

Preference	*Acres*	*%*
Rent	1,736	67
Grow own	238	9
Sell only	600	23
	2,574	100

When asked about their preference in a separate question, landowner preference was consistent with their response to the individual options (%):

	Per cent of total area	*Per cent of area available*
Rent land	17	63
Grow own energy crops	4	15
Sell land	6	22
None	72	–
No response	1	–
	100	100

31. Energy crop production, i.e., growing it themselves.

Table 44: *Breakdown of landowner willingness and area available for energy crop production by land option*

Column 1.	*2. Landowner preference*	*3. Land for renting*		*4. Landowner energy crop production*		*5. Land to sell*		*6. Maximum total*		*7. Minimum total*	
Option(s)	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*	*Acres*	*%*
1) Rent only	51.0	1736	48.3	—	—	—	—	1736	28.6	1736	37.8
2) Grow own only	7.7	—	—	238	27.0	—	—	238	3.9	238	5.2
3) Sell only	8.9	—	—	—	—	600	37.6	600	9.9	600	13.0
4) Rent + grow own	8.1	977	27.2	450	51.1	—	—	1427	23.5	977	21.3
5) Rent + sell	19.1	782	21.8	—	—	853	53.4	1635	26.9	853	18.6
6) Grow own + sell	0.8	—	—	3	0.3	3	0.2	6	0.1	3	0.1
7) All	4.4	100	2.8	189	21.5	141	8.8	430	7.1	189	4.1
Total	100.0	3595	100.0	880	100.0	1597	100.0	6072	100.0	4596	100.0

Source: Landowner survey.

Land Available for ECP

Earlier we presented the preference of landowners concerning means of participation when the areas where one option only was specified were involved. If we included all the areas where an option – either singly or in combination – was specified, we found the following:

	Acres	*% of total*
Rent	3,595	7.7
Landowner energy crop production	880	1.9
Sell land	1,597	3.4
Total	6,072	13.0
Not available	40,719	87.0
Grand total	46,791	100.0

Of the 6,072 acres "available" from our sample owners, 59 per cent of the area is potentially available for renting, 14 per cent for landowner crop production and 26 per cent for selling.

Table 45 lists the land potentially available for ECP by land type and option. It can be seen that for each of the 3 options, well drained grassland and rough grazing comprise the favoured site types – see Columns (5), (8) and (11).

Reasons Given for Landowner Disinterest in ECP

For each option that the landowner refused to consider, they were asked to specify their reasons. From our pilot survey, a list of likely responses was developed, and landowners were asked to rank-order their reasons (from 1-3) in order of decreasing importance. Table 46 (Column 1) lists the total combined response (i.e., the sum of responses of 1st and 2nd or 3rd in importance) of each reason for disinterest, by option. The responses are unweighted by the ranking. The second column lists the most important reason for disinterest as a percentage of the total response, by option.

For the first option, land rental, it is interesting to note that even though the minimum period offered landowners is 12 years, only 7 per cent gave age as a reason for not participating. Lack of interest and a too small farm size rated high for all three of the options, in terms of the total unweighted response, and the reason given as most important for disinterest in ECP.

Conventional Forestry

Although 27.5 per cent of landowners said that they had already planted

Table 45: *Land available for energy crop production by land type*

	All land surveyed		*Land for renting*			*Landowner energy crop production*			*Land to sell*		
Land type	*Total acres*	*% of all land surveyed*	*Total acres*	*% of all land type*	*% of all land for renting*	*Total acres*	*% of all land type*	*% of all land for owner production*	*Total acres*	*% of all land type*	*% of all land to sell*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Cropland	1345	2.9	616	46.1	17.1	60	4.5	6.8	0	--	—
Well drained grassland	26348	56.3	857	3.2	23.8	295	1.1	33.5	699	2.7	43.8
Poorly drained grassland	8715	18.6	669	7.7	18.6	145	1.7	16.5	233	2.7	14.6
Woodland	604	1.3	168	27.8	4.7	120	19.9	13.6	11	1.8	0.7
Rough grazing	7538	16.1	791	10.5	22.0	185	2.5	21.0	412	5.5	25.8
Bogland	1694	3.6	494	29.2	13.7	75	4.4	8.5	242	14.3	15.2
Other	547	1.2	—	—	—	—	—	—	—	—	—
Total	46791	100.0	3595	7.7	100.0	880	1.9	100.0	1597	3.4	100.0

Source: Landowner Survey.

Table 46: *Reasons given (by option) for landowner disinterest in energy crop production*

Option	*Per cent of total response**	*Most important reason for disinterest as a percentage of total response*
1 Land Rental		
No interest	24	26
Farm too small	24	37
No suitable land available	12	8
Too old to bother	7	7
12 years too long	16	5
Don't like trees	2	1
Lack of knowledge/information	3	1
Other – use other land	12	15
	100	100
2 Landowner ECP		
Lack of knowledge/information	5	2
No interest	23	29
Too much work	21	25
Too old to bother	12	13
Farm too small	19	16
No suitable land available	9	5
Don't like trees	1	1
Other – no time	10	9
	100	100
3 Sell Land		
Want to farm all of it	22	34
No suitable land available	4	2
Want to pass it on to descendants	19	19
Farm is too small	23	22
Don't want to break up holding	19	11
No interest	11	9
Other – speculation	2	3
	100	100

*Giving equal weight to each of reasons, 1, 2 and 3 given for not participating.

trees, the area involved is very modest, amounting to only 1,000 acres in aggregate, comprising 2.1 per cent of the total land area. From Table 47, we can see that 80 per cent of them listed provision of a windbreak as the most important reason for tree planting. Only 1 per cent listed advice from their agricultural adviser as the most important reason. The planting grant was likewise cited by only 1 per cent as the most significant stimulus for planting.

For the 71.5 per cent of owners who have not planted trees, 40 per cent listed "no interest" as their most important reason for not doing so, "enough trees already" and lack of suitable land ranked next in this regard (Table 47).

Landowners were told initially that, for energy crops, a minimum commitment of their land for 12 years would be required. They were then asked if the period were extended to 24 years for energy crops, or 30 years for conventional forestry, would they require additional income in order to commit their land to these uses. The results were inconclusive in so far as, in each case, a majority of "no responses" were received:

*Change in rental payment required**	*Energy Crops*	*Conventional forestry*
	(Per cent)	
Increase	8	5
Decrease	0	0
No effect	3	5
Don't know	12	14
No response	77	77
	100	100

*From that based on a 12 year planting period.

It is clear that for some landowners the extended horizon imposes a cost, but it is by no means clear how significant it is. We did not discover any antipathy *per se* among landowners to conventional forestry.

Summary and Conclusions relating to Landowner Survey:

The results of the landowner survey must be interpreted with caution:

(a) For some questions, owners are likely to make "strategic" responses which are not an accurate reflection of their true inclinations.

Table 47: *Reasons why landowners already planted or did not plant trees*

	% of total combined response	*% of response to "most important" reason*
Reasons why planted trees already:		
Windbreak	52	80
Financial return	5	6
Provide for children/descendants	3	2
Aesthetic reasons	12	4
Patriotic duty	3	1
Availability of planting grant	2	1
Advice from ag. adviser	2	1
Advice of neighbour/friend	8	0
Waste land available	12	5
Other (gift)	1	0
	100	100
Reasons why never planted trees:		
Lack of knowledge/information	10	4
Couldn't afford it	11	9
No interest	32	40
Trees take too long to grow	12	6
Don't like trees	2	1
No suitable land available	17	17
Ag. adviser recommended against it	0	0
Other (enough trees already)	16	23
	100	100

Source: Landowner survey.

(b) A survey captures attitudes at the time of the interview. Over time, as circumstances change, they may also change sharply.

(c) Landowners may not understand the question(s), or, if they do, they may not have sufficient knowledge to respond accurately.

By following the landowner survey by an on-site land-use survey, it was possible to ensure that the areas specified, together with land quality, size, inputs required, etc., were estimated with considerable precision. However, in this chapter we have been dealing with attitudes, which are much more difficult to discern accurately. Nevertheless, we feel that the general direction of our survey findings in this regard are valid.

They have brought to light several interesting features regarding the potential for ECP in the three county region. Nearly a third of those contacted indicated willingness to allocate land for energy crops.

The strong support for the renting option, in terms of both number of landowners and area, is of interest; 63 per cent of all willing landowners are interested in just renting land, or renting plus one or both of the other options. (Nearly half of all willing landowners are interested in renting only.) In terms of area potentially available, between 59 per cent and 78 per cent (depending upon the assumptions) of all the land offered was offered for renting. This compares with 14-19 per cent for landowner energy crop production and 26-35 per cent for selling.

Unfortunately, the characteristics that one would expect, *a priori*, to influence landowner willingness, show no clear pattern in this regard. This indicates either that variables were not included in the questionnaire that should have been asked, or, willingness is truly a random variable. Perhaps the dominant influence affecting each landowner decision was unique, producing a near random distribution of willingness. There does appear to be markedly less interest at the extremes of age and off-farm income with the richest and the poorest in the latter respect, and the youngest and the oldest evincing a relatively low willingness to participate. However, this does not provide a very pointed guide for policymakers.

Chapter 11

REGIONAL AND ENERGY IMPACTS

In order to assay the policy implications of our analysis, it is necessary to establish a sense of the magnitude of the land area and investment which would likely be involved in an energy crops/conventional forestry programme.

Gardiner and Radford (1980) developed estimates of the areas of marginal land – defined as land yielding close to zero rent because of climatic, topographic, and/or soil limitations – in each county in Ireland (Table 49). In Map 4, the counties with 50 per cent or more of their land so defined are identified. In Table 48, the total area of marginal land, by site type, is listed.

