

The following PRICES will be given for clean,  
found SEEDS of FORREST TREES, &c.

BY JOHN M<sup>c</sup>EV OY,  
Of COLLON, near DROGHEDA.

			S. D.		
SYCAMORE KEYS	-	4	4	per Barrel,	} 13 Stone to the Barrel, free of Stalks or Leaves;
HAWS or THORN	-	4	4	Do.	
ACORNS	-	4	0	per Bushel,	} The Bushel is equal to Ten Gallons and one Half.
BEECH MAST	-	5	0	Do.	
HORNBEAM	-	8	0	Do.	
HORSE CHESNUT	-	3	0	Do.	
SPINDLE-TREE	-	2	0	Do.	
YEW BERRIES	-	4	0	Do.	
HOLLY BERRIES	-	3	6	Do.	
APPLE PIPPINS	-	1	6	per Gallon.	} None will be taken ex- cept Seed got out by the Heat of the Sun in Spring.
MEZERIAN BERRIES	-	1	6	Do.	
HEPS OF ROSES	-	1	6	Do.	
SPRUCE FIRR	-	3	0	per Pound,	
SCOTCH FIRR	-	3	0	Do.	
LARCH	-	5	0	Do.	
SILVER FIRR	-	2	6	Do.	

DUBLIN: PRINTED BY P. BYRNE, No. 108, GRAFTON-STREET.

# IRISH FORESTRY

Journal of the Society  
of Irish Foresters  
Published Twice Yearly

Volume 24 No. 1

SPRING, 1967 10/-

# **CLONDALKIN PAPER MILLS LTD.**

**CLONDALKIN, Co. DUBLIN**

---

Suppliers of Newsprint to Ireland's Newspapers

and

Producers of a wide range of printing, writing, and  
Packaging Papers.

---

The Newsprint operation is based on  
Mechanical Woodpulp made at Clondalkin from  
thinnings from the state forests.

---

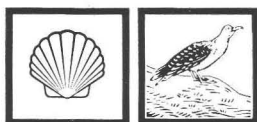
Newsprint and Woodpulp production will be doubled  
when Pulpwood or Forest Thinnings are in adequate  
supply.

---

**Clondalkin, Co., Dublin. Tel. 592741 Telex 5206**

---

P.S. Why not specify our Moyle Bond for your  
business stationery — its good and it can save you  
money.



**Shell and Albatros  
get themselves  
a brand new name**



**Albatros  
Shellstar Ltd.**

Why? Well, it says out plain and straight exactly what we supply to the Irish farmer—Albatros Fertilisers and Shellstar Agricultural Chemicals.

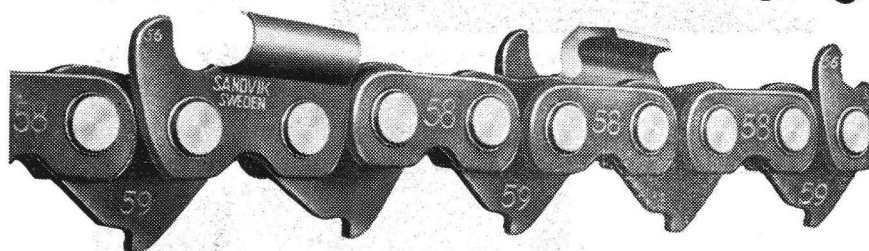
Albatros Shellstar Ltd. will mean plenty to the farmer as we continue to bring the very latest aids to scientific and profitable farming.

Talk to your Albatros Shellstar supplier and let him tell you what this means for you.

**Albatros Shellstar Ltd.**

—Sign of Better Times to Come

# SANDVIK LOW-VIBRATION CHAIN NOW AVAILABLE IN $\frac{3}{8}$ " PITCH



*Here is a new  $\frac{3}{8}$ " pitch saw chain that's really **superior**... and this is why!*

**SWEDISH STEEL.** New SANDVIK  $\frac{3}{8}$ " chain is made of finest quality nickel-chrome steel. Cutters are chrome-plated for lasting sharpness.

## **MORE STRENGTH—LESS WEAR.**

Extra metal beneath rivet holes in cutters and side links protects these previously vulnerable parts from excessive wear. You only throw *this*  $\frac{3}{8}$ " chain away when there's not enough cutter left to sharpen!

**BIGGER CUTTER—MORE LIFE.** Design of the cutter link gives a 10% longer

cutter which allows more refilings. And SANDVIK  $\frac{3}{8}$ " chain has the same high efficiency chipper shape as other SANDVIK chains.

## **BETTER BALANCE—LOW VIBRATION.**

Advanced cutter shape with depth regulator placed well forward improves chain balance. Close manufacturing control and factory pre-running guarantees low vibration level and minimum chain stretching.

You will need to examine SANDVIK PS SPEED-TOP  $\frac{3}{8}$ " CHAIN to see just how *superior* it is. Ask your local chain supplier for further information or write to Dave Patterson, Hand Tools Division, at the address below for more details!

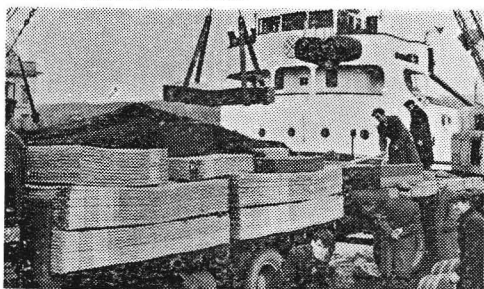
# SANDVIK

## **SANDVIK U.K. LIMITED**

Manor Way, Halesowen, Birmingham. Tel: 021-550-4700. Telex: 33164. Scotland: Whin Place East Kilbride, Glasgow. Tel: East Kilbride 25256



Building  
a new  
Ireland



Bowater Board is recognised by architects, engineers and builders as an important constructional material with a wide range of applications in buildings for industry, agriculture, and in the home. Its unique versatility and range of attractive finishes make Bowater Board the ideal board for all types of contemporary building and interior design.

Bowaters of Athy make full use of Irish materials. The mills are the largest users of native timber; power (over 250 tons of turf, almost 20,000 units of electricity a week), and transport. And, as a major Irish exporter, exporting two thirds of its production, Bowaters contribute to the growth of the Irish economy.

# BOWATER BOARD

THE IRISH-MADE HARDBOARD

BOWATERS IRISH WALLBOARD MILLS LIMITED, ATHY, CO. KILDARE.

TEL: ATHY 21280. TELEX: DUBLIN 5368.

# **McCulloch announces the first electric starting chain saw.**



Now you can push a button and start either of two new McCulloch chain saws. How? A completely self-contained starter/generator gives you fast, safe starts everytime—recharges the long-life batteries as you cut. Oils its chain automatically, too. All this and still lighter than most ordinary saws! And it's the world's safest to start... you start with both hands on it.



Ask your local McCulloch dealer for details of this, and the other saws in the McCulloch range, or write for full particulars to:—

**R. Broderick & Sons Ltd.**

**43 Dame Street, Dublin 2 Tel: 778116/7/8**

**Distributors for:**

**McCulloch: chain saws, outboard motors, ARC welders, and generators.**

---

Brindley Adv.



## FOR HERBICIDES IN FORESTRY

---

- Pre-sowing and pre-emergence weed control in nurseries  
GRAMOXONE (PARAQUAT)
  - Post-emergence treatment . . . . .  
GRAMOXONE AND SIMAZINE
  - Transplant lines . . . . .  
GRAMOXONE AND SIMAZINE
  - Scutch in fallow . . . . .  
WEEDAZOL TL
  - Fire breaks and fence lines . . . . .  
CELEFOUR 5T(245T/24D)
- 

**CONSULT OUR TECHNICAL DEPARTMENT**



**chemical services limited**

A GUINNESS-PHILIPS COMPANY

Rainsford Street,

Dublin, 8. 'Phone : 54271.

---

# IRISH FORESTRY

---

## CONTENTS

*(The views expressed in the articles and notes in this journal are not necessarily the views of the Editor or of the Society of Irish Foresters.)*

COVER PHOTOGRAPH: John McEvoy's price list, which is in the form of a broadsheet  $7\frac{1}{2}$  ins. by 9 ins., was probably printed about 1785. It is reproduced by kind permission of the National Library of Ireland.

PAGE

### Original Articles :

Principles of drainage with special reference to peat ( <i>W. Burke, B.Agr.Sc., M.S.</i> ) ... ..	1
Irish Peats and their drainage for afforestation ( <i>W. G. Dallas, Agr. (Forest) B., M.F.</i> ) ... ..	8
European Peats: drainage and the effects of climate ( <i>T. M. Black, B.Sc., Pl.D.</i> ) ... ..	24

*(Above papers were presented at a symposium on drainage held at Pomeroy Forest School and are published by kind permission of the Minister for Agriculture, Northern Ireland).*

Notes on Eighteenth Century Irish Nurserymen ( <i>Eileen McCracken, B.A., Ph.D.</i> ) ... ..	39
--	----

### Society Activities :

Lecture on landscape planning ... ..	59
Lecture on B.F.C. Management Tables ... ..	60

# SOCIETY OF IRISH FORESTERS

---

## *President:*

PROFESSOR T. CLEAR, Sheetrim, Monastery Road, Clondalkin, Co. Dublin.