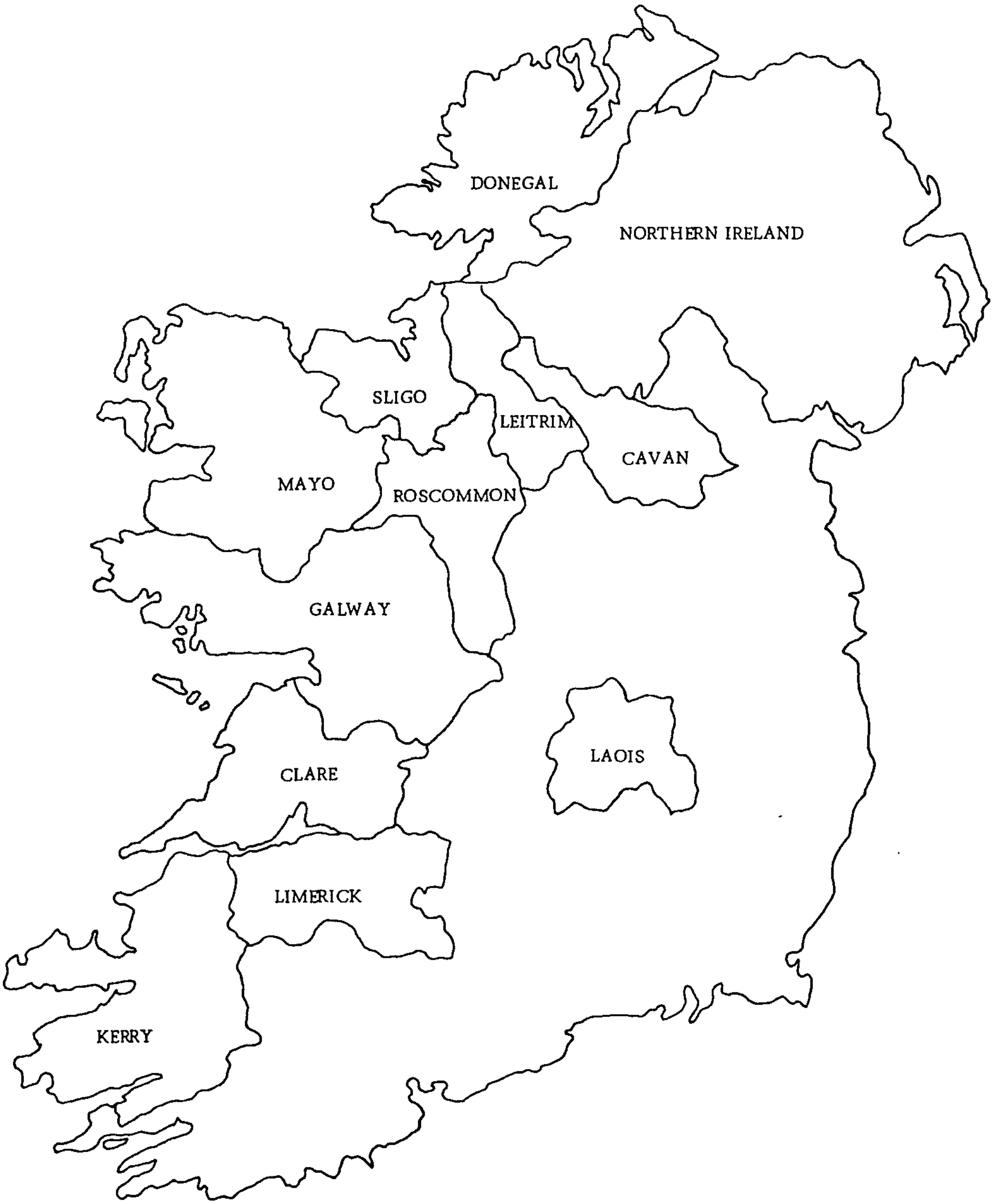
In responding to our questionnaire, landowners indicated that they would be willing to allocate in the order of 10-13 per cent of their total land area to tree growing. However, when the land which they had suggested as being available was mapped, it amounted in reality to 85,860 acres, comprising 8.1 per cent of the total; this amounts to 10.2 per cent of the marginal area in the three county region.

In Table 50, the area of marginal land in the Western and Border Region (defined as all the contiguous counties in Map 4, i.e., all except Laois, together with Monaghan) is presented, together with family farm income arising in 1977 (the latest date for which county data are available).

We feel that 500,000 acres from this area – representing 8.4 per cent of the marginal land – could be allocated to tree growing to considerable financial advantage. Based on our discussions *vis-à-vis* returns to agriculture, energy crops and conventional forestry, we estimate that, if those areas where tree growing has the greatest net income generating advantage are chosen, an average increase in net income per acre per annum of £45 (1981£) could be achieved by the transfer.

The reader will note that here we extend our regional canvas beyond the confines of the three county border area, to embrace "the West". We do so because we believe that the evidence available from the many economic and social studies and soil surveys conducted by An Foras Talúntais supports the hypothesis that the analysis and conclusions of our three county area can be generalised to all of the counties which have more than half of their agricultural land classified as "marginal": the landowners in these counties

Map 4: *Counties in the Republic of Ireland with Greater than 50% marginal land*



Source: Table 48.

Table 48: *Extent of marginal land by county*

County	*Per cent*	*Acres*
A. TOTAL		
Leitrim	97	357,301
Donegal	80	942,346
Kerry	80	930,574
Cavan	76	347,696
Mayo	73	955,693
Clare	70	542,797
Roscommon	58	347,867
Galway	54	781,625
Sligo	54	237,933
Limerick	53	348,123
Laois	52	223,315
Monaghan	44	137,542
Wicklow	43	213,367
Longford	41	104,191
Cork	37	684,210
Offaly	35	172,589
Kildare	33	135,049
Tipperary	32	331,699
Carlow	22	47,395
Westmeath	21	91,361
Kilkenny	20	102,448
Wexford	15	89,439
Meath	13	77,852
Louth	13	35,231
Dublin	12	226,500
Waterford	8	35,028
B. BORDER REGION		
Leitrim	97	357,301
Cavan	76	347,696
Monaghan	44	137,542
		842,539

Source: Gardiner and Radford (1980), p. 139.

Table 49: *Marginal land area, by site type*

Category	*Acres*	*Percentage of total land area*
Mountain and hill	1,668,110	9.9
Hill	286,443	1.7
Wet mineral lowland	3,531,226	21.0
Blanket peat — high level	987,601	5.8
— low level	873,372	5.2
Basin peat	982,125	5.8
Total	8,324,917	49.4

Source: Gardiner and Radford (1980), p. 137.

Table 50: *Marginal land and family farm income, western and border region*

	Marginal land area (acres)	*Family farm income (000s 1977 £)*
Cavan	347,696	28,874
Clare	542,797	27,218
Donegal	942,346	20,820
Galway	781,625	43,066
Kerry	930,574	47,998
Leitrim	357,301	8,620
Limerick	348,123	47,663
Mayo	955,693	35,260
Monaghan	137,542	20,514
Roscommon	347,867	21,974
Sligo	237,933	15,858
	5,929,497	317,865

Sources: Table 48 and Ross (1980).

share the demographic and socio-economic characteristics of owners in the border area; the difficulties of generating an adequate income on marginal land from existing agriculture are also shared; productivity and the costs of establishing conventional forests and energy crop plantations will be close in magnitude to those which pertain in Cavan, Leitrim and Monaghan.

Regional Impact

Income

In terms of the Western and Border Region, once the total area was planted, this would add £22.5 million (1981£) annually to income; however, since it would be phased in – say at the rate of 25,000 acres per year,[32] the annual income supplement would be £1.125 million in the first year, building to £22.5 million over a 20-year period. This "ultimate" annual income gain amounts to 7.1 per cent of the 1977 aggregate family farm income. While this does not comprise a dramatic increase, it is by no means negligible. If it were concentrated in the poorer counties, the income effect could be proportionately greater. For example, if 20 per cent of Leitrim's marginal land area were so allocated, yielding an average net income increase of £45 per acre, the annual income increase would amount to £3.216 million, comprising 37.3 per cent of the farm income generated in 1977.

" New" income arising will have a positive multiplier effect in the regional economy, to the extent that there are underemployed labour and other resources available which are utilised as a consequence of the spending of the additional income, supplying inputs, and processing output. We will discuss these linkage effects further in our review of employment implications. The larger "the region" that is defined, the bigger, other things being equal, the multiplier effect is likely to be, since more economic activity is likely to be encompassed in the area under study. From the rather scanty evidence available,[33] we estimate that the net regional income multiplier would be about 1.3; with half a million acres planted, the net increment to regional income will be of the order of £29 million, amounting to 9.5 per cent of family farm income (1977).

Employment

The establishment of either energy crops or conventional forest plantations is not a labour intensive activity. In Table 7 the labour requirements for establishing an energy plantation were estimated:

Activity	*Labour requirement (hours) per*	
	Hectare	*25 acres*
Ploughing	15	150
Drainage	2.25	22.5
Planting	86.9	869
Fertiliser	20.45	204.5
	124.6	1,246

(footnotes 32, 33 overleaf)

Allowing 6 working hours per day, this yields 208 working days, or about a man year of employment to establish 25 acres of energy plantations. This understates the employment content to some degree, because the labour content in fencing and roading have not been included. However, even if the employment involved at crop establishment (25 acres) were doubled – to 2 man years – it would still be very low. The labour content in conventional forestry is likely to be even less, since the number of plants required per unit area is significantly lower. The employment involved in managing plantations in the pre-harvest stage is very modest, for both energy crops and conventional forestry.

The net direct effects of energy crops/conventional forestry on employment will depend on the labour intensity of the activity displaced, and on how landowners utilise any time made available as a result of investing in tree growing. Agriculture is more labour intensive, on average, in terms of on-land activity than either form of tree growing. However, since the latter would be phased-in over 20 years, and would in any event only take up in total 8.4 per cent of the marginal land area, we expect that the net reduction in employment resulting in farming would not be great. Overall, we judge that the regional impact, in terms of on-land employment, of the tree growing schedule outlined, will be either neutral or mildly negative.

Forward Linkage

For regions with underemployed resources, conventional forestry has the advantage that it generates a substantial volume of employment and income at the wood harvesting, transportation and processing stages, and that most of such activity takes place locally. It has the significant disadvantage that it is typically 15 years before the first harvest (thinnings) takes place, and the bulk of such benefits do not accrue until 35-40 years after planting.

Energy crops have the advantage *vis-à-vis* forestry that the harvesting cycle begins much earlier, but they suffer relatively in respect of the employment and income generated in processing. Sawmilling, in particular, is quite labour intensive, while direct combustion of wood is not. However, if the processing of wood to produce chemical fuel (methanol), pelletised animal feed, etc., became economically feasible, then the impacts in these respects would be more positive.

In order to establish a sense of the order of magnitude of the forward

32. Until recently, this was about the annual rate of planting achieved by the Forest and Wildlife Service.
33. See Baker and Ross (1975), and Ross (1972).

linkage employment impacts which might be expected, we arbitrarily assume that 250,000 acres of each of energy crops and conventional forestry are established over 20 years, that the energy crops have an annual average net production of 13 dry tonnes per hectare per year which is harvested on a 5 year cycle, and that conventional forestry plantations of average Yield Class 22 (22 cubic metres produced per hectare per year, but incorporating a 15 per cent reduction for losses due to fire, wind damage, insects and disease), are established, with thinning beginning in year 15, and clear-felling taking place in year 40.

The wood output from such regimes is presented in Table 51. Below we present estimates of the wood output requirement per full time equivalent job generated in harvesting transport and processing for sawlogs, pulpwood and energy crops (Table 52).

These estimates are very conservative: for conventional forestry we assume a rapid introduction of mechanisation in harvesting and processing, which will reduce the employment generated per unit of wood in these activities

Table 51: *Output from conventional forestry and energy crops, in cubic metres (M^3) (green wt.)*

Year	*Total area planted*	*Total harvest*			
		Energy crops		*Conventional forestry*	
	(acres)	*Dry tonnes*	M^3	*Pulpwood* M^3	*Sawlogs* M^3
1	25,000				
5	125,000	328,750	664,141		
10	250,000	657,500	1,328,283		
15	275,000	986,250	1,992,424	106,250	
20	500,000	1,315,000	2,656,566	428,000	
25		1,643,750	3,320,707	718,750	40,469
30				926,250	161,719
35				1,047,500	374,219
40				1,265,000	1,695,000

Notes: For energy crops, dry tonnes are converted to green (55% moisture) weight by dividing by 0.45; tonnes are converted to cubic metres by dividing by 1.1. It is assumed that 12,500 acres of both energy crops *and* conventional forest plantations are established annually for 20 years, to yield total areas of 250,000 acres each. Net energy crops production assumed to be 13 dry tonnes per hectare per year, harvested on a 5-year production cycle. Conventional forestry yield class (Sitka Spruce) 22 is assumed. The pulpwood and sawlog (including boxwood) harvests are taken from Appendix 11, adjusted to per acre terms.

Table 52: *Wood requirement per worker per year, harvesting, transport processing, energy crops and forestry*

	Wood requirement (M^3/worker/year)		
	Harvesting	*Transport*	*Processing*
Sawlogs	1500	7500	1000
Pulpwood	1200	10000	1200
Energy crops	1500	10000	3367

Sources: The sawlog and pulpwood estimates are updated from Convery (1979) pp. 136, 137, and Convery (1981). For energy crops, it is estimated that a 40 MW ESB station, employing 90 workers, will use 150,000 tonnes of dry matter or 303,000 M^3, comprising 3367 M^3 per worker.

to 50 per cent of present levels. For energy crops it is assumed that all of the wood is utilised in modern ESB power stations, which are highly capital intensive, and parsimonious in the use of labour. The consequences of applying these coefficients to output are presented in Table 53. The following employment projections emerge:

	Employment (man years)		
Year	*Energy Crops*	*Forestry*	*Total*
0		—	
5	706	—	706
10	1,413	—	1,413
15	2,119	189	2,308
20	2,826	750	3,576
30	3,532	1,929	5,461
40	3,532	5,285	8,817

Source: Table 53.

The ultimate employment level generated by conventional forestry is 50 per cent higher than that of energy crops, but the latter makes a substantial contribution much earlier on.

In terms of direct output-based employment, this is a gross rather than a net figure. If agricultural output is reduced thereby, the forward linkage forgone as a result should be netted out. However, as we noted earlier, we feel that the displacement will be slight, because of the gradual phasing-in (over 20 years) of what is in any event a relatively modest total share — 8.4 per cent — of the marginal land area. There is, in addition, the fact that the

Table 53: *Employment generated in harvesting, transport and processing, by energy crops and conventional forestry, for selected years Western and Border Region*

Year	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*
Energy crops (M³)	664,141	1,328,283	1,992,424	2,656,566	3,320,707			
Harvest (H.)	443	886	1,328	1,771	2,214			
Transport (T.)	66	132	199	266	332			
Process (P.)	197	395	592	789	986			
Total	706	1,413	2,119	2,826	3,532			
Forestry (M³)								
Sawlogs (M³)					40,469	161,719	374,219	1,695,000
H.					27	108	249	1,130
T.					5	22	50	226
P.					40	162	374	1,695
Tot.					72	292	673	3,051
Pulpwood (M³)			106,250	425,000	718,750	926,250	1,049,500	1,265,000
H.			89	354	599	772	873	1,054
T.			11	42	72	93	105	126
P.			89	354	599	772	873	1,054
Tot.			189	750	1,270	1,637	1,851	2,234
Total forestry								
H.			89	354	626	880	1,122	2,184
T.			11	42	77	115	155	352
P.			89	354	639	934	1,247	2,749
Tot.			189	750	1,342	1,929	2,524	5,285
Grand total								
H.	443	886	1,417	2,125	2,840	3,094	3,336	4,398
T.	66	132	210	308	409	447	487	684
P.	197	395	681	1,143	1,625	1,920	2,233	3,735
Tot.	706	1,413	2,308	3,576	4,874	5,461	6,056	8,817

Source: Derived directly from Tables 51 and 52.

forward linkage impacts of Irish agriculture are in any event very modest. If some of those employed in harvesting, transport and processing, would, in the absence of these plantations, be engaged in other economic activity in the region then employing them may not be a net gain.

On the positive side, the purchases by firms and workers involved in the harvesting/processing chain will have an attributable multiplier effect, as will the expenditure of the increased landowner income, to the extent that underemployed resources are mobilised thereby. However, it is very difficult to identify the magnitude of this "net" multiplier. Altogether, we feel that it is reasonable to assume that conversion of half a million acres of marginal land in the Western and Border counties, divided equally between energy crops and conventional forestry, would add about 9,000-10,000 jobs to the regional economy, but phased-in slowly over a period of 40 years. If the Border counties of Cavan, Leitrim and Monaghan share proportionately in this activity (planting 35,500 acres each of energy crops and conventional forestry), the additional employment resulting there will be of the order of 1,200-1,400.

Regional Impact: Summary

Overall, the regional impacts of an energy crops/conventional forestry investment programme are positive. If the payments for the use of the land for tree growing are made in the form of annual rentals, there will be an immediate net income increase, which will grow over time as the area planted increases. This income-boosting property is perhaps the most significant regional benefit. It is important to note that it is yielded by an investment which is self-amortising at real rates of interest in the range of 2-4 per cent; no element of subsidy is involved.

The on-land employment impact will be neutral, or perhaps slightly negative. The forward linkage employment impact is quite substantial, but it takes 35-40 years before it is fully realised. The increased income to landowners, and the expenditures by firms and workers engaged in harvesting, transport and processing, will have some multiplier effect on income and employment.

Energy Policy

If we use the 250,000 acres of private land devoted to energy crops as a benchmark, planted over 20 years, we find that, under the assumptions specified, from year 5, the output and energy contribution will be as shown in Table 54. By year 25, under the assumption specified, energy crops would amount to 7.6 per cent of the level of total primary energy consumption, or

34.5 per cent of domestic primary energy production, achieved in 1980. This overstates the actual contribution to primary energy, since the conversion efficiency of wood in most cases will be less than that of oil and natural gas, which account for the bulk of our primary energy consumption. Killen (1981) forecasts a primary energy consumption level in the range of 15.3-16.6 million TOE by the year 2000; taking 16 million TOE as the expected value, we find that the 25 year energy crops contribution projected would provide 3.9 per cent of this total. If all of the projected wood output were to be supplied to custom-built ESB power stations, then the 25 year wood output level would maintain a generating capacity equal to 12.2 per cent of existing installed capacity.

These are quite significant potential impacts; the 25 year output level would amount to 54 per cent of the energy contribution from peat in 1980, and close to the total energy equivalent output of Bord na Móna in that year. The strategic advantage of having a native resource, the environmental benefits of burning a low sulphur fuel, and the regional and national advantage of having the funds which are used to purchase it go to Irish rather than overseas interests, are complementary supporting arguments in its favour.

Northern Ireland

Since the land in the adjacent counties north of the border is of the same quality and productive capacity as that of the south, and since the area is also equally economically deprived, the advantages, in terms of return on investment, and regional income and employment of allocating a portion of the marginal land to energy crops/conventional forestry, are manifest. The region also imports almost all of its energy. However, it has a very large excess of oil-fired electricity generating capacity, so that as a market for wood, electricity generation does not look promising in the short term. It is interesting that the greatest interest in industrial utilisation of energy crop output in Ireland has come from a private manufacturing firm in Northern Ireland.

EEC

Much of Ireland's agriculturally marginal land is highly productive for tree growth. In this respect, the country is unique in a European context, so that the potential which we have identified is not directly transferable to other countries. However, since the EEC is a major net importer of both energy and forest products, the ability of a member state to expand its output of each of these in an economically efficient manner is of interest and value. We

Table 54: *Energy production from energy crops*

	Energy crop production		*Per cent of*		*Electricity generating capacity*[3] *(MW)*	
Year	*Dry tonnes*	*TOEs*	*Total primary energy*[1]	*Domestically produced primary energy*[2]	*Contribution*[4]	*Per cent of total*[5]
0						
5	328,750	125,000	1.5	6.9	76	2.4
10	657,500	250,000	3.0	13.8	152	4.9
15	986,250	375,000	4.6	20.7	228	7.3
20	1,315,000	500,000	6.1	27.6	303	9.7
25	1,643,750	625,000	7.6	34.5	379	12.2

Note: Assuming 12,500 acres planted each year for 20 years, with an average annual production of 13 tonnes of dry matter per hectare.

1. Amounting to 8.21 million tonnes of oil equivalent in 1980.
2. Including hydro (0.22), peat (1.15) and natural gas (0.49), amounting to 1.81 million TOEs in 1980.
3. Assuming 4333 tonnes of dry matter required annually per MW of capacity.
4. If energy crop output is devoted entirely to electricity production.
5. Capacity in 1980/1981 of 3117.1 MW.

argued that the reduction in agricultural output would be modest if an energy crops/conventional programme comprising 8.4 per cent of the marginal land area in the Western and Border Region were phased-in over 20 years: we assumed that the labour and other factors thereby "released" from agriculture would expand output on the remaining agricultural area, and that, in any event, the wood growing would tend to be concentrated on relatively low yielding agricultural sites. However, to the extent that there is a reduction, it should commend itself to the EEC, since milk and beef are both in surplus, and measures are being considered to discourage output.

Costs

In Table 55, we present the capital and rental costs of a 20 year equal-area energy crops/conventional forestry programme totalling 0.5 million acres, assuming that all of this land is leased at an average rate of £45 per acre. Total gross investment and rental outlays over the period will amount to £187.5 million and £236.25 million, respectively, totalling £423.75 million. However, from year 5 onwards, the energy crops will be generating revenue annually. Assuming a revenue of £17/dry tonne and an average output level of 13 dry tonnes per hectare (5.26 DT/Ac.), annual revenue will grow from £1.118 million in year 5 to £22.355 million in year 25 and thereafter, so that the revenues from the energy crops would be sufficient to cover the rental costs for both conventional forestry and energy crops at that stage. The bulk of conventional forestry revenues accrue after year 20. While the absolute magnitude of the total costs may seem intimidating, we estimated earlier that, given certain assumptions they can show a real rate of return in the order of 2-4 per cent, while the potential regional and energy policy benefits also appear to be quite substantial.

It is important to emphasise that reaping the benefits of the energy crops component, as outlined in this chapter, is contingent upon achieving the production levels assumed, i.e., an average of 13 dry tonnes per hectare per annum. While the evidence available from Northern Ireland relating to output on low lying wet mineral soils supports this assumption, we do not yet have enough data concerning production under field conditions to justify a full-blown investment programme.