## *Vice-President:*

A. M. S. HANAN, Woodlands, Killarney Road, Bray, Co. Wicklow.

## *Secretary:*

J. O'DRISCOLL, 84 Farmhill Park, Goatstown, Dublin, 14.

## *Treasurer:*

T. MOLONEY, 1 Rosehall, Templeogue Road, Dublin, 6.

## *Editor:*

M. H. SWAN, 17 Landscape Crescent, Dublin 14.

## *Business Editor:*

J. D. ROBINSON, 75 Dodder Pk. Rd., Rathfarnham, Dublin, 14.

## *Hon. Auditor:*

D. M. CRAIG, 85 Harcourt Street, Dublin, 2.

## *Grade I Councillors:*

D. MCGLYNN, 88 Priory Avenue, Stillorgan, Co. Dublin.

L. CONDON, Fitzwilliam Road, Wicklow.

D. MCGUIRE, Columcille, Novara Road, Bray, Co. Wicklow.

D. O'SULLIVAN Ballydowling, Glenealy, Co. Wicklow.

## *Grade II Councillors:*

W. LUDDY, Rathnew, Co. Wicklow.

J. D'ARCY, Killygordan, Lifford, Co. Oonegal.

## *Associate Councillors:*

MISS E. FURLONG, Silevrace, Clontarf Road, Dublin 3.

S. GALVIN, Park Cottage, Wexford.

# IRISH FORESTRY

Volume 24

SPRING 1967

Number 1

## Principles of Drainage with Special Reference to Peat

By W. BURKE

Any general discussion on the principles of drainage must take all factors of the hydrological cycle into account. These factors are precipitation, infiltration and run-off, evaporation and evapo-transpiration, soil permeability and the water retaining power of the soil. Of equal importance are the physiological factors and the functions of root systems in the soil.

In this paper an attempt has been made to give a brief summary of the more important of these factors and an account is given of the main results of drainage research at the Peat Station of the Irish Agricultural Institute at Glenamoy, Co. Mayo.

### *Permeability and waterflow in soil*

In 1856 a French engineer called Darcy carried out some experiments on the flow of water through saturated beds of sand. As a result of these experiments he enunciated a law which has since been generalised and expressed in various forms but is always known as 'Darcy's Law'.

One method of writing it is

$$\frac{Q}{t} = \frac{K.A.h}{d} \quad (1)$$

$Q$  is the quantity of water that flows in time  $t$  across an area  $A$  under a potential of  $h$  through a medium of thickness  $d$ ,  $K$  is a coefficient that depends on the physical properties of the medium and is called the hydraulic conductivity.

Re-arranging equation (1) gives

$$\frac{Q}{A.t} = \frac{K.h}{d}$$

or  $V$  (velocity) =  $K.i$ , ( $i$  is called the hydraulic gradient.)

$K$  is large for coarse materials e.g. coarse sand or soils with good structure.  $K$  is very small for fine materials e.g. clay soils with poor structure and peat. We have measured  $K$  values which differed by a factor of more than 100,000,000.

In simple language Darcy's Law states that the velocity with which water flows through a porous medium is directly proportional to the product of the hydraulic conductivity of the medium and the potential energy of the water, and inversely proportional to the distance through which the water must travel. Darcy's experiments dealt with vertical flow but at a later stage various workers applied Darcy's Law to develop equations expressing the continuity of flow in porous media. The results gave new equations and their solutions described accurately the flow of water to drains in saturated soil. Data became available for various types of soil conditions e.g. layered soils and soils with drains at different depths and spacings. The correctness of the mathematical analysis can be demonstrated by models in the laboratory.

Saturated flow does not always occur. Unsaturated flow, which very often occurs here—probably more often than saturated flow still remains largely unsolved although recently the computer has enabled much progress to be made.

#### *Non Darcy Flow*

Recently it has been suggested that flow in very fine pores does not strictly obey Darcy's Law. It was suggested that under these conditions there is a minimum or threshold gradient required before any flow can take place. This theory has yet to be conclusively proved or disproved.

#### *Water Retention*

The second aspect of soil drainage to be discussed is soil water retention. It is a matter of observation that even after drainage has taken place the soil remains moist. This moisture is held by surface tension forces in soil pores. This water retention is governed by a fundamental principle of physics and has great implications in soil drainage.

If one end of a capillary tube is placed in water, water will rise in the tube and stay at a level which depends on the diameter of the tube. If a suction is applied to the upper end of the tube the water will rise higher but will return to its original level in the tube as soon as the suction is released. It can be easily demonstrated that there is a precise law relating the level at which water stands in the tube with the tube diameter. It is as follows

$$h = \frac{0.30}{d}$$

$d$  is the tube diameter,  $h$  is the height of rise of water in the tube. The significance of this law in soil drainage is as follows. Soil consists of "grains" of material in contact. Thus there is pore space between these grains and the finer the grains the finer the pores. In effect the fine pores behave exactly like capillary tubes and the watertable corresponds to the water in which the end of the capillary tube is placed. In the simplest case if a drain is placed in

soil that has a watertable, the watertable is lowered to the level of the drain bottom. Depending on effective pore diameters in the soil, water will stand at varying heights above the watertable in the finer pores but some of the larger pores will drain freely. The porosity of the soil affects permeability. Water moves more freely through large than through small pores, the difference is largely due to friction between the water and the walls of the pores. Thus a coarse textured open soil will drain faster than a fine textured one and the latter soil will hold more water by capillarity than the former after drainage has taken place.

### *Infiltration and Rainfall*

So far water movement and water retention in soil has been discussed, but it is also necessary to consider how water gets into the soil.

Except in the case of seepage, springs and floods, water arrives at the soil surface as precipitation and enters or infiltrates into the top soil. The maximum rate which water can enter a soil is called the "infiltration capacity". This varies considerably with soils. For instance we have measured infiltration capacities that varied from 0 to  $\frac{1}{2}$  inch per day on a Drumlin soil in Co. Leitrim to 10 inches per day on a good soil in Co. Cork. The importance of infiltration capacity lies in its relationship with rate of rainfall. While rainfall rate exceeds infiltration capacity all the water cannot soak into the soil. Instead it flows over the surface and usually collects in depressions. These depressions with their stored water act as reservoirs to keep the soil saturated in patches for long periods. This is particularly evident in persistent patches of water in fields through the winter or in the continually wet top soil that results from poaching and treading damage by animals' hooves.

### *Evaporation*

One other aspect requires some attention. While this, strictly speaking, is not drainage it is a process that removes a large quantity of water from the soil and cannot be overlooked. This process is evaporation and on the average it removes from 15-18 inches of water from the soil in Ireland each year. Evaporation is a physical process and two operations are involved.

Firstly the water must change from the liquid to the vapour phase i.e. latent heat of vaporisation must be supplied. The amount of heat or energy required is 590 calories per cubic centimeter of water. This energy all comes from the sun.

The second factor is wind, or turbulence of the atmosphere, which removes the vapour to higher levels, thus permitting evaporation or evapotranspiration as it is sometimes called to proceed continually. The limiting factor in evaporation is energy for the supply of latent heat of vaporisation. Sometimes some of this energy can be supplied by a warm dry wind blowing across the country. This is often called advected energy. Because energy is limiting there is

an absolute or "potential" evaporation that can occur. Measurements and calculations indicate that this *potential* evaporation for Ireland lies normally between 15 and 20 inches and three-quarters of it occurs from April to September inclusive. For various reasons actual evaporation will be lower. Thus the overall water balance for the country shows a big excess of precipitation from October to March inclusive, with an approximate balance between rainfall and evaporation during Summer, with considerable local variation in the Summer pattern.

#### *Plant Physiological factors in drainage*

The above gives a summary of the physical processes of soil and climate that govern soil drainage. The next aspect to be considered is the crop.

Some plants can tolerate poor drainage and some plants do best in conditions of poor drainage but the majority of economic crops demand good drainage. All of the physiological factors involved have not been clearly described, but aeration appears to be the most important. It is known for instance that root respiration depends on :

- (a) Rate of oxygen supply.
- (b) Concentration of Carbon dioxide present.
- (c) The relative amounts of Oxygen and Carbon dioxide that are present.

Different plants appear to have different requirements and the morphology of the plant root appears to be of equal importance with the physical properties of the soil. Aquatic plants often have in them large intercellular cavities through which gaseous exchange can take place internally. Non-aquatic plants also have intercellular spaces but to a much lesser extent. It has been shown that in an average corn root with 8 percent intercellular space enough oxygen can diffuse down the root to supply 10 cm of root length while in an aquatic root with 75 per cent intercellular space enough oxygen can diffuse to supply 50 cms of root length (1). In a normal crop when flooding takes place the  $O_2/CO_2$  balance for the deeper roots is quickly upset and if the condition persists permanent damage occurs to the plant. The condition appears to be due to an upset in the biochemistry of the plant leading to the production of phytotoxic chemicals.

#### *Root Functions*

The principal functions of the roots are :—

1. Anchorage.
2. Water absorption.
3. Mineral absorption.
4. Synthesis of hormones and other organic compounds (2).

The volume of soil occupied by the roots and therefore the depth of roots govern all of the above factors. When root depth of normally deep rooting plants is restricted it is usually for one of two reasons

(a) Mechanical impedance in the soil.

(b) A high watertable.

Evidence of mechanical impedance to roots is available from the failure of plants to penetrate iron pans, cemented layers or compact B horizons. Impedence due to a high watertable occurs because any roots that penetrate, quickly die due to some type of physiological upset.

Whatever the cause of impedance the effects are the same. A restricted root system gives poor anchorage and the plants are easily toppled in a storm—very often the trees that are uprooted in a storm are seen to have shallow roots. Because of the small soil volume occupied by the roots, nutrients and, in dry weather, water may be in short supply, though the latter factor is seldom serious here. Regarding nutrients it may be possible to supply Phosphorus, Potassium and Nitrogen to a plant with a restricted root system but if the restriction is caused by waterlogging there is a probability of rapid de-nitrification with consequent Nitrogen deficiency which may be difficult to correct.