Table 55: *Costs of crop establishment and rental outlays, energy crops and conventional forestry, 000s 1981 £*

Year	Total area (000s acres)	Establishment costs: Energy crops	Establishment costs: Conventional forestry	Establishment costs: Total	Rental costs	Grand total
1	25	6,075	3,300	9,375	1,125	10,500
2	50	6,075	3,300	9,375	2,250	11,625
3	75				3,375	12,750
4	100				4,500	13,875
5	125				5,625	15,000
6	150				6,750	16,125
7	175				7,875	17,250
8	200				9,000	18,375
9	225				10,125	19,500
10	250				11,250	20,625
11	275				12,375	21,750
12	300				13,500	22,875
13	325				14,625	24,000
14	350				15,750	25,125
15	375				16,875	26,250
16	400				18,000	27,375
17	425				19,125	28,500
18	450				20,250	29,625
19	475				21,375	30,750
20	500				22,500	31,875
Total		121,500	66,000	187,500	236,250	423,750

Note: Total area of 500,000 acres divided equally between energy crops and conventional forestry. It is assumed that per acre crop establishment costs amount to £486 and £264 for energy crops and forestry, respectively. Rental of £45 per acre per annum is payable to landowners with both crops.

Chapter 12

POLICY IMPLICATIONS AND SUGGESTIONS

We need to decide what, if anything, should be done about energy crops/ conventional forestry, who should do it, and how it should be funded.

It was demonstrated that, on certain sites, and given certain assumptions, both energy crops and conventional forestry could show a very attractive return compared with average returns in agriculture. We suggested that, on 8.4 per cent of the marginal land area in the Western and Border counties, an annual average net gain of £45 (1981 £) per acre could be achieved by converting this area to energy crops and/or conventional forestry. It is difficult to be precise on this, since we were not able to "match" agricultural output on a given acre with the returns yielded thereon by energy crops/conventional forestry. In addition, the extent to which per acre management and investment income or family farm income is the appropriate measure of net return to agriculture – it turns on the degree to which the landowner's own labour has an opportunity cost – will significantly influence the magnitude of the advantage which lies with tree growing. Nevertheless, we believe that our conclusion is probably conservative, since the acres yielding the greatest net return should first be converted; with less than 10 per cent of the total marginal area being devoted to energy crops/conventional forestry, diminishing returns are unlikely to have set in to a significant degree. How robust are the estimates of the returns to energy crops and conventional forestry?

In the case of conventional forestry, both the cost and productivity estimates are very soundly based, being derived from a long history of experience and work-study practice in the Forest and Wildlife Service. What is most uncertain is the price which can be obtained for the output. However, even at the low wood price estimate, the annual equivalent returns are positive in the higher yield classes at real interest rates of 2 and 4 per cent:

Annual equivalent per acre (low output price) in 1981 £

Yield Class	*.02*	*.04*
20	21	2
22	25	8
24	32	11
26	36	20

Thus, we feel that the risk of large losses attending investment in conventional forestry are relatively modest.

With energy crops, the spread of estimated future performance is much wider than is the case with conventional forestry. This is so because of our relative ignorance regarding costs, productivity and prices with these crops. With the best combination of factors the returns are very handsome, while with what appear to be conservative assumptions, returns are significantly negative. It will be necessary to narrow the margin for error before an investment programme can be advocated.

	Annual equivalent per acre (1981 £)	
	i = .02	*i* = .04
High[1]	137	125
Conservative[2]	– 23	– 29

[1] Production of 20 tonnes of dry matter per hectare; standing price per tonne of £22.
[2] Production of 10 tonnes of dry matter per hectare; standing price per tonne of £3.
Source: Table 27.

About one-third of landowners expressed interest in energy crop production, and indicated that 8.1 per cent of the total land area could be available for this purpose.

On about two-thirds of the acres available, renting was the preferred option; on over 20 per cent selling was favoured, while on only 9-15 per cent was the growing of energy crops by the owner preferred.

The evidence available indicates that the use of some of the marginal land in the Western and Border Region for tree growing is likely to be a sound financial investment, generating substantial regional income and employment benefits, and having favourable effects on energy policy and environmental quality. As such, it supports similar conclusions arrived at by one of the authors in a study undertaken for the National Economic and Social Council (Convery, 1979). To work towards the achievement of these ends, we suggest the following:

1. *Combined Programme*

In our analysis, we have presented energy crops and conventional forestry as two distinct and competing land uses. This clarifies issues and facilitates comparisons, but it is misleading. It would be mutually advantageous to consider both activities in combination, for the following reasons:

(i) It spreads the risk. If, for example, there is a collapse in energy prices, then the forest products component can mitigate the adverse impact, some of the energy crop output can be channeled to work processing industries, and vice versa.

(ii) The early returns — from year 5 on — yielded by energy crops complement the later returns by conventional forestry. This should make financing easier to obtain, and should also make tree growing more attractive to older landowners.

(iii) The market opportunities for energy crop output can be highly localised and site-specific. If a high-paying market, e.g., industrial/institutional, is fully supplied, the remaining opportunities (if any) may be relatively unattractive. Conventional forestry can be used to "fill in", and allow energy crops to take their most favourable market niches.

(iv) If the two are treated as distinct and competing entities, the opportunities to draw fully on the silvicultural possibilities — e.g., allowing about 250 stems per hectare to grow to sawlog size in an energy crop — are unlikely to be fully explored. The territorial imperatives driving the professional and institutional interests will probably result in the fostering of mutual antagonisms which are inimical to progress.

2. *Research/Demonstration*

In our analysis of energy crops, we assumed productivity levels in the range of 7 to 20 tonnes of dry matter per hectare, with a presumption that actual average output was likely to fall in the range of 10-15 dry tonnes per hectare on the wet mineral soils. Evidence in support of this assumption is provided by the very high productivity of existing conventional forestry species on the marginal soils in question, and by results from a few experimental plots in Northern Ireland. However, these are insufficient data on which to base a major investment programme.

It is important that we get better estimates of the output which can be expected to be achieved by energy crops on a variety of sites under normal management conditions. Many of the experimental plots established in the Republic were designed to show the extent to which various species could survive. They are not appropriate for providing generalisable yield data. We endorse the undertaking of a major demonstration phase under the direction of Bord na Móna and partially funded by the EEC. This will generate some of the desired production data. However, this project is confined to peatlands (including cutaway) under State jurisdiction. No information will be provided by this project concerning wet mineral soils, or the problems and opportunities of establishing and managing energy crops on privately owned land. Since the bulk of the potentially usable marginal land is privately owned, and the wetland mineral sites are among the most productive in the country, this is a serious deficiency in the demonstration phase of the R+D programme.

We strongly recommend that the demonstration phase be extended to include privately-owned wet mineral soils. This should be designed so as to provide actual field-production data on productivity, costs of crop establishment and harvesting, and information on the most appropriate means of involving private landowners. It is essential that this latter element be addressed. It is easy for researchers to confine their attention to the derivation and interpretation of physical production data, the estimation of costs and returns, etc.; such work can be done in a rigorous fashion with verifiable results. However, if the unique potential of the wet mineral soils for tree growing is to be harnessed successfully, it will be necessary to address the ownership issue, a topic to which we now turn.

3. *Private Landowner Participation*

Our survey results showed a marked preference among landowners for the option of renting their land for tree growing. "Growing their own" was the least favoured means of participating. Since 73 per cent of the members of the landowning population are above 46 years old (52 per cent are 56 years +) this is not surprising. Few people in later life hold their posterity in such esteem that they are willing to make big sacrifices in terms of income so that their successors can prosper. Among the third of the landowning population which is single, this reluctance is likely to be especially pronounced.

Although this difficulty applies with particular force to conventional forestry, with its 30-40 year lag before the bulk of the returns are yielded, it is also germane to energy crops. Although, in the latter case, the payoffs start after 5 years, there are heavy crop establishment costs to be incurred and it is necessary to leave the crop producing for about 25 years if maximum net returns are to be achieved.

We feel that any scheme to encourage private tree growing in the socio-economic circumstances obtaining in the border region will have only limited success if it does not provide net income immediately to the landowner. We therefore predict that the very generous tree planting grant scheme now available as part of the Western "package" will not achieve much in the way of afforestation; it does not address the fundamental needs of most of the local landowning population.

However, since a proportion, albeit a small one, of landowners do express interest in participating themselves, they should be facilitated and encouraged to do so. It may well turn out that there is a demonstration effect; as landowners see their neighbours getting involved, their own reluctance to do so may diminish.

4. *Markets*

We devoted a considerable effort to identifying the price implications of markets for the outputs of both conventional forestry and energy crops. We discovered that there was no published in-depth analyses of wood energy markets, while there was likewise not much available on conventional forest-product markets. With regard to the former, the demonstration phase should be designed so as to yield information in this regard. The following illustrates the manner in which this might be incorporated. There is one firm in Northern Ireland which has expressed interest in providing the bulk of its energy requirements from wood. This provides a useful opportunity to test the viability of supplying energy to an industry from wood grown on land surrounding the plant. All of the production, cost and willingness to pay data could be compiled and analysed.

The market analyses which we have conducted have of necessity been rather in the nature of an overview. Much more detailed investigations into the quantity and price implications of the various outlets need to be undertaken. As the wood output from the demonstration project now underway on cutaway bog gets fed to an ESB station, the market and price implications should be carefully monitored.

The extent of the domestic market is unknown; associated matters, such as the form and quantity of wood preferred by households, storage requirements, etc., remain largely unexplored.

5. *Wood for Electricity Generation*

Our discussion of domestic, commercial and institutional markets was of necessity cursory, in part because custom-designed wood burning units for these outlets are not available. Likewise, quality of discussion of the electricity-generation wood-use option was impaired by the fact that there is no power station designed for wood-burning; our only field performance data come from very old — and inefficient — sod-peat burning stations which have taken some wood-chips.

The data on which our assessment of a new custom-built wood-burning unit are derived are based on estimated costs and efficiencies. It is important that these assumptions be tested by practical experience. For example, it was argued by reviewers of an earlier draft of this paper that the assumed conversion efficiency for a new 40 MW wood-burning plant — 29.5 per cent — was too low, and that there was no reason why a new wood-fired unit, burning appropriately dried wood, should not have efficiencies close to those projected for achievement in the coal-fired plant at Moneypoint. It is difficult to evaluate the legitimacy of these and related comments in the absence of rigorous and appropriately funded demonstration work.

With the recession-induced curtailment of growth in electricity consumption and the pending completion of the 900 MW of coal-fired capacity at Moneypoint, the ESB is going to have a significant excess of generating capacity. It is receiving a large allocation of natural gas for which it has been charged a price below the energy equivalent price of heavy fuel oil, although the latter is a less attractive fuel in a number of respects. Oil prices – in dollar terms – have stabilised and even shown some real decline in 1982. All of these factors combine to produce a sense of complacency regarding future energy availability and price generally, and a lower sense of urgency regarding the investigation of indigenous sources. As noted above, the pressures and incentives facing the ESB in particular are calculated to diminish the enthusiasm and resources which the agency devotes to the investigation of longer-term and seemingly intractable problems associated with the use of potentially indigenous energy sources. It would, in our view, be very unfortunate if this coincidence of circumstances were to result in the reduction, or even elimination, of the resources devoted to the investigation of wood as a fuel for electricity generation. It may be that this is a form of conversion which will never be economically or socially viable on any significant scale. However, given the seemingly very high inherent productivity of our land for wood growth, and our high degree of dependence on energy imports, it is a proposition which deserves to be seriously and comprehensively investigated before a decision is made. We recommend that this be undertaken.