### *Inadequate Drainage*

The provision of an inadequate drainage system must be avoided. Such a system will lower the watertable during a moderately dry period but will permit the watertable to stay high in a prolonged wet period. Under such a system vigorous root development may take place in dry weather. Then comes a wet period, the roots are submerged with very serious consequences. A similar and even more serious consequence follows if an adequate drainage system deteriorates after a number of years. In this case the extensive root systems become swamped and the effect is disastrous. Small plantations of fruit trees and conifers that have been killed in this way are often seen.

### *Drainage at Glenamoy*

The following is a brief account of research on drainage at Glenamoy and the above factors are referred to where applicable.

Drainage research at Glenamoy commenced in 1957 and the programme was directed completely towards drainage for agriculture—mainly grass production. It had three main objectives.

- (i) To determine what drain spacing and depth was required to control the watertable in the peat.
- (ii) What were the effects of this drainage on the peat and on crops.
- (iii) To devise practical means of achieving this drainage.

At Glenamoy rainfall is in excess of 50 inches per annum and is fairly uniformly distributed. Measured and calculated evaporation shows values of about 16 inches most of which occurs in Summer. Thus drainage in Glenamoy involves the removal of some 35 inches of water per annum.

#### *Physical Properties of Glenamoy Blanket Peat*

The peat at the station varies in thickness from 4 to 20 feet. Most of the drainage experimentation was done where the peat is 12 to 16 feet thick. Bulk density values ranged from about 0.95 gm/cc at the surface to 1.01 gm/cc below 12". Ash contents is 2% and moisture content is about 90 gm water to 10 gm dry matter. Air filled pore space after drainage is about 5 to 8 percent by volume at the surface. The hydraulic conductivity of the peat is very low about 1 cm per day for undrained peat.

#### *Effect of Drainage on Watertable*

In the initial experiments three feet deep drains were installed at various spacings ranging from 8 to 100 feet and the shape of the watertable was measured. From this study it became obvious that a spacing of 12-15 feet was needed to achieve reasonable control of watertable. The initial trials were confined to 3 feet deep drains but in a subsequent experiment the watertable was lowered by pumping from a well. In this trial a depth of 7 feet was reached in stages and the net effect was that there was a disadvantage in drains deeper than about 3 feet. As the watertable was lowered the permeability of the peat was reduced to about .3 cm/day at a suction of 4 p.s.i. and rate of discharge from the well also fell off. Details are given in Table I.

Table I

*Daily Discharge figures from Well (Steady state assumed) and corresponding permeability values*

Well Drawdown (ft.)	Measured Discharge per day (ccs)	Average Permeability cms/day (Dupuit)
1	12,816	0.97
3	24,804	0.65
5	21,859	0.38
7	19,911	0.29

#### *Effect of Drainage on Water Removal*

Flow recorders were used to determine the characteristics of water removal from a drained and an undrained area. The drained area had 3 foot deep drains installed at 12' centres. In the undrained area the water table remained near the surface and precipitation emerged almost immediately through the flow recorders. In the drained area the watertable was reasonably well controlled at a depth of about 1½' to 2' in summertime but the rate of removal of

water was slower. The difference in water removal rate was probably due to the fact that in the undrained peat much of the water flowed overground while in the drained peat the water flowed through the peat to the drains.

#### *Effect of drainage on crop yields*

The effects of drains at 1', 2', 3' depth were compared with that of no drainage on the yield of Rye grass, Cocksfoot, Potatoes and Oats. An increase of about 20% was obtained at the 3' drainage over the no-drainage for all crops.

#### *Practical Means of Achieving Drainage*

The first system tried out was one of open drains. This system was completely unpractical for livestock because drain maintenance is expensive and livestock losses were very high.

An early development at Glenamoy was the tunnel plough. This was never fully developed and is now scarcely used but it gave excellent results when used properly where conditions were suitable.

About three years ago nearly several different materials were installed in drains at Glenamoy. These materials included (i) plastic pipes of various kinds with and without glass fibre wrapping, permeable fill etc. (ii) Drains made of peat sods and dried peat. (iii) Drains made of sand and gravel laid on a strip of polythene. All are working well so far and nearly all are expensive. Plastic costs £50 per acre for materials. Peat and sod drains have high labour costs. Gravel on polythene is cheaper but until a mechanical method of laying it is achieved it remains difficult to instal. A type of drain that gives good promise consists of two layers of expanded polystyrene mesh sandwiched between two layers of glass fibre. The material cost of this is about £25 per acre for 15 ft. spacing.

#### *References*

1. Woolley, Joseph T. Drainage Requirements of Plants. Conference Proceedings on Drainage for Efficient Crop Production Chicago Dec. 6-7, 1965. Pub. ASAE, St. Josephs, Michigan.
2. Kramer, Paul J. Effects of Deficient Aeration on the Roots of Plants

# Irish Peats and their Drainage for Afforestation

By W. G. DALLAS

## INTRODUCTION :

Systems of drainage, like peats evolve with time and this evolution has been extremely obvious in forestry. In Northern Ireland our evolution has been proceeding actively since 1949. Evolution is brought about by progressive changes of state and where this process is applied to ideas a healthy, forward looking state of mind is indicated. It is essential, however, that the ideas are soundly based on scientific fact. In the case of the drainage of peat there appears to be a dearth of such facts. As a result foresters sometimes have doubts about their solution to the drainage problem. This paper does not purport to supply basic scientific facts required, but is designed to stimulate a more basic approach and to build a foundation from which a more fundamental consideration of the problem may be made.

O'Leary (1955) said :

"Before an intelligent approach can be made towards the large scale exploitation of bog for any purpose—even for fuel production—it is necessary to appreciate to some extent the broad history of peat deposition and the main features of the principal peat types, so that the problems of development may be dealt with effectively".

In essence what will be attempted in this paper will be the preparation of a literature survey of peat and its drainage problems with reference to afforestation in Ireland. Together with Dr. Black's paper it will, if not directly solving our problems, analyse them basically. The analysis may then be used as a check list to determine the extent of our success to date and plan future research work.

O'Leary's quotation, then, is where this paper must begin—with an explanation of the principal peat types in Ireland. By a process of elimination we will arrive at the main type of peat confronting foresters and it will be investigated in greater detail.

## PART I: FORMATION AND CLASSIFICATION OF PEAT HISTORICAL :

Peat has been studied for many years, not only in Ireland where it is so familiar, but in Britain and on the continent as well. As far back as 1535, John Leland described peat lands in England and Wales using such familiar descriptive terms as Moor, Moss, Marsh, Fen and Carr. Gorham (1953) quotes Gerard Boate (1652) as the first person known to attempt a classification of peat lands.

Boate was Doctor of Physics to the State of Ireland and his classification is contained in his treatise on Ireland's Natural History which was published in 1652. It is interesting to know that this treatise was prepared "by remote control" in that Gorham (1953) comments that it appeared to be completed before Boate set foot in Ireland. His sources of information were his brother and other gentlemen resident in Ireland. Other workers and commentators through the ages were William King (1685), a Fellow of the Royal Dublin Society, Arthur Young (1780) and Griffith (1810-1811). Many well founded views on the formation and action of peat were expressed by these men and also the authors (anon.) of Reports of the commissioners appointed to enquire into the nature and extent of several bogs in Ireland: and the practicability of draining and cultivating them (Vols. I-IV 1810-14). Less well founded, however was the view of Dr. Anderson of Aberdeenshire expressed in 1794. He supported the hypothesis of early Dutch naturalists that a peat bog was a living growing organism, and that the surface vegetation merely grew upon its dead outer skin—Gorham (1957). Rennie (1807) in opposing this hypothesis stated that he would "dismiss this new species of vegetable from the list of plants, till its habits and qualities are distinctly ascertained. I would only suggest, that of all devouring monsters it must be the most dreadful, according to the Doctor's account, for, as I shall show, ploughed fields, large trees, loaded boats, men and women, and the largest animals, houses, nay, streets and whole cities, have been swallowed up in its all devouring jaws". It is however to the modern workers that we must turn for an appreciation of peat based on sound scientific facts.

## FORMATION AND CLASSIFICATION

Peat for all its apparent simplicity is a most difficult substance to define. To be exceedingly brief one can put it in a nutshell and say that it is a form of humus which, like mor, forms a covering above the mineral soil from which it is sharply demarcated. (Tamm, 1950). It is the effect of climate topography and soil on this humus formation that complicates the basic product. McConaghy and McAllister (19—) state that under natural conditions the amount of humus usually reaches, and is maintained at, an optimum value if conditions such as drainage, soil base supplies, etc., remain satisfactory. Any definite deterioration in these conditions may seriously upset the balance between oxidative decomposition (i.e. to carbon-di-oxide decomposition) of organic matter and may completely change the type of humification. Such changes are responsible for the formation and accumulation of peaty organic matter.

In describing peat it is necessary to consider the conditions under which it is formed. Also, in describing peat formation it becomes classified automatically. Many different classifications exist,

each however, more or less suited to a particular country or environment. For example a German school of classification uses the terms :—

*Hochmore* — or high bog.

*Neidermoore* — or low bog.

*Übergangsmoore* — or transition bogs.

Barry (1954) comments that while this classification was intended to fit the bogs of North West Germany and the Netherlands it primarily applied fairly well to Ireland's raised bogs but not to the western blanket and high level bogs. On considering further the classification and terminologies of other European schools it becomes more evident that all are completely or partially unsuitable and that a classification locally evolved in Ireland, if possible in this case for Northern Irish conditions, is required. While a substantial amount of work has been done and commentaries written in the Republic of Ireland (Barry 1954, Condon 1961, Jessen 1949, McEvoy 1954, and Mitchell) only the division described by McConaghy and McAllister (19—) appears specific to Northern Ireland. This classification by formation is as follows :—

- I. Acid-peat or raw humus soil developing by an acid type of humification under conditions of good drainage.
- II. Peats developing under drainage conditions which may be due to impermeable or slowly permeable subsoils or to high water table.
- III. Peats accumulating under waterlogged conditions due mainly to the influence of rain water, high humidity and low temperatures.

#### *I. Raw humus or "mor" humus*

This type of peat is formed under cool humid conditions where drainage is good with no appreciable reserves of lime or other bases. In essence the raw humus here forms part of a typical podsol profile and its depth although generally shallow is variable. The authors state that in some podsoles there may be a distinct separation in the zones of humus and of iron enrichment within the B horizon. This may occur as the level of water table rises and is accompanied by an increase in the depth of surface peat which changes from the "mor" or acid humus type developed under free drainage to bog peat. The lower parts of the profile may begin to show some mottling due to reducing conditions and oxidising conditions co-existing and a Gley horizon becomes evident. This process is also described by Tamm (1950—pp. 130-131). As the ground water level continues to rise the growth of surface peat increases and the movement of humus and sesquioxides from the surface decreases. The ultimate development is peat bog. Tamm (1950—p.118) reckons that the limit of the peat's thickness at which podolisation ceases seems to lie at about 12 inches. Fraser (1933) terms this soil a

gley-podsol and states that it is found below the greater area of the more shallow peat in places where the topography is fairly regular or on slopes which are not very steep. This peat type is often referred to as "soligenous" in that its ground water is derived from the soil. Peats formed by this process are common on the quaternary deposits (i.e. areas of deposits of glacial sands and gravels) in counties Tyrone and Londonderry. This is undoubtedly the Moraine Heath type of peat recognised by Fraser (1933).

Since the peat is generally little over 12 inches deep and since only limited areas have been acquired for afforestation it presents a relatively small problem.

Drainage, however, is not so serious a problem and it is recorded that quite extensive reclamation of this type for grassland has been successful in Tyrone and Londonderry (Sherrard (1953).

## *II. Peats developed under poor drainage conditions*

The peat developed under these conditions is similar to that well described by Fraser (1933) and termed Basin Moor. McConaghy and McAllister follow another of the more common present day terminologies and use the name Basin peat. The term Basin bog is also frequently used. Fraser (1933) cites the English Fens as the best example of this type of peat formation but notes that the process is similar in regions of low elevation at the free water surface of shallow lakes or in basin-like depressions where water collects through faulty drainage and where water movement is hindered to such a degree that floating and marsh plants may become established. In the still, shallow water conditions growth is greater on the water margin. Plant debris accumulates on the bed of the lake and in time the rim is raised to the level of the water surface. The marsh plants continue to build up the margin producing a saucer like effect. This stage Fraser (1933) terms Low moor. The process continues towards the centre of the water area and as it does the original marginal area becomes drier. Eventually when the surface levels out the stage of Transition or Flat moor is reached. The final stage in this progression is High moor when the profile assumes the shape of an inverted saucer due to the continued growth of vegetation in the centre of the previous pool towards which much of the surface water flow. McConaghy and McAllister (19—) quote good examples of this type of peat at Lough Gall, Co. Armagh and in Co. Fermanagh. The vegetation succession referred to above is similar to that seen on the shores of many of our lakes to-day. Reed (*Phragmites*) occurs on the water margin also the Reed-mace (*Typha*). Sedges (*Carex spp.*) then follow the reed formation. This succession, in turn may then be followed by Alder and Willow.

Basin Bog may also occur in areas which are not basins or hollows, as such, but where the subsoil is impermeable giving what may be

termed a suspended water-table. (McConaghy and McAllister 19—). Basin Bogs are of yet smaller consequence in the Northern Ireland afforestation programme.

*III Peats accumulating under water-logged conditions due mainly to the influence of rain water, high humidity and low temperature.*

The description of this type of peat commences where we have just left off in that in one of its forms it overgrows Basin Bogs. The change occurs when the developing vegetation, principally sphagnum spp., on these bogs is influenced more by precipitation than ground water. The result, terminologically, of this evolution is Raised Bog. It is so called because of the convex profile it assumes when seen in section. Raised bog types are often termed "ombrogenous" due to their being completely removed from the influence of water from mineral soil.

By virtue of a "hollow-hummock" cycle *calluna* invades the developing medium and a *calluna* type peat eventually emerges. These bogs are extremely common in Ireland especially in the central plain where Jessen (1949) considers their development "magnificent and unique". They are also common in Northern Ireland and several areas such as the Garry Bog have been acquired for afforestation. Raised bogs have been recorded also originating on convex floors, e.g. at Cluain Sosta, where Barry (1964) reports this as a reversal of the classical concept of raised bog formation.

On the higher areas another type of climatic peat is formed. These areas have a well distributed rainfall of from 50 inches to 90 inches, relative humidities are in excess of 80 and precipitation exceeds evaporation over the most of the year. They also have constantly low mean annual temperatures. Formation commences when peat forming plants, e.g. Sphagnum moss, forms on the almost perpetually wet humus layer. Due to the water retaining power of the sphagnum, etc. and to the high precipitation, aeration of the humus layer ceases and the plant remains accumulate to form peat. These plant remains derive from the vegetation familiar to us all, i.e., *Eriophorum* spp, *Scirpus/Tricophorum caespitosus*, *Molinia caerulea*, *Narthecium ossifragum*, and *Erica tetralix*.

Due to the constant nature of our humid, cool, climate accumulation of this type of peat often exceeds 20 feet.

The term "Blanket Bog" has been coined to describe adequately such a peat formation in that it covers the entire ground surface, slopes and plateaus alike. The terms terrain-covering bog (Oswald) and climatic moor (Fraser 1933) are also often used but for simplicity and general understanding Blanket Bog is recommended for use.

In summary now let us look at the three basic peat types again.

- I. Acid peat or raw humus in areas of originally good drainage—eventually deteriorating to gley-podsols. Peat relatively shallow. Predominant vegetation *calluna*. Does not present a very serious drainage problem. Area available for afforestation relatively small.
- II. Basin Bog/Fen Peat type, formed in waterlogged therefore anaerobic conditions, water Base Rich. Limited application for forestry due to rarity of occurrence. It is principally of interest in that it underlies Raised bogs.
- III. Blanket Bog—developed in areas of high rainfall, high humidity and low temperature. Formed therefore from precipitation alone and therefore relatively infertile. Pseudo-fibrous in character (Fraser 1933) and almost gelatinous. Extensive areas available for forestry.

This latter type of peat presents us with our main problem but before passing on to deal specifically with it a word of warning is necessary. While peat has, above, been segregated into three classes it is stressed that the classification of a substance so variable into only three basic types is an over simplification. The worker with peat must at all times realise that there are many variations brought about by both the individual and combined effects of topography, soil and climate and of course the influences of these factors on the vegetation.

As proof of variability of formation in Ireland we have Type I above modified in the western counties of Kerry, Galway, Mayo and Donegal, where low summer temperature, high humidity and high rainfall develop a Blanket peat over the podsol peat. (McEvoy 1954).

There is also the phenomenon of flush peats where mineral rich water passes through the surface of the ground. Such peats may be found in both Raised and Blanket bogs. Fraser (1933) recognises four basic types, Rush Flush, *Molinia* Flush, *Eriophorum vaginatum* Flush and Iron Flush.

Also in an effort to illustrate the variability in Blanket Bog, Condon (1961) in a manner after Zehetmayr (1954) divides it into five types. Dickson (1962) also divides Blanket Bog into types recognising three basic categories. Zehetmayr's, Condon's and Dickson's approaches are exercises in an objective approach to a problem which at first sight appears simple. The problem is of course the effective draining and afforesting of Blanket Peat.

Barry (1954) states "The most concise statement that can be made about the conditions governing the nature of a particular peat type is the following. "The nature of peat depends upon the plant association which has given rise to it and which in turn has been controlled by the climate, physiography and other locality factors

of the district and in particular by the nature and amount of the mineral nutrients in the waters of the locality and of the spot in which the plants were growing". Barry acknowledges that part of this statement is due to Waksman (1942).

## PART II

### BLANKET BOG — ITS CHARACTERISTICS AND DRAINAGE

It might be asked at this stage why distinguish between Blanket Bog and Raised Bog and Barry (1954) answers this question in stating that the practical importance of distinguishing between the two types in Ireland stems from the fact that they are fundamentally different as regards such characteristics as drying and rewetting, combustion, chemical constituents, responses to drainage and load bearing qualities for machine use.

#### Moisture Content

From the work of Dickson (1962) and the observations of Condon (1961) moisture contents of 91% may be expected in the upper 20 inches of Blanket peat. Dickson's figures are given for Lough Navar, Beaghs and Ballypatrick Forests and Condon's for Glenamoy. It is interesting to note that the Glenamoy figure increases to 93.8% in the range of 20 inches-40 inches. From this it drops to 90.1% between depths of 10 ft. and 11 ft. These figures of course indicate stagnation levels where tree roots can not survive. Drainage therefore must be so intensive that the moisture content in the upper layers can be reduced to a degree where healthy root growth and penetration can be promoted. A similar problem also faces those wishing to win peat for fuel. In the latter case effective use of machinery and drying of the processed product may only continue with a greatly reduced water table. It is therefore reassuring to know that others share our problem.