The price of electricity is based on the costs of operation and distribution. We did not trace the implications for electricity prices of a substantial energy crops programme directed to supplying electricity generating stations. Until we know more about wood growing productivity (see point no. 2) and costs of growing, harvesting, transporting and converting, we cannot estimate the price at which wood will be delivered to a station, and therefore, cannot assay the consequences for electricity prices. When reliable data on these matters are available, then the electricity price effects can be derived.

6. *Northern Ireland*

Since the biological productivity and socio-economic circumstances are common to both sides of the border, and research is also being conducted north and south, there is considerable logic in designing an integrated programme of research and demonstration, leading to a co-ordinated investment programme, if (as seems likely) such is warranted.

7. *Some Institutional Considerations*

It is clear that there is a substantial volume of work being undertaken in the energy crops area (see Chapter 1). We sense that it is now time to give a little more centralised direction to these efforts. Thus far, the NBST has encouraged and cajoled but has not had the authority or perhaps the inclination to direct. Because of the manner in which a number of organisations with different goals and research traditions initiated work at different times, it is difficult for the outsider to interpret what some of the results imply, the extent to which they can be generalised from, the overall priorities they suggest, and so on. While we feel that the diversity of interests involved has been beneficial, we think that it would now be worthwhile to integrate the resulting information into a cohesive whole, involving establishing priorities for the future, developing the full policy implications of existing research results, standardising terminology, estimation and reporting procedures, and allocating resources and personnel to the areas needing them. There is now a sufficient volume of work underway such that the integrative role deserves high priority. As the time for major policy decisions approaches, it is important to have available an authoritative overall view. Responsibility for this should either be explicitly delegated to the NBST or taken on by the Department of Energy.

The above discussion begs the question as to which agency should actually be given central responsibility for carrying out a policy of assuring that tree growing of a desirable mix, quality and quantity takes place on the appropriate privately owned land. We are assuming that Bord na Móna will maintain responsibility for such activity on the cutaway land under its jurisdiction.

There are a number of choices:

(i) Bord na Móna: The limitations with this mechanism are three-fold. The agency has relatively little experience of dealing with large numbers of landowners on a continuing, co-operative basis (although its new role in encouraging private turf development may alter this); it would not be easily able to combine a consideration of energy crops with conventional forestry; it would have to develop staff virtually *de novo* to fulfil the assignment.

(ii) The Forest and Wildlife Service: This agency already has statutory authority *vis-à-vis* the encouragement of private forestry, and also has considerable expertise and experience – both research and field – in the establishment and management of tree crops. However, it too suffers from a number of limitations. Although it has responsibility for private forestry, the achievements in this respect have been very modest. The establishment of a State forest estate has been the primary institutional preoccupation. Although private forestry has been given more attention in recent years, it is not certain that the Service, with its dual technical/administrative Civil Service structure, has the institutional flexibility and marketing abilities to overcome the very substantial obstacles which have to be overcome.

It does not have day-to-day dealings with landowners, and its relationships in this respect are often not the most cordial, because of the parsimonious land pricing policy the agency has had to follow in the past in its acquisitions. The bulk of the organisation experience has of necessity been concentrated on coniferous species planted on upland sites, and this in turn has engendered professional traditions and preferences which may not yield easily to embrace the use of coppicing hardwood species. It is not without significance that in both Northern Ireland and the Republic the early work and initiative in this field did not come from the two Forest Services.

(iii) ACOT: ACOT has the considerable advantage of being in frequent contact with landowners, and of advising on land-use and farm management practice. It has experience of dealing with field drainage and other major land-related capital investments. However, many agricultural advisers seem to know very little about tree-growing and have little interest in its promotion: only 1 per cent of those landowners interviewed who have planted trees listed advice from their agricultural adviser as the most important reason for so doing. The organisation would therefore have to acquire the relevant skills, and, perhaps more importantly, accept tree growing as an integral and worthy component of the farm enterprise.

(iv) Create a new agency with singular responsibility for achieving energy crop/conventional forestry targets on private land: this has the potential of harnessing the *esprit de corps* which is often associated with new agencies which have a clearly defined mission and are given the financial and statutory resources necessary to its achievement. However, this would involve substantial "start-up" costs, the acquiring of all of the necessary technical skills, and would probably engender serious and perhaps performance-damaging tensions with related agencies.

In NESC Report No. 46 ("Irish Forestry Policy"), one of the authors put forward some institutional proposals *vis-à-vis* Irish forestry which are germane (Convery, 1979). There, it was suggested that an umbrella Forest Authority be established within which would serve three interdependent components, all with a unified management structure: a unit to manage and extend the existing State forest area (the Forest and Wildlife Service), a Forest Products Development Board to promote forest product development and marketing, and a unit to promote tree farming on privately owned land. This system would draw effectively on existing technical and administrative resources. However, there has been no official endorsement, or overt interest, in these proposals, so that there is some question as to their administrative/political feasibility and/or attractiveness.

To sum up, there is no existing institutional framework which is ideally suited to the carrying out of policy on privately owned land in the energy crops area. There are a number of possible approaches, as outlined above. As the energy crops development work moves more vigorously into the demonstration phase, these and other options should be examined in some detail, so that the best approach can be quickly acted upon when it is appropriate to do so.

Funding Mechanisms

Before examining possible sources and methods of funding, it is useful to raise the issue as to why any Government intervention is necessary in this area.

Rationales for Public Intervention

If the return from tree growing on a particular area exceeds that yielded by agriculture, will not self-interest on the part of the landowner guide the land into this higher yielding use? If the necessary conditions for the operation of reasonably competitive markets exist, then, on economic efficiency grounds, intervention would not be warranted. When these conditions are not met, then the market is said to fail. Identifying the manifestations of market failure in the use of conventional forestry/energy crops provides an entry point to the discussion of the most cost-effective means of policy intervention:

(i) Landowners are unaware of the investment opportunites.

This is clearly the case with energy crops – indeed it could be said that the investment opportunities in this area do not yet exist – but our survey also showed a high degree of ignorance among landowners concerning conventional forestry. Since the agricultural adviser was cited by the majority of landowners as their preferred source of information, it follows that advisers should be especially well informed if the ignorance problem is to be overcome. More general education, in schools, through the media, etc., could also help, by providing some background, and creating an atmosphere of acceptability for tree growing. The use of demonstration tree farms to illustrate techniques and opportunities, could do likewise.

(ii) High rate of time preference by landowners and financial institutions.

With a predominance of landowners being elderly, they cannot expect in most cases to reap the bulk of the return on the investment in tree growing. If intermediary markets in immature plantations developed, then this difficulty could be ameliorated. Thus, a plantation could be established and sold-on after a few years, and the initiator would reap the profit. A difficulty which inhibits this practice from becoming widespread is the strong sense of identity with a place which is said to characterise landownership in Ireland. Since residence and land usually go together, the latter cannot be traded as readily as a commodity such as wheat. Financial institutions also tend to have planning horizons shorter than those associated with conventional forestry; energy crops are likely to be more attractive in this regard. It is notable that the first major investment by private financial interests in forestry in Ireland is being made in already established plantations,[34] where the risk of loss is reduced and the period to crop harvesting is shortened.

Investment by the public in the early years, to shorten the period during which private funds must be committed, the payment of annual rentals for the use of land for tree growing, and the encouragement of intermediary markets where the ownership of land is not an inhibiting factor, are all approaches to overcoming this form of market failure.

(iii) Sensitivity concerning forms of private landownership.

There is some grudging acceptance of the legitimacy of Government as a large-scale acquirer of land for afforestation and turf development. However, this tolerance is unlikely to be extended to private interests – e.g., financial institutions – if they become owners of very large areas.

(iv) External benefits of tree growing.

An external benefit is defined as a benefit for which the producers thereof are not compensated. Thus, at combustion, energy crops are more environmentally benign (emitting only a negligible amount of sulphur) than oil or coal (especially the latter), and they have security of supply, balance of payments and employment generation advantages over imports. None of these benefits are capturable by the private investor in energy crops.

(v) A single major purchaser (monopsony).

Since in the case of energy crops, the ESB is a major prospective purchaser, its behaviour will be of great significance for energy crop prospects. If the utility gets a fuel – e.g., natural gas or peat – at a price below the market-clearing level, this could reduce its willingness to pay for wood.

34. By the Allied Irish Investment Bank.

In addition to the above economic efficiency rationales for some form of public intervention, there can also be equity arguments. If a group of relatively economically deprived individuals, and/or those in a poor region, would benefit from such intervention, then this provides a complementary justification for same. It is important to note, however, that we confined our analysis to rather narrowly defined financial efficiency concerns. We did so for two reasons: this is an aspect which can be quantified and analysed with a reasonable degree of rigour; secondly, if the financial returns proved to be promising, then it would not be necessary to introduce these further – less quantifiable – contributions. They enhance – to a degree unspecified – the force of the conclusions flowing from the financial analyses.

Consistent with our approach to this analysis, so long as it is accepted that the bulk of Ireland's farm land is to remain privately owned, we favour parsimony in the manner and extent to which the State intervenes; such intervention should be calibrated so as to achieve the desired objectives in a cost-effective manner.

Financing Strategies

There are three broad strategies available for encouraging tree growing on private land, which can be used singly or in combination: the planting grant, which is already available; payment by the State for rental for tree growing in the early plantation years, with appropriate share of subsequent revenues; the use of tax concessions.

Tax Concessions

This proved to be very successful in the United Kingdom, with annual planting on private land in Great Britain amounting to about 50,000 acres annually in the 1970-75 period. Expenditure on afforestation could be deducted from current income in arriving at taxable income. With high marginal tax rates, this made such investments very attractive. In general, land was purchased and planted by intermediary companies, and then sold on. It is unlikely that such an approach, involving relatively large scale land acquisitions by "outside" interests, would be feasible in Ireland, given our attitude to land tenure and ownership. It also raises equity issues, and can be a blunt and relatively expensive (in terms of Exchequer receipts forgone) means of compensating for market failure. In the UK, its success was facilitated by the development of a market for "immature" plantations. Costs of plantation establishment cannot be "expensed" against current income in arriving at taxable income in Ireland.

Planting Grants

The magnitude of the planting grant available depends on the location of the land in question. In the West – defined as Counties Cavan, Clare, Donegal, Galway, Kerry, Leitrim, Longford, Mayo, Monaghan, Roscommon, Sligo, West Cork, West Limerick – there is a grant available covering 85 per cent of approved costs, up to a maximum of £324 per acre, paid in two instalments: 75 per cent at crop establishment and 25 per cent after four years. In the rest of the country, the grant available amounts to £125 per acre paid in three instalments: £65 at crop establishment, £25 in year 4 and £35 in year 8. In addition, there is a further grant of £60 per acre available for the planting of Poplar and other hardwoods.