#### Drainage

The effect of drainage on a peat soil is much more complicated than for a mineral soil. Strictly speaking only surface water (rainfall and snow melt) is easily removed by drainage. The bulk of the water in peat is capillary bound or absorbed by the colloids of the peat. By removing the surface water it is prevented from being taken up by absorption. One of the basic characteristics affecting the movement of water in peat is the degree of humification and O'Hare (1955) stresses that in the same peat profile there is as great a difference in texture as between a heavy clay soil and a sandy loam. This greatly influences the water holding capacity. An indication of the degree of humification is however easy to obtain using the VON POST system. Small samples of peat are squeezed in the hand. If a sample is fresh, clear water is squeezed from the peat. As humification progresses the colour of the exudate changes to brown through yellow. A scale<sup>1</sup> ranging from 1-10 has been drawn

up with H1 corresponding to a colourless liquid exudate and H10 to the state when a fully humified amorphous exudate flows through the fingers leaving no residue in the hand.

<sup>1</sup>H1-H4 Clear—Turbid Brown

H5-H7  $\frac{2}{3}$  mass passes through fingers.

H8-H9 70% mass passes through fingers.

For example if the water which runs off is clear or yellowish the degree of decomposition of the peat is not sufficient to permit drying by drainage alone (Tamm—1956).

A slightly decomposed peat has most of its water capillary bound and therefore drainage however intensive has little effect. A well decomposed peat on the other hand responds to evaporation, shrinks and cracks thus permitting the run off of precipitation through the fissures. This and the amount of water capable of being removed from peat by transpiration is of supreme importance when assessing the drainability of a particular peat area. Such an assessment prior to drainage is considered by Tam (1950) to be extremely important and he advocates the use of a Martonne type index which is in essence a mathematical expression of the degree of humidity, viz. :—

$$\frac{N}{T+10} = \text{Martonne coefficient}$$

N = Mean annual rainfall.  
T = Mean annual temperature.

T+10+ Above+10°

Similar coefficients have been drawn up for Sweden by Hesselman (1932) who called it the humidity coefficient.

Wright (1959) summarises the drainage difficulties in peat thus "—Peat can never be dried by drainage to any significant extent as which peat is composed holds water so tenaciously that lateral flow to an open drain is extremely slow". For practical purposes he restricts it to 2-3 feet on either side and quotes the Lon Mor square chain block of peat isolated in 1936 by trench excavated to the underlying moraine. After 22 years Wright quotes no appreciable change in peat depth or floristic composition of the vegetation. He further states that the function of drainage on deep peat is therefore to remove stagnant water from the site and to give local aeration in early years to trees planted on excavated material. "It is the transpiration of the tree crop which will eventually dry out the peat". (Wright) 1959).

The matter of lateral flow in soils generally is also discussed by Tamm (1950). Unfortunately he does not deal specifically with peat but figures for fine sand of 165-550 yards per annum (Rindell 1919) indicate that peat by virtue of its colloidal structure as opposed

to the particle structure of the sand will be infinitely slower irrespective of slope.

This is substantiated by work recorded via Commonwealth of Soils Studies of the rate of free water movement in peaty soils measured with  $S_{35}$  revealed a movement of 4-6 cms. per day in the upper horizons of a pine/sphagnum/cottongrass peat. In the underlying soil it was 50-58 cms. per day. In a peaty soil under Alder, Birch and Spiraea, movement was 11-12 cms. per day and in the underlying soil 150 cms. per day. The above work quotes 1 metre per day for movement in the peat/soil zone of contact. Strikingly low as these movement figures may be the movement quoted for Glenamoy peat of 1 cm. per day emphasises clearly the extent of our problem.

The water tenacity of peat is thus well shown. The next step is to examine actual and possible effects from draining.

Possibly the first British worker to approach this problem was Fraser (1933) who reports his findings in what is still a standard reference work. Fraser's work was however limited by the lack of draining machinery. Unfortunately the bulk of references on the drainage of peat refer to peat types other than Blanket Bog. Particular reference is made to cultivation of agricultural crops on peat. A good synopsis of this work is given by Burke and O'Hare (1962) but, as Burke (1961) states, the information is often contradictory. Parkin (1957), O'Carroll (1962) and Dallas (1962) further added to the amount of empirical information. It was not, however, until the classical experiments at the Peatland Research Station of the Agricultural Institute, Glenamoy, Co. Mayo, were commenced that the drainage of Blanket peat could be scientifically assessed. Glenamoy peat is basically similar to the bulk of the Blanket peat in Northern Ireland, if any thing being more gelatinous with a lower hydraulic conductivity. The findings at Glenamoy have been well illustrated in the previous paper.

To recap, research workers have concluded that drains at 12 feet are required for proper watertable control. This spacing gives good control of watertable and affords rapid watertable lowering after rain. It is felt that the maximum distance apart might be increased to 15 feet without serious loss of drainage efficiency. (Burke and O'Hare 1962, Burke 1961 and 1963, Peatland and Experimental Station Guide).

Drainage spacing is one problem of concern, but having decided on an optimum figure one must consider an optimum depth. This is also important from an economic aspect as well. Interim reports on a borehole pumping experiment at Glenamoy have also been quoted indicating that  $3\frac{1}{2}$  feet is the optimum level to aim for, but, due to the long term nature of the experiment, results are not yet accepted as final. (Burke, O'Hare, etc.).

Until recently the Glenamoy figures were the only indication of the measurable effect of drainage on water-table in Blanket peats apart from research findings in the Forestry Divisions of the Ministry of Agriculture and the Department of Lands. The results of water-table experiments carried out by Bord na Mona have now been kindly provided. These are for investigations carried out by stand pipe measurements on Western Blanket Bog near Bellacorrig, Co. Mayo. (Tionnsca Abhann Einne—T.A.E.). Measurements were taken across peat fields of 185 ft., 175 ft., 100 ft., 75 ft. and 50 ft. The drains bounding the fields were approximately 4 ft. deep. Original water levels were taken in February 1953 and final levels in April 1954. Intermediate readings were taken in March, April, May, June and October 1953.

Briefly the results bear out the Glenamoy findings showing that the drains have an optimum lateral effect of between 6 and 9 feet. Drops in water level on all fields at midfield may be attributable to evapo-transpiration. A surprising fact is the immediacy of the effect of the drains. In some cases drops of 6" occur in one month.

It is interesting to note that the result of drainage research has been applied in Western Mayo by Min Fheir Teoranta at Geesala. This company produces grass, from reclaimed Western blanket bog, for the manufacture of grass meal. The basic drainage system there is one of 2 ft.-3 ft. drains at 120 ft. spacing. Due to the difficulty of working harvesting machinery over open drains this system is supplemented by mole draining at 12 ft.-15 ft. and about 3 ft. deep. However, some subsidence has occurred as a result of the moleing and local wet areas impossible for machinery have resulted. This experience together with the results of observation has led to a recommendation for the future of a drain matrix at 60 ft. with no mole drains. The success of this venture and of that of the Irish Sugar Company at Gowla using basically similar methods, illustrates that peat can at least be dewatered sufficiently to successfully root grass and to carry quite substantial harvesting machines.

The foregoing information assures foresters that a certain control of water table in Blanket peat may be obtained by varying drain intensities. However, in the interests of economy it is essential that the minimum drainage system capable of growing an optimum crop is required.

The questions now posed are:

1. How effective do we require the drainage to be?
2. How deep will the tree roots go given an optimum root pervious zone. There is an absolute dearth of information on rooting of conifers on deep peat. Steven (1923) is probably the only worker to have approached the problem on a broad scale. His work, however, is of limited value since it preceded mechanical drainage and ploughing. Yeatman (1955) studied the problem authoritatively for upland heaths and the necessity for a similar approach is indicated

for deep peat. Limited local studies are reported by Jack (1965) but these only stress the necessity for further investigation.

A substantial amount of work has however been done on the subject of optimum rooting level for forest trees on low and raised bogs principally by Heikurainen. Dittich (1954) recommends for "low grade" trees such as *Picea*, *Pinus* and *Betula* the ground water must be lowered to at least  $1\frac{1}{2}$  feet below surface.

In essence the answer to the first question above must be — deep enough to provide a rooting medium capable of sustaining a wind stable crop, certainly not less than 18 inches. Fraser's (1962) interesting paper concluded that drainage significantly increased rooting depth especially on peat.

A considerable amount of the information available on the effect of drainage on water-table comes from agriculturalists and until more facts are produced for forestry these must act as guidance together with the forestry figures we have. A standard reference on this subject is Roe (1936) who working at the University of Minnesota investigated the degree of drainage that produced the best practical results with field and horticultural crops. He found for grass that best results were obtained with a  $1\frac{1}{2}$ -2 feet depth to ground water level. While fen peat is vastly different in its water holding properties it is interesting to note that Nicholson and Firth (1958) found a ground water level of  $2\frac{1}{2}$ -3 feet optimum for most crops and 2 feet optimum for potatoes and celery. This example illustrates two marginally interesting points—the difference in permeability of fen peat which enables a ground water level of 3 feet to be achieved and the rooting depth required to provide nutrient for a vegetable crop.

The second question posed above is more difficult to deal with, in other words, it may be asked if it is possible to provide a rooting medium of 3 feet, will the roots penetrate to this level. We do know that in Blanket peat a nutrient gradient occurs down the profile, the highest gradients being at the surface. (Brown, Carlisle and White 1964, 1966; Corden 1961; Binns 1962; Walsh and Barry 1958; O'Hare 1955).

Consideration must be given at this stage to the Division's present system and some comment made on it. The drainage layout currently in use is described by Dallas (1962). This layout produces drains approximately 24" deep at 15 feet spacing. For maximum effect it will be remembered that 12 feet spacing at 3 feet depth is optimum. The above is at least a compromise but it must be asked is it adequate? At this stage reference could be made to the results to date of Divisional experiment—Killeter 1/61. This experiment had as a secondary aim the study of the effect of draining on peat vegetation. Drainage patterns used were:

- (i) Deep (11'-12'') double furrow ploughing at 10' intervals.

(ii) Deep (24"-30") single furrow ploughing at 30' intervals with shallow (9") double furrow ploughing at 10' intervals between.

(iii) Single furrow ploughing (24"-30") deep 6 feet apart.

From ground water level readings taken in standpipes in 1964 and 1966 it appears that the greatest effect comes from the 6 feet spacing single furrow ploughing which provided 33 cubic feet of peat per plant above the water table (Jack 1964). This may be compared with a volume per plant of 15 cubic feet resulting from double furrow ploughing at 10 feet intervals. In profile both water tables were at drain bottom level with a convex rise between drains.

O'Carroll has carried out similar stand pipe experiments at Glenamoy (22/62) and these quite well verify Jack's findings above. This work was done with a combination of normal double furrow Cuthbertson ploughing and single furrows 18" x 24" deep. The single furrow drains in this experiment seemed able to control the water table over a distance of 30 feet keeping it well below the bottom of the double furrow drains.

During the author's recent tour of the main peat utilisation centres of Ireland two facts commenced to impress themselves forcibly. The first of these was the tremendous amount of pre-operational survey work deemed necessary by both Bord na Mona and the Agricultural Institute at Glenamoy. O'Hare (1955) outlines this work well. He quotes: "It may be argued that all this mapping, profile sampling, soil sampling and what not, is unnecessary and that bog is bog no matter where it is. Nothing could be further from the truth. Within the peat types of Ireland, indeed, sometimes in the same profile there is as great a difference in texture as between a heavy clay soil and a sandy loam".

O'Hare then proceeds to state that at Glenamoy, humification on the Von Post Scale varies from H5-6 at the surface to H9-10 on the bog floor. From survey data such information as humification index and moisture percentage for each  $\frac{1}{2}$  metre zone is known. "Information of this type is essential when planning the distance apart at which field drains will be opened and the depth at which main drains will be maintained".

During the extensive literature search just completed the necessity for a more objective consideration of our development areas was further stressed. Continental workers also insist on a detailed survey before work is commenced and drainage systems are all based on scientific facts accumulated for each peat type. This is illustrated well in the works of Werts (1963), Segeberg (1964), Baden (1964) and in *Spravochnik po Torfu* Sec. 6-2. (Bord na Mona Translation).

More thorough examination of peat prior to embarking on an afforestation drainage programme would undoubtedly be profitable. The second of the facts referred to above is the great lack of a

medium for the exchange of information on deep peat. We have in Ireland, two forest services, Bord na Mona, Irish Sugar Company, Agricultural Institute, and Min Fheir Teoranta intimately concerned with peat drainage and yet there is no mechanism for assembling and exchanging information between these bodies. This matter has been raised previously by Barry (1954) and by Mitchell (1954) who wanted an International Institute to consider the problem. At this stage Bord na Mona must be complimented for producing peat abstracts, which unfortunately are not generally known of.

It is hoped that this paper will have refreshed in the minds the basic method of peat formation and illustrated the complexity of the problem of dealing with peat. It was stressed at the start that the paper would not be an "open Sesame" to the problem of producing an efficient drainage system. I hope that it, together with the preceding and succeeding papers, will make people think longer and deeper about peat.

The only definite statement that the study stimulates the author to make is that due to the variable nature of peat, a stereotyped system of drainage cannot be placed on an area of Blanket Bog and success expected. Each area must be considered on its own and drainage systems planned for each taking into account the data accumulated for each. With a planting programme of over 4,000 acres, 80 per cent of which is Blanket Bog the process of education commenced today must continue and as well as indoctrinating Forest Officers in the basic sciences of peat formation and exploitation the work must be carried on to the foresters on the actual job.

Acknowledgement of unreserved assistance from the following bodies is herewith made with grateful thanks:

Agricultural Institute, Ireland.

Forestry Division, Department of Lands, Ireland.

Bord na Mona.

Irish Sugar Company.

Min Fheir Teoranto.

Department of Industrial and Forensic Science, Northern Ireland.

Forestry Division Library.

Ministry of Agriculture, Northern Ireland.

The author is particularly grateful to the Staff of the Chemical Research Division (Soils Section), Ministry of Agriculture, Northern Ireland, particularly to S. McConaghy and Dr. Dickson. Access to the unpublished material of McConaghy and McAllister was most valuable.

#### BIBLIOGRAPHY

1. Anon. Draining Bogs. Spravochnik po Torfu. Sec. 6-2. pp. 132-141. Bord na Mona Translation (E.S.) No. 637.
2. Anon., 1966. Peatland Experimental Station, Glenamoy. Guide. Agricultural Institute (Ireland).

- 2A. Baden W., 1964. Development and present state of bog cultivation. *Angewandte Botanik*, Vol. 28. 2/3.
3. Barry, T. A., 1954. Some considerations affecting the classification of the bogs of Ireland and their peats. *International peat symposium Dublin, 1954 and Irish Forestry Vol. XI*, No. 2.
4. Barry, T. A., 1964. The cut over peats of Cluain Sosta, main bog in 1964. *Bord na Mona Report No. 171(a) and 171(b)*.
5. Binns, W. O., 1962. Some aspects of peat as a substrate for tree growth. *Irish Forestry*. Vol. XIX. No. 1 pp. 32-55.
6. Boate, G., 1652. *Ireland's Natural History*. London.
7. Brown, A. H. F., Carlisle, A. and White, E. J., 1964. Nutrient deficiencies of Scots Pine on peat at 1,800 feet in the Northern Pennines. *Comm. Forestry Review*. Vol. 43(4) No. 118 pp. 292-302.
8. Brown, A. H. F., Carlisle, A. and White, E. J., 1966. Some aspects of the nutrition of Scots Pine on peat. *Supplement to Journal of Society of Foresters of Great Britain*, pp. 78-86.
9. Burke, W., 1961. Drainage investigation on bogland. *Irish Journal of Agricultural Research Vol. 1. No. 1. An Foras Taluntais*. Dublin.
10. Burke, W. and O'Hare, P. J., 1962. Problems of peatland International soil conference New Zealand. *Transactions Internal Society of Soil Science*.
11. Burke, W., 1963. The drainage of Blanket peat at Glenamoy. *International peat congress Leningrad*. Unpublished.
12. Condon, L., 1961. The Progress of Deep Peat. *Afforestation in the North-West. Irish Forestry Vol XVIII No. 1*. pp. 3-18.
13. Dallas, W. G., 1962. The progress of Peatland Afforestation in Northern Ireland. *Irish Forestry Vol. XIX. No. 1* pp. 84-93.
14. Dickson, D. A., 1962. The Indicator value of peatland Vegetation. *Irish Forestry*. Vol. XIX No. 1. pp. 14-32.
15. Dittrich, J., 1954. *Afforestation of Bog Soils. International Peat Symposium. Dublin 1954. Section F.1*.
16. Fraser, G. K., 1954. *Classification and Nomenclature of Peat and Peat Deposits. International Peat Symposium. Section B.2. Dublin 1954*.
17. Fraser, A. I., 1962. The soil and roots as factors in tree stability. *Journal of Society of Foresters of Great Britain*. Vol. XXXV. No. 2 pp. 117-127.
18. Gorham, Eville., 1953. Some early ideas concerning the Nature, Origin and Development of Peat Lands. *The Journal of Ecology*. Volume 41, No. 1. pp. 257-274.
19. Gorham, Eville, 1957. The Development of Peat Lands. *Quarterly Review of Biology*. Vol. 32, No. 2, pp. 145-166.

- 19A. Griffith, R., 1810, 1811. Appendix 4, First and Second Reports of Irish Bog Commission.
20. Hesselman, H., 1932. Om klimatets humiditet i vart land och dess inverkan på mark, vegetation och skog. Medd. fr. st. skogsförsöksanst. 26. Stockholm.
21. Jack, W. H., 1964. Departmental Communication.
22. Jack, W. H., 1965. Experiments on tree growing on peat in N. Ireland. Journal of Society of Foresters of Great Britain. Vol. XXXVIII. No. 1. pp. 20-40.
23. Jessen, K., 1949. Late Quaternary Deposits and Flora-history of Ireland. Proceedings Royal Irish Academy 52. B. 6
24. King, W., 1685. On the Bogs and Loughs in Ireland. Phil. Trans. Vol. 15, 948.
25. Leland, J., 1535-43. Leland's Itinerary in England and Wales, Ed. L. T. Smith, 1906-10 London.
26. McConaghy, S. and McAllister, J. S. V. The peats soils of Northern Ireland—unpublished manuscript.
27. McEvoy, T., 1954. Afforestation of peat soils. International peat symposium Dublin, 1954 Section F.2. and Irish Forestry Vol. XI, No. 2.
28. Mitchell, G. F.
29. Nicholson, H. H. and Firth, D. H., 1958. Journal Agriculture Society. Vol. 50.
30. O'Carroll, R. N., 1966. Personal Communication.
31. O'Carroll, R. N., 1962. The progress of Peatland Afforestation in the Republic of Ireland. Irish Forestry Vol. XIX.
32. O'Hare, P. J., 1955. An approach to peat reclamation. Journal of the Agricultural Science Association (Ireland) Vol. VIII. pp. 18-32.
33. O'Leary Jos., 1955. Main Bog Types. Journal of the Agricultural Science Association. (Ireland). Vol. VIII. pp. 74-79.
34. Parkin, K. F., 1957. Afforestation of Peatlands in Northern Ireland. Irish Forestry Vol. 14 pp. 111-117.
35. Rennie, R., 1807. Essays on the Natural History and origin of Peat Moss. I and II Edinburgh.
36. Rindell, A., 1919. Lärobok i agrikulturkemi och agrikulturfysik. Helsinki.
37. Roe, H. B., 1936. The influence of depth of Ground-water level on yields of crops grown on peatlands. Bulletin 330. University of Minnesota, Agricultural Experiment Station.
38. Segeberg, H., 1964. Determination of deposit density of peat and similar bog soils. Tsschrift Fur Kulturtech and flurbereingung 5 jg. No. 1.
39. Sherrard, E. G., 1953. Reclamation of peatland. British Agriculture Bulletin. Vol. No. 23. pp. 320-324.