The Western grant is available as part of a Western aid package, the latter amounting in total to £300 million. Six per cent of this, i.e., £18 million, is available for private forestry, to be disbursed over a ten-year period, beginning in 1981. A provisional planting target of 60,000 acres has been established.

We estimated earlier that the average on-site costs of establishing a conventional forestry and an energy crops plantation amount respectively to £264 and £450 per acre. Thus, the maximum grant levels per acre now available in the West – £324 for conifers and £384 for hardwoods – are very generous. They should be at a level sufficient to interest the private entrepreneurial investor and some of those landowners who are young, have some agricultural land yielding low or negative rents, and have off-farm income (11 per cent of landowners in our survey said that they had off-farm income in excess of £5,000 (1980 £) per annum).

However, for the bulk of landowners, to achieve commitment of a significant proportion of their land to tree growing will require that they continue to earn some income therefrom. Our survey results indicate that some form of annual rental payment for the use of land for tree growing was favoured by a majority of landowners. Although we understand that private interests have become involved, on a very small scale, in the payment of rentals to landowners for allowing their land to be used for tree growing, this mechanism has not thus far been utilised by the State. We believe that this approach is sufficiently promising to deserve a trial. We recommend that the extension of the demonstration phase in energy crops, which we suggested earlier, be designed to incorporate a rental dimension, whereby an annual payment is made to a number of landowners for the right to grow wood on their land, over, let us say, a 10-15 year period. In order to get a sense of real (as opposed to the hypothetical) willingness to participate at a given price, the opportunity should be advertised, and the price and requirements for participation pre-specified.

There are a number of possible funding sources. In addition to the Western

Development package, of which £18 million is allocated to forestry over ten years, there is also the Non-Quota Regional Development Fund, of which £21 million is allocated over five years to border projects. The European Investment Bank has already made a loan to help finance road-construction and other activities in State forests. In NESC Report No. 46 (Convery, 1979) means of linking up such sources with existing farm-retirement and other programmes are outlined. We recognise that having the State buy-in to a portion of the tree crop, by making the early-on rental payments, is unconventional, falling as it does outside existing administrative and financing procedures. However, given the scope of the opportunity, and our sense – which is not rejected by the landowner survey results – that the rental (or similar) approach is necessary to achieve the desired results, we feel that some venturesomeness, at least on a pilot study basis, is called for. The financing could be done exclusively by the State, or combined with private capital.

Both conventional forestry and energy crops have the great advantage that investments at the margin can be quite modest. With an incremental approach, as silvicultural and engineering experience and knowledge regarding landowner behaviour all grow over time, programmes can be adapted, cut-back, expanded, etc., as appropriate, with relatively little loss.

Chapter 13

SUMMARY AND CONCLUSIONS

Based on a site survey of land available (at a price) for tree growing in counties Cavan, Leitrim and Monaghan, it was shown, using well documented costing and productivity assessment procedures, that conventional forestry could yield a net annual return on many sites significantly in excess of the average now generated by agriculture. This supported conclusions reached earlier, from a much smaller data base in NESC Report No. 46 (Convery, 1979).

Although there is at present a wide range of research underway, we do not yet have information on costs, productivity and prices with energy crops which is in any way comparable in quality to that which is available for conventional forestry. However, making plausible assumptions based on what evidence is available – including the known productivity of conventional forestry – we concluded that, as in the case of forestry, energy crops could in certain circumstances significantly improve landowner income. The price achievable for the output was of particular significance as a determinant of net revenue generating capacity.

As a means of providing context, we assumed that 500,000 acres, divided equally between energy crops and conventional forestry, would be established in the Western (including the Border) counties; this amounts to 8.4 per cent of the marginal land in this region. We assumed, based on a comparison of returns from tree growing and agriculture, that it would be possible to increase landowner net income by an average of £45 (1981 £) per acre per year. If all of the 500,000 acres were planted in equal annual increments over a 20 year period, and the land was rented from landowners, rental income accruing to them would grow from £1.125 million the first year to £22.5 million in year 20, the latter amount representing 7.1 per cent of 1977 family farm income for the region. It was estimated that employment in harvesting, transport and processing would increase from about 700 in year 5 to over 4,000 in year 20, reaching almost 9,000 forty years after programme initiation, as the first conventional forestry crop is clear-felled. There would be positive multiplier effects, resulting from the purchases of firms and the expenditure by landowners and workers in harvesting, transport and processing of their increased income. However, against these positive effects must be set the reduced activity caused by the lowering of agricultural output and the labour and other resources which are withdrawn from other activities. There is also the larger question as to the possible regional effects which would have been engendered (but must now be forgone) if the money invested in tree growing has instead been allocated to other activities. Thus, while we feel that the "net" regional multiplier is positive, we were unable to estimate it.

Annual investment and rental costs would grow from £10.5 million the first year to about £32 million in year 20. Given the medium range of price and productivity assumptions, revenues from energy crops alone would amount to over £1 million in year 5, growing to about £23 million in year 25. The bulk of forestry revenues accrue after year 20.

In terms of energy policy impact, 250,000 acres under energy crops would produce sufficient energy – assuming a net annual dry matter production of 13 tonnes per hectare – to meet 7.6 per cent of total primary energy consumption, or 34.5 per cent of domestic primary energy consumption in 1980; this is close to Bord na Móna's total energy contribution in 1980. (The share of total primary energy overstates the significance of wood, since the latter is less efficiently converted to useful energy than oil and gas.) The output of a quarter of a million acres would supply 380 MW of electricity generating capacity, amounting to 12.2 per cent of existing capacity. Under the assumptions specified, it would take about half a million acres of energy crops to supply 600 MW of capacity (29.5 per cent conversion efficiency) which is the size generally proposed for a nuclear power station in Ireland. If the nuclear unit had a conversion efficiency in excess of 29.5 per cent – as it almost certainly would have – the land requirement to provide an equivalent amount of electricity output with wood would be larger.

The case for conventional forestry is quite robust, while that for energy crops is also promising, but further work is required before the launching of a fully-fledged programme would be warranted. To advance the time when a decision in this regard can be taken with some assurance, the following steps are suggested:

That conventional forestry and energy crops be treated as complementary activities. Combination would facilitate risk-spreading, provide early-on returns, allow energy crops to take their most favourable market niches and maximise the silvicultural possibilities.

Develop demonstration projects for both conventional forestry and energy crops on privately owned lands, with a focus on the wet mineral soils. These pilot schemes should be designed to provide information on productivity, costs and the most appropriate means of involving private landowners under actual field conditions. Rental should be emphasised as one means of getting participation.

The market potential for energy crop output should be explored more vigorously than heretofore. This should take the form of both desk studies and pilot utilisation schemes. The latter should involve industrial, domestic and electricity generation users. In such cases, costs, efficiencies, etc., should be monitored so that valid comparisons can be made across users.

A large volume of heterogeneous work has already been undertaken, mainly under the general inspiration and guidance of the NBST. It is now time to integrate the resulting information into a cohesive whole, involving the standardisation of terminology, estimation and reporting procedures, the development of policy implications of existing work and the establishment of policy priorities for the future. Responsibility for this should be either explicitly delegated to the NBST or taken on by the Department of Energy.

There is no existing institutional framework which is ideally suited to the carrying out of private land rental/leasing for tree growing. The various options should be examined in some detail, so that the best approach can be quickly acted upon when it is appropriate to do so.

If the results of the demonstration, marketing and institutional studies prove to be sufficiently promising – as we suspect will be the case – an integrated energy crops/conventional forestry programme should be designed and implemented, with appropriate specified targets and implementing procedures.

Given the coincidence of interest in Northern Ireland and the Republic in this area, we feel that there is merit in attempting to mount an integrated demonstration phase embracing both parts of Ireland. If the results are appropriate, it would also be logical to continue this co-operation into programme implementation.

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LIST OF ABBREVIATIONS AND OF IRISH TERMS USED

ACOT:	An Chomhairle Oiliúna Talmhaíochta (Council for Development in Agriculture)
AFT:	An Foras Talúntais (The Agricultural Institute)
Bord na Móna:	Irish Peat Development Authority
FWS:	Forest and Wildlife Service
ESB:	Electricity Supply Board
NBST:	National Board for Science and Technology
NIHE:	National Institute for Higher Education

APPENDIX 1

Socio-Economic Aspects of the Border Region

The border county region is recognised as one of the most disadvantaged regions within the EEC; the area is characterised by a low population density, high unemployment, emigration and low incomes. In addition, much of the labour force is in agriculture, even though most of the region is categorised by the EEC as "more severely handicapped" or "less disadvantaged" for agriculture. A recent classification of Irish soils (Gardiner and Radford, 1980) lists the border area as being largely of marginal quality land.[35]

Extent of marginal land by county

County	*Marginal land as per cent of total land area*	*Acres*
Leitrim	97	357,301
Cavan	76	347,696
Monaghan	44	137,542

Source: Gardiner and Radford (1980).

The extent of marginal land is particularly high in Co. Leitrim (97%) as compared with 40 per cent for the whole country.

Population

In Ireland, population declined from the mid-nineteenth century until 1961, when the trend reversed. Since then, national population has increased steadily.

Percentage change in population in border areas and at national level

County	*1901-1961*	*1961-1966*	*1966-1971*	*1971-1979*
Leitrim	–5.9	–8.7	–7.2	–1.1
Cavan	–4.4	–4.5	–2.6	+1.3
Monaghan	–3.8	–2.9	+1.1	+5.5
State	–1.1	+2.3	+3.3	+8.0

Source: Census of Population.

35. "Marginal land" is defined by the authors as areas which (p. 137): "fall either at or below the no rent (or extensive) margin for the particular uses considered . . . the term marginal refers to areas with natural limitations imposed by soil, topography or climate".

The three counties exhibited continued population decline through the initial period of national growth, 1961-1966; population growth started for Co. Monaghan in 1966 and for Co. Cavan in 1971. However, at the 1979 Census, Co. Leitrim was still registering a population decline of 1.1 per cent, while for the same period, national population grew by 8.0 per cent.

Employment

The border region is characterised by relatively high unemployment particularly in the North West/Donegal region:

*Percentage unemployed among currently insured persons, at mid-March 1980**

Planning region	*Percentage unemployed*
North East (Cavan, Monaghan, Louth)	11.1
North West (Sligo, Leitrim)/Donegal	16.2
All regions (State)	9.3

Note: The CSO does not publish unemployment statistics on a county basis.
Source: Central Statistics Office, (1980), p. 141.
*Employment in agriculture, fishing and private domestic service excluded.

Percentage unemployed is the number of currently insured persons on the Live Register of Unemployment as a percentage of the estimated currently insured population.

The sectoral breakdown of employment in the three counties is as follows:

	Agriculture, forestry and fishing	*Industry*	*Services*
Cavan, Monaghan, Leitrim	32.6	30.6	36.8
State	20.8	31.2	48.0

Agricultural Output

Over the 1960-77 period, Counties Cavan and Monaghan have shown considerable growth:

Volume of agricultural output, 1960-1977 gross output volume (£)*

	1960	*1977*	Δ *1977-1960*	%Δ
Leitrim	8730	9572	842	10
Cavan	16705	35905	19200	115
Monaghan	13404	29968	16564	124

*Money output adjusted to volume using the Agricultural Output Index.
Source: Convery (1980), p. 18.

Co. Leitrim, on the other hand, has exhibited very little growth in the 17 year period.

Northern Ireland

Unfortunately, socio-economic statistics are not available on a county basis, but do exist for the border region encompassing the District Council areas of Derry, Strabane, Omagh, Fermanagh, Dungannon, Armagh, Newry and Mourne. This area, like the border region in the Republic, is characterised by severe socio-economic problems, including high unemployment, low incomes, high dependence on agriculture, low population density and a high birth rate. The border area embraces 47 per cent of the total land area and 25 per cent of the total population.

1. *Unemployment.* Based on employment data for travel-to-work areas, (which approximate District Council areas), unemployment ranged (1980) from 16 per cent in Armagh to 29 per cent in Strabane, with an average of 23 per cent for the entire border area.

2. *Low incomes.* A proxy for intra-regional income statistics (which are not available), is the rateable value of domestic property (at mid-1979). Values range from 90 per cent of the Northern Ireland average in Armagh, to 73 per cent in Fermanagh. This, combined with high unemployment and a large dependence on agriculture, implies relatively depressed incomes in the border region.

3. *High dependence on agriculture.* As compared with the overall Northern Ireland figure of 10 per cent (1978), the average percentage of the total population employed in agriculture in the border areas was 28 per cent (excluding Derry).

4. *Birth rate.* The birth rate (live births per 1,000 population) in the border area (1977) averaged 19.8, as compared with 16.5 (Northern Ireland) and 11.8 (GB).

Overall

While the region as a whole can be categorised as relatively economically deprived, there has been, over the past two decades, substantial agricultural development in Cavan and Monaghan, but modest progress in this regard in Leitrim. The landowning population is relatively old and lacking in formal education, with 45 per cent of owners being single or widowed. A land-use activity which significantly increased net incomes per hectare would clearly be of regional benefit.

APPENDIX 2

Primary energy consumption, Ireland, 1960-1981 (Millions of tons of oil equivalent)

Year	*Hydro*	*Peat*	*Coal*	*Oils*	*Natural gas*	*Total*
1960	0.63	1.28	1.16	1.16	–	4.23
1961	0.41	1.25	1.25	1.48	–	4.39
1962	0.32	1.26	1.05	1.75	–	4.38
1963	0.31	1.28	1.03	1.78	–	4.40
1964	0.34	1.30	0.93	2.06	–	4.63
1965	0.35	1.03	0.92	2.31	–	4.61
1966	0.31	1.17	0.94	2.55	–	4.97
1967	0.29	1.27	0.89	2.95	–	5.40
1968	0.19	1.39	0.94	2.53	–	5.05
1969	0.14	1.35	0.87	2.98	–	5.34
1970	0.20	1.17	0.92	3.45	–	5.75
1971	0.12	1.26	0.75	4.65	–	6.78
1972	0.19	1.22	0.63	4.78	–	6.82
1973	0.18	1.09	0.57	5.24	–	7.08
1974	0.21	1.13	0.54	5.33	–	7.21
1975	0.14	1.17	0.43	5.05	–	6.79
1976	0.16	1.19	0.49	5.20	–	7.04
1977	0.20	1.24	0.52	5.53	–	7.49
1978	0.19	1.18	0.55	5.78	–	7.70
1979	0.21	1.16	0.79	6.24	0.26	8.66
1980	0.22	1.15	0.73	5.62	0.49	8.21
1981	0.22	1.11	0.69	5.07	0.92	8.01

Sources: Personal communication from John Brady, National Board for Science and Technology, for 1960-67 data. *Energy-Ireland,* Department of Industry, Commerce and Energy, Government Publications, Dublin, 1978, p. 17 for 1968-1977 data. *Energy in Ireland,* issues for 1978, 1979, 1980 and 1981 for 1978-81 data.

APPENDIX 3

Productivity, area and forest establishment costs by soil type. Costs in 1981 £

Lot no.	*Yield class (conifers)*	*Productivity class (hardwoods)*	*Gley*			*Peaty gley*			*Peat*			*Good mineral*			*Swamp*		
			Area	*Total cost*	*Cost per ac.*	*Area*	*Total cost*	*Cost per ac.*	*Area*	*Total cost*	*Cost per ac.*	*Area*	*Total cost*	*Cost per ac.*	*Area*	*Total cost*	*Cost per ac.*
1	22	G	4	737	184												
2	16	P				1	246	246									
3_1	24	G										12	4468	372			
3_2	20	G										6	684	114			
4	14	P													1	219	219
6	16	P													16	10663	666
7_1	16	P							3	639	213						
7_2	20	G				2	365	183									
8_1	16	M	2	361	180												
8_2	22	G										1	101	101			
9	14	P				2	710	355									
11_1	22	G										1	161	161			
11_2	24	G	1	101	101												
12	16	M							2	290	145						
13_1	16	P							1	134	134						
13_2	16	P													1	190	190
14_1	24	G										4	423	106			
14_2	24	G	3	319	106												
15_1	18	P							7	3128	447						
15_2	18	P							1	162	162						
15_3	18	M							3	696	232						
16	16	P							4	599	150						
17	18	P													1	241	241

APPENDIX 4

Evaluation of land suitability for energy crop production

Resp. code [| | |] (1–4)

1. Name of landowner ____________________

2. Address ____________________

____

3. Total number of plots available ________

4. Location (a) County: Cavan 1
   Monaghan 2
   Leitrim 3

   (b) 6" map [|]

   (c) Nearest town ____________________

5. Area of land holding (statute acres) [| |]

6. Area offered for energy crop production (acres):

Cropland	[| |]
Well drained grassland	[| |]
Poorly drained grassland	[| |]
Woodland	[| |]
Rough grazing	[| |]
Bogland	[| |]

7. Soil (acres):

Gley	[| |]
Peaty gley	[| |]
Peat	[| |]
Good mineral	[| |]
Swamp	[| |]
Other	[| |]

Specify ____________________

(a) Brief Description ____________________

____

APPENDIX 5

Unit cost estimates, conventional forestry, (1981 £)

Roads (£ per yard)

Cheap	–	7.00 per yard
Moderate	–	10.00 per yard
Expensive	–	14.00 per yard

Fencing (£ per yard)

Stock only	–	0.60 per yard
Stock/sheep	–	0.70 per yard

Planting:

Sitka Spruce:
Cost of plants – £32/1000
Planting 8 S.M.H.*/1000 @ £4.30/hr. 67.40/1000 = 68.22/Ac**
Haulage and trenching £1/1000

Lodgepole pine:
Cost of plants – £28/1000
Planting 8 S.M.H./1000 @ £4.50/hr. 61.40/1000 = 62.15/Ac**
Haulage and trenching £1/1000

(a) *Ploughing*

	Machine hours per acre			*Costs per hour (£)*		
Plough type	*E.*	*Med.*	*Diff.*	*E.*	*Med.*	*Diff.*
Cuthbertson	0.6	1.2	2.4	8.70	17.40	34.80
Clark	1.2	2.2	2.8	18.60	34.10	43.40
Ripper	–	1.5	2.0	–	27.00	36.00
Agricultural	1.0	1.5	–	10.00	12.50	–

This cost is for ploughing at 2 metre spacing.

Fertiliser costs per acre (£)

Light

Distribution of bags by tractor	– 0.5 hrs./acre –	4.00
Manual application	– 1.5 hrs./acre –	6.45
Cost of fertiliser		29.41
Total		39.86

Heavy

Distribution of bags by tractor	– 1.0 hr./acre –	8.00
Manual application	– 2.4 hrs./acre –	10.32
Cost of fertiliser		29.41
Total		47.73

Drainage (£)

(Manual)		
20 yards	–	7.00
20-40 yds.	–	11.61
40-60 "	–	19.35
60-80 "	–	27.09
80-100 "	–	34.82
100-150 "	–	48.37
150-200 "	–	67.72
200 "	–	77.40

Cleaning

	Costs per acre (£)		
Low	4 S.M. hours (per occasion)	–	17.20
Medium	6 " " " "	–	25.80
High	8 " " " "	–	34.40

*S.M.H. = standard man hours.

**Assuming a planting density of 2500 plants per hectare, or 1012 plants per acre.

APPENDIX 6A

Present net worth and annual equivalents per hectare and per acre, conventional forestry, by yield class and site type (1981 £)

Net returns per hectare (per acre)		*Average of all plots*					
Production (yield class)		*Price (1981 £)*					
i = 0.02		*High*		*Medium*		*Low*	
12	Present net worth	2575	(1042)	1182	(478)	177	(72)
	Annual equivalent	82	(33)	38	(15)	6	(2)
14	Present net worth	3310	(1340)	1613	(653)	433	(175)
	Annual equivalent	105	(42)	51	(21)	14	(6)
16	Present net worth	3235	(1309)	1517	(614)	282	(114)
	Annual equivalent	110	(45)	51	(21)	10	(4)
18	Present net worth	4211	(1704)	2225	(900)	833	(337)
	Annual equivalent	143	(58)	75	(30)	28	(11)
20	Present net worth	5392	(2182)	3112	(1259)	1542	(624)
	Annual equivalent	183	(74)	106	(43)	52	(21)
22	Present net worth	5609	(2270)	3285	(1329)	1691	(684)
	Annual equivalent	205	(83)	120	(49)	62	(25)
24	Present net worth	6535	(2645)	3943	(1596)	2172	(879)
	Annual equivalent	239	(97)	144	(58)	79	(32)
26	Present net worth	6504	(2632)	3996	(1617)	2254	(912)
	Annual equivalent	260	(105)	160	(65)	90	(36)
i = 0.04							
12	Present net worth	709	(287)	69	(28)	-410	(-166)
	Annual equivalent	79	(32)	3	(1)	-19	(-8)
14	Present net worth	836	(338)	33	(13)	-548	(-222)
	Annual equivalent	39	(16)	2	(1)	-26	(-11)
16	Present net worth	945	(382)	115	(47)	-499	(-202)
	Annual equivalent	46	(19)	6	(2)	-24	(-10)
18	Present net worth	1395	(565)	426	(172)	-274	(-111)
	Annual equivalent	67	(27)	21	(8)	-13	(-5)
20	Present net worth	2015	(815)	891	(361)	90	(36)
	Annual equivalent	97	(39)	43	(17)	4	(2)
22	Present net worth	2454	(993)	1231	(498)	367	(149)
	Annual equivalent	124	(50)	62	(25)	19	(8)
24	Present net worth	2882	(1166)	1509	(611)	543	(220)
	Annual equivalent	146	(59)	76	(31)	27	(11)
26	Present net worth	3354	(1357)	1933	(782)	921	(373)
	Annual equivalent	180	(73)	104	(42)	49	(20)