40. Steven, H. M., 1923. Root form on peat. Appendix British Forestry Commission Bulletin No. 22 H.M.S.O. London 1954.
41. Tamm, O., 1950. Northern Coniferous Forest Soils. Oxford.
42. Waksman, S.A. (1942. The peats of New Jersey and their utilisation. Bulletin 55, Geologic series. Dept. A. Conservation and Development, State of New Jersey.
43. Walsh, T. and Barry, T. A., 1958. The chemical composition of some Irish Peats. Proceedings Royal Irish Academy. Vol. 59, 15B.
44. Werts, G., 1963. New Research on physical properties of peat and its application in Designing Drainage systems. International peat symposium Leningrad.
45. Wright, T. W., 1959. Forest soils in Scotland. Empire Forestry Review. 38(1) No. 95.
46. Yeatsman, C. W., 1955. Tree root development on Upland Heaths. British Forestry Commission Bulletin No. 21 H.M.S.O. London.
- 46A. Young, A., 1780. A Tour in Ireland. London.
47. Zehetmayr, J. W. L., 1954. Experiments in tree planting on peat. Bulletin No. 22, British Forestry Commission, H.M.S.O. London.

## **“European Peats, Drainage and the Effects of Climate”**

By T. M. BLACK

**C**ONSIDERABLE work has been done in Europe on peat drainage and the methods applied and results obtained are worthy of consideration, especially in view of the large areas of plantation which have been established on deep peat in Ireland.

In Norway Thurmann-Moe has devised a classification for peat bogs which divides them into two main types—wooded and treeless—each of these types is divided into five grades ranging from very good to poor. The grading is done mainly on the basis of vegetation on the grounds that vegetation reflects the nutrient content. However, the degree of humification, depth of bog, and climate all have to be considered. The type of ground mainly afforested in N. Ireland falls into the lowest grade of the treeless section. In another publication Thurmann-Moe makes it clear that he considers only wooded bogs i.e. those carrying birch, Norway spruce, and Scots Pine, are worth draining. In some areas even bogs of this type are considered unsuitable for draining because the increase in production will be limited due to climatic or site conditions (see Löddesöl, 1948). Work on the afforestation of treeless peats has been done in Norway and Table I is one of the products of this research. From this it would appear that the drainage effect in Norwegian peats extends for a considerable distance from the edge of the drain. This is confirmed by Thurmann-Moe who recommends drains 15-30 metres apart and 80-130 cm. deep according to latitude, altitude and rainfall (Thurmann-Moe, 1959).

Sweden is also more concerned with draining existing forests than with afforestation. However the peat bogs and moors which are mainly in the west of the country cover 6,000,000 hectares and if afforested it is estimated would yield 13,00,000 cubic metres per year. The present annual timber production of Sweden is about 50,000,000 cubic metres. (Thorbjornson, 1954).

Finland has probably more experience of peat drainage than any other country in Europe. This is not surprising as about a third of the land surface is peat covered. In the period 1958-1962 more than 450,000 hectares were drained. However, the bogs drained are mainly covered by forests and there is no large scale afforestation of open peat lands. It is interesting to note that fertilisation of peat lands is now common practice. The figure of 450,000 hectares may appear large but Finland has more than 10,000,000 hectares of peatland of which 6,000,000 hectares are forested. It is estimated that about

3,000,000 hectares could be drained economically and a further 1,000,000 could be drained if economics were not considered. In addition it is estimated that nearly 1,500,000 hectares of ordinary firm forest soils need drainage. (Heikurainen, 1960: Kivinen, 1954: Numminen, 1962).

Peat soils can be classified by the plant remains and the following types are distinguished in Finland.

- (1) Sphagnum.
- (2) Eriophorum-Sphagnum.
- (3) Carex-Sphagnum.
- (4) Sphagnum-Carex.
- (5) Carex.
- (6) Bryales-Carex.
- (7) Miscellaneous peats containing wood remains.

Peats in Finland are usually of low humification and it is evidently fairly easy to distinguish the different kinds of peats. The peats containing wood remains are most humified and their identification can cause some difficulties. (Kivinen, 1954: Heikurainen, 1964: Salmi, 1954).

Drains are normally spaced 40-60 metres apart and if the ditch reaches mineral soil a depth of 60 cm. is considered adequate. On deep peat the depth is normally 70-80 cm.

The Soviet Union has vast areas of peatland but forest drainage is apparently concentrated in the north western part of the country. During the period 1959-65 it was planned to drain 843,000 hectares (Pintshuk in Heikurainen, 1964). One worker (Vomperskij, 1958) in discussing surveys of peatland prior to drainage emphasised that ash content of the peat governed the site class. Thus, for Pine, peat of more than 5-6% ash content gave a Class I site: peat of less than 2% ash content gave only Class IV-V sites, while Norway spruce grew well only on peats with an ash content of more than 8%. It was considered that a layer of poorly decomposed peat more than 40-50 cm. thick made the site unsuitable for tree growth, irrespective of the ash content of the peat. The drains formed are seldom closer than 80 metres or deeper than 60 cm. although it is recommended that the mineral soil be reached where possible. It is interesting to note that the planting of dense spruce and pine along ditches has been recommended the idea being that the shade will reduce the overgrowing of the drain bottom. However, it is also recommended that a clear strip be left alongside drains for mechanised maintenance (Timofeev, 1959).

In southern European Russia, conditions are different. Regal (1947) states that irrigation has been used to improve the growth of grasses on acid peat and Kozhanov (1953) describes how the water requirements of agricultural crops on drained peat bog can exceed the pre-

cipitation, and reserves of available moisture, in dry years on the Polesia plain. He recommends watering when the groundwater level falls below 75-80 cm. This practice has increased the yield of perennial grasses by up to 44% and barley by up to 41%.

In Latvia an area of 210,000 hectares was to be drained during the period 1959-65 and experiments (Buss and Sabo, 1959) indicated that the optimum ditch spacings and depths were:—

Sphagnum type peats—100-140 metres apart, 70 cm. deep.

Carex/Phragmites types—160-200 metres apart, 100 cm. deep.

Molinia/Vaccinium types—90 metres apart, 60 cm. deep.

France has only a comparatively small area of peat land, about 100,000 hectares (in Burke and O'Hare, 1962). However, some work has been done on the agricultural reclamation of the Vernier Bog in Normandy. Here the drains are normally 50 metres apart and 75 cm. in depth. A layer of fibrous peat which is relatively pervious has been found at a depth of 60-80 cm. and ground drained to this depth dries comparatively quickly (Ferroniere, 1954). It was also discovered that cultivation resulted in a loss of some of the colloidal properties of the peat and, hence, it has been recommended that the peat should be left bare for as short a time as possible and that a quick growth of vegetation was desirable to protect the peat against loss of moisture (Hedin and Lefebure, 1954).

Holland is another country where peat is evidently not a problem. Pliny has described the origin of the peat industry in Holland in the sentence:— "The mud of their soil they knead with their hands, dry it in sun and wind, after that they burn it to cook their food and to warm their stiff bodies".

One classification of peat in Holland is very simple, only two types being recognised:

*Black peat* which can be irreversibly dried and is used for fuel and *White peat* which is reversible on drying and very hygroscopic.

At one time the most important use of peat moss was in horses stables. However, this use is now decreasing rapidly but new markets are being developed e.g. in horticulture (Sijbolts, 1954).

The Florida Everglades offer a good contrast to European conditions. Most of the Everglades peat is formed from weeds and sedges, mainly saw-grass, and is light and fibrous. Water control is essential and the aim is to keep the water table as high as possible consistent with a proper root environment for the crop. In fallow periods the fields are sometimes flooded as this reduces subsidence and the incidence of some insects and diseases. Hence the drainage system must be capable of dealing with heavy rain and, at the same time, capable of acting as an irrigation system (Forsee, 1963).

A considerable amount of work has been done on the effect of drainage on forested bogs. In Sweden a survey of drained peatlands

showed that all the plots examined, originally unproductive and carrying few trees, had improved and were all covered with young well grown trees. (Borjeson, 1957). In Latvia Buss and Sabo (1959) examined tree growth on a sedge-pine swamp 30 years after drainage was carried out. They found a correlation between tree growth and the distance of the tree from the ditch — the nearer the ditch the better the growth. Other swamp types were also examined and it was found the poorer the swamp the steeper the correlation i.e. the beneficial effects of drainage were lost very much quicker as distance from the ditch increased. Similar studies in Finland also showed a close correlation between drain spacing and the increment of the growing stock after draining (Heikurainen, 1959, in Heikurainen, 1964).