APPENDIX 6B

Present net worth and annual equivalents per acre, energy crops, mineral and peat soils, (1981 £)

Production (dry tonnes per ha.)		Net returns per hectare — Price per tonne (1981 £)					
1. Mineral soils		3		17		22	
i = 0.02							
7	Present net worth	-1268	(-513)	571	(231)	1228	(497)
	Annual equivalent	-65	(-26)	29	(12)	63	(25)
10	Present net worth	-1097	(-444)	1527	(618)	2466	(998)
	Annual equivalent	-56	(-23)	78	(32)	126	(51)
15	Present net worth	-818	(-331)	3121	(1263)	4529	(1833)
	Annual equivalent	-42	(-17)	160	(65)	232	(94)
20	Present net worth	-536	(-217)	4717	(1909)	6592	(2668)
	Annual equivalent	-27	(-11)	242	(98)	338	(137)
i = 0.04							
7	Present net worth	-1237	(-501)	176	(71)	681	(276)
	Annual equivalent	-79	(-32)	11	(4)	44	(18)
10	Present net worth	-1107	(-448)	912	(369)	1633	(661)
	Annual equivalent	-71	(-29)	58	(23)	105	(42)
15	Present net worth	-891	(-361)	2137	(865)	3219	(1303)
	Annual equivalent	-57	(-23)	137	(55)	206	(83)
20	Present net worth	-675	(-273)	3363	(1361)	4805	(1945)
	Annual equivalent	-43	(-17)	215	(87)	308	(125)
i = 0.07							
7	Present net worth	-1209	(-489)	-216	(-87)	139	(56)
	Annual equivalent	-104	(-42)	-19	(-8)	12	(5)
10	Present net worth	-1118	(-452)	301	(122)	807	(327)
	Annual equivalent	-96	(-39)	26	(11)	69	(28)
15	Present net worth	-966	(-391)	1162	(470)	1922	(778)
	Annual equivalent	-83	(-34)	100	(40)	165	(67)
20	Present net worth	-814	(-329)	2023	(819)	3037	(1229)
	Annual equivalent	-70	(-28)	174	(70)	261	(106)
i = 0.10							
7	Present net worth	-1192	(-482)	-464	(-188)	-203	(-82)
	Annual equivalent	-131	(-53)	-51	(-21)	-22	(-9)
10	Present net worth	-1125	(-455)	-84	(-34)	287	(116)
	Annual equivalent	-124	(-50)	-9	(-4)	32	(13)
15	Present net worth	-1014	(-410)	548	(222)	1105	(447)
	Annual equivalent	-112	(-45)	60	(24)	122	(49)
20	Present net worth	-902	(-365)	1179	(477)	1914	(775)
	Annual equivalent	-99	(-40)	130	(53)	211	(85)

APPENDIX 7

Acres potentially available for energy crop production (ECP), by option and price

	Acres available			
*Price**	*Rent land*	*Accumulated rental area*	*Landowner ECP*	*Sell land*
0	560	560	255	169
10	10	570	—	30
15	4	574	—	—
20	20	594	—	—
25	20	614	2	6
30	114	728	—	47
40	34	762	—	13.5
45	7	769	—	—
50	208	977	60	181
60	662.5	1639	75	45
69	100	1800	—	—
70	61	1800	—	85
75	8	1808	—	—
80	117	1925	—	—
83	—	1925	33	—
88	7	1925	—	—
90	8	1934	15	—
100	516	2450	90	288.5
105	80	2530	—	—
110	17	2547	—	—
120	8	2555	8	10
125	67.25	2622	13.25	—
130	5	2627	19	—
140	19	2646	—	—
143	—	2646	—	56
150	277	2923	13	113
160	—		—	79
167	—		8	—
175	130		105	—
185	—		1	—
200	308		26	87
230	1		—	—
250	41		22	25
270	3		—	—
285	—		19	—
300	68		50	69
325	—		—	103
350	—		8	—
400	23		—	132
420	—		—	36
500	32		16	10
600	4		—	10
750	16		—	—
800	—		—	2
999	39		2	—
1250	—		40	—
Total acres	3594.75		880.25	1597

*£/acre/year for renting, landowner ECP; £/acre for selling. All values in 1980 £.
Source: Landowner survey.

APPENDIX 8

Survey of the willingness of landowners in Counties Cavan, Leitrim, and Monaghan to allocate land for energy crop production

The ESRI is conducting a study in Counties Cavan, Leitrim and Monaghan to determine how much land might be available for "energy crop production" or "tree farming". Under this system, trees such as Alder and Willow are planted and then cut at 3 to 6 year intervals; after cutting, the stumps are allowed to regrow. After 12 years, you would have the option of having the stumps ploughed up and the land returned to you for conventional farming. The harvested wood is to be burned in power stations to produce electricity or in stoves to heat homes, schools, factories, etc. Energy crops can, of course, be grown on good agricultural land, but bogs and rough grazing land may also be suitable. Thus, energy crop production could in some cases yield a worthwhile income from land which is currently producing very little.

We are interviewing about 1,000 landowners in the three counties to see whether they would be interested in energy crop production. We are very anxious that you should co-operate since your views will represent those of many other landowners whom we cannot interview. Your responses will be treated in the strictest confidence and no informmation about any individual will be released to anyone outside the ESRI.

At present, the study is at a very preliminary stage. If sufficient land is found to be available at an economic rental, further investigation will be carried out to determine whether the land offered is suitable for energy crop production.

First of all, I'd like to get some background information on you and your present land uses.

Card 1
Resp. code [| | |] 1 4

1. Name of landowner ______________________ Intrvr. [|] 5 6

2. Address ______________________

____

3. Is the landowner resident? Yes . . . . 1 No . . . . 2 7 [ ] 8

Where is he/she located? Location (specify town and county if in Ireland; country if abroad) ______________________

(Interviewer: If landowner is not resident, inquire at Post Office or neighbour where he/she is resident.)

4. Principal Occupation ______________________ [ ] 9

APPENDIX 9

Reasons for non-interviews

	Quota	*Farm sold New owner*	*Unknown (letter)*	*Returns*	*Refusals*	*Non-contacts*	*Gone away*	*Hospital ill*	*House vacant*	*Deceased*	*Miscellaneous*
Leitrim	303	1	21	229	5	9	12	3	1	20	1 incomplete 1 same farm
Cavan	402		15	355	9	6	7	4		5	1 same farm
Monaghan	297		17	251	2	10	3	2		10	2 same farm
Total	1,002	1	53	835	16	25	22	9	1	35	5 same farm

APPENDIX 10

Pulpwood, boxwood, sawlog and total volume and value output from conventional forestry, by yield class

Yield Class 12 (Lodgepole Pine)

Crop Age	Pulpwood Volume (M^3)		Pulpwood Value (£)			Boxwood Volume (M^3)		Boxwood Value			Sawlog Volume		Sawlog Value			Total Volume		Total Value		
	Original	Reduced	High	Med.	Low	Original	Reduced	High	Med.	Low	Original	Reduced	High	Med.	Low	Original	Reduced	High	Med.	Low
15																				
20	38	32	384	205	40											38	32	384	205	40
25	41	35	420	224	44	1	1	20	12	7						42	36	440	236	51
30	38	32	384	205	40	4	3	60	35	21						42	36	444	240	61
35	32	27	324	173	34	9	8	161	94	56	1	1	30	23	19	42	36	515	290	109
40	24	20	240	128	25	15	13	261	153	91	3	3	90	68	56	42	36	591	349	172
45	17	14	168	90	18	18	15	302	177	105	7	6	179	136	111	42	36	649	403	234
50	59	50	600	320	63	108	92	1849	1086	644	141	120	3588	2712	2220	308	262	6037	4118	2927

Notes: Original output volumes [in cubic metres (M^3)] are taken from: *Forest Management Tables (Metric)*. Booklet No. 34, Forestry Commission, London, 1971. The reduced volumes are the original volumes x 0.85 (to the nearest cubic metre); the 15 per cent reduction is to allow for anticipated losses due to the impacts of insects, animal damage, disease and fire.

The following prices (1981 £) per cubic metre standing (M^3) are applied to the reduced volumes in order to arrive at the high, medium and low value estimates.

	High	*Medium*	*Low*
Sawlogs	29.9	22.6	18.5
Boxwood	20.1	11.8	7.0
Pulpwood	12.0	6.4	1.25

APPENDIX 11

Physical description of the candidate land areas (Cos. Cavan, Monaghan, Leitrim)

Characteristic		*Total acres*	*% of total*
Vegetation:	Grass/rush	220	24
	Grass	259	29
	Rush	118	13
	Scrub	5	1
	Swamp	69	8
	Other	232	26
	Total	903	100
pH:	Below 4 (very acidic)	199	22
	4 - 6 (acidic)	547	61
	Over 6 (mildly acidic)	157	17
	Total	903	100
Slope:	Slight	393	44
	Moderate	277	31
	Steep	13	1
	None	220	24
	Total	903	100
Elevation:	<600′	888	98
	600 - 800′	13	1
	800 - 1200′	2	0
	>1200′	—	—
	Total	903	100
Aspect:	North	82	9
	South	149	16
	East	79	9
	West	95	11
	North-East	52	6
	North-West	38	4
	South-East	37	4
	South-West	151	17
	Neutral	220	24
	Total	903	100
Exposure:	Sheltered	888	98
	Moderately exposed	15	2
	Very exposed	—	—
	Total	903	100

Source: Land evaluation survey.

APPENDIX 12

Candidate land area in each county by soil type and yield class (Border Region)

		Acreage and per cent brackets			
		Cavan	*Monaghan*	*Leitrim*	*Total acres*
Soil type:	Gley	175 (31)	28 (13)	80 (59)	283 (31)
	Peaty gley	22 (4)	26 (12)	9 (7)	57 (6)
	Peat	133 (24)	47 (22)	44 (33)	224 (25)
	Good mineral	188 (34)	80 (38)	0 –	268 (30)
	Swamp	40 (7)	28 (13)	2 (1)	70 (8)
	Other	0 –	1 (0)	0 –	1 (0)
	Total	558 (100%)	210 (100%)	135 (100%)	903 (100%)
Yield class:	12	0 –	3 (1)	0 –	3 (0)
	14	3 (1)	33 (16)	13 (10)	49 (5)
	16	66 (12)	32 (15)	26 (19)	124 (14)
	18	69 (12)	8 (4)	7 (5)	84 (9)
	20	53 (10)	13 (6)	0 –	66 (7)
	22	137 (25)	58 (28)	81 (60)	276 (31)
	24	230 (41)	44 (21)	8 (6)	282 (31)
	26	0 –	19 (9)	0 –	19 (2)
	Total	558 (100%)	210 (100%)	135 (100%)	903 (100%)

Source: Land evaluation survey.

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