However, Heikurainen and Kuusela (1962) showed that small trees grow better after drainage than big ones. The marginal dimensions of the size over which height increment cannot revive appear to be about 15 cm. diameter at breast height and 12 metres in height. In regard to radial growth only the marginal dimension of 22 cm. diameter was found. Over these size values trees grow less after drainage than before it. Age had some effect in that the youngest trees increased their height increment most, trees 30-70 years of age grew fairly well, and the oldest trees hardly grew at all after drainage. However, it was concluded that the size of the trees at the time of draining was more important than the age.

Ground water levels have also been studied and Huikari (in Heikurainen, 1964) found that only with very narrow spacings of 5-10 metres could the ground water level be definitely lowered; with spacings of 40-100 metres no clear differences were found. The effect of drain spacing on run-off was also studied and here also it was found that very narrow spacings (5-10 metres) were required to increase the run-off. These results were obtained on infertile Sphagnum swamps and it would appear from the generally beneficial effect of drainage on tree growth that the results are different on better, more fertile swamps.

The drying characteristics of peat turfs have been studied and some results are of interest in that they underline the difficulty of draining or drying peat. The drying characteristics of peat sods depend on the physical and chemical manner in which water is held by the peat.

Ostwald states that water held by peat may be divided into the following categories:—

- (1) Occluded water, held in pores over 1 mm. in diameter.
- (2) Capillary water, held between and within capillary walls.
- (3) Colloidally bound water.
- (4) Osmotically held water within undecomposed plant cells.
- (5) Chemically bound e.g. water of crystallisation.

A simpler classification (Stadnikoff's) only distinguishes two categories :—

(1) Mechanically held water which is easily removed by pressure, and

(2) Colloidally bound water. (See Dalton, 1954).

However, tests on pressing samples of peat at 450 lbs. per sq. in. for a period of two minutes have indicated that the moisture content can only be reduced from 90% to between 70 and 80% (Grinsted, 1954).

Ditches obviously vary in their draining effect under different conditions and in different peats. Field capacity can be defined as the amount of water held in a soil after the excess has drained away. Drains cannot reduce the moisture content below field capacity and since the field capacity of peats is high the direct effect of ditches must be comparatively limited (Heikurainen, 1964). This is especially true of well humified peats with their very low permeability (see Table II). Furthermore, the effect of drains has, in many cases, been measured by the drop in the ground water table. This is by far, the simplest and most convenient method of measuring drainage effect. However, the correlation between the level of the ground water table and the moisture content of the peat above this level is known for a few peat types only and it is clear that the existence of the ground water table at, say, 25 cm. does not imply that 25 cm. is available as a rooting medium. In Finland tests indicated that water content was linearly related to the depth of the water table (Heikurainen, Paivanen, and Sarasto, 1964), but the relationship depends entirely on the type of peat and degree of humification.

The relationship between climate and drainage has been investigated and in Norway Thurmann-Moe (1963) distinguished five climatic divisions giving conditions suitable for drainage. The divisions are based on summer temperatures, the mean monthly temperatures for the four months June-September being considered. If the temperature falls between 13.6 and 14.°C conditions are considered to be excellent for draining. The other divisions are :—

Very good	12.4-13.6°C
Good	11.7-12.4°C
Fairly good	11.1-11.7°C
Moderately good	10.5-11.1°C

Rainfall is also important but the effect of high rainfall in reducing the suitability of an area for draining will be less for high than for low temperatures.

In Finland the country has been divided (by Heikurainen, 1963 and 1964) into five climatic zones based on the growth of the trees within these climatic zones. The zones are related to latitude and in

the northern one which is situated on the Arctic Circle forest drainage is hardly carried out at all.

Robertson, Nicholson and Hughes (1963) studied the run-off from a raised bog in Lanark having a *Calluna*/*Eriophorum*/*Sphagnum* vegetation. The average rainfall was 32 inches per annum and the run-off was equal to 19 inches per annum. It was concluded that the 41% loss of water was due to evapo-transpiration. Huikari (1960) in a Finnish study concluded that evaporation, especially in dry summers, had a greater drying effect than seepage into drains. He also concluded that the amount of tree growth had a decisive drying effect and that drain spacing was more important than drain depth.

There are several reports of the drying effects of forest cover. Two adjacent catchments in the Harz Mountains, one having a heavy crop of Norway spruce and the other a short grass crop were studied and it was concluded that the evaporation from the forest area was about 10% greater than from the grass area (in Penman, 1963). In Yorkshire Law (1956) compared water losses from a small plantation of Sitka spruce with those from adjoining grass land and concluded that Sitka spruce was responsible for the loss of 11 inches of rainfall more than the grass. In the Phillippines the piped water supply from a small stream failed regularly for a few hours in the afternoon and recovered in the evening. This was attributed to heavy transpiration by the forest on the catchment area (Wendover, 1950). Clear felling of aspen in Wisconsin resulted in a rise in the water table of 14 inches and converted a well drained soil into a semi-swamp (Wilde and others, 1953, in Penman, 1963).

The total evaporation from an area covered with vegetation consists of the following components:—

- (1) Evaporation of intercepted water.
- (2) Transpiration.
- (3) Evaporation from the soil.

The amount of intercepted water depends on the kind and amount of the precipitation and its frequency. Interception is influenced mainly by (a) the amount of water required to saturate the canopy surfaces (b) the size of individual showers, especially if the showers are too light to saturate the canopy surface and (c) the evaporation between showers, creating dry surfaces and allowing the interception of subsequent showers (Rutter, 1963: Aranda and Coutts, 1963). Rutter (1963) found that 32% of the annual precipitation was intercepted by the crowns of a 16 year old stand of Scots pine. Norway spruce has been reported as intercepting 26% of the annual rainfall, and beech 7.5% (Eidmann, 1959).

After a swamp has been drained surface evaporation will decrease and one experiment in Finland (Multamaki, 1942), in Heikurainen, (1964) showed that evapo-transpiration on a drained bog was only two thirds of that on an undrained bog. After drainage, however,

the growth of the trees normally improves and thus total transpiration increases. Another Finnish work indicated that evapo-transpiration from a wooded strip was more than twice that from an open strip (Huikari, 1959, in Heikurainen, 1964). In Russia a straight-line relationship was found to exist between the volume of water transpired and the current annual increment of stands of Aspen (Smirnov and Odinokova, 1954).

A study of oak, beech and Norway spruce stands on similar soils in Denmark showed that during the growing season oak lowered the watertable by 205 cm., beech by 115 cm. and Norway spruce 75 cm. The lowering of the watertable under the beech and spruce occurred over 3-4 months but under the oak the lowering took place in less than 6 weeks (Holstener-Jorgensen, 1959). It has been shown for some agricultural crops e.g. wheat, maize and beet that transpiration during the short rapid growth stage which normally lasts about 30-40 days accounted for 70-85% of the annual water consumption (Kállay, 1966).

The transpiration of individual trees varies with crown size, crown shape, and between light and shade trees. Under Danish conditions birch, oak and poplar have much lighter transpiration rates than ash, alder, beech and sycamore. The estimated daily water consumption in June for a stand of 25-30 year old beech having 1381 stems per hectare was found to be as follows:— On a sunny day with an air humidity of 60-70% and a temperature of 20-25°C the consumption was 40,000 litres per hectare. This dropped to 20,000 litres per hectare on a dull day with air humidity 85-90% and air temperature 13-16°C. In wet weather the water consumption was found to be negligible. When soil moisture is high, water consumption evidently depends mainly on light intensity and air humidity, less on air temperature in the range 10-20°C, while wind strength has a slight effect (Ladefoged, 1956).

The volume of water transpired varies with species. Birch was found to be a heavy transpirer in Denmark (Ladefoged, 1956) and other Scandinavian work also showed that it transpired more than Scots pine or Norway spruce (in Heikurainen, 1964). There are also numerous reports on transpiration differences between provenances of the same species. In European larch northern and lowland provenances transpire more on cool days than southern and Alpine provenances. The northern and lowland provenances conversely transpired less on warm days. Polish provenances had the lowest total transpiration and restricted their transpiration most under conditions of reduced moisture (Kral, 1962). A Russian study of oak also showed the existence of provenances whose transpiration rates differed by up to 37%. (Sütjaev, 1964).

The amount of available moisture influences the water uptake of trees. In America evapo-transpiration was found to be nearly 3.5 inches greater in swamps having a high stable watertable than

in nearby swamps where the rooting zone dried out (Satterlund, 1961). Studies of 23 year old oak/ash stands in Russia showed that ash had the greater ability to adapt its water uptake to the water supply. It was better able to limit it in dry weather and was able to increase it sharply when sufficient moisture was available (Krasulin and Pankratova, 1957). Thus in suitable climatic conditions where large quantities of soil water are available transpiration will be heavy.

The amount of evaporation which can take place from a bare soil is limited. Evaporation at the soil surface sets up a suction gradient and at the same time the soil permeability is decreased. This limits the amount of water which can be lost from the soil surface (Penman, 1963). Apparently this is also true of peat. In any case the amount of evaporation which can take place from the soil surface under forest is severely limited.

From time to time the view has been expressed that a vigorously growing tree crop would help to dry out the peat on which it was standing. It was stated earlier in this paper that evaporation from a wooded area could be divided into:—

- (1) Evaporation of intercepted water.
- (2) Transpiration.
- (3) Evaporation from the soil.

It has been pointed out that evaporation from the soil under a tree crop will be limited. This means that transpiration and the evaporation of intercepted water will be the main agents in this drying out. Investigations into the relationship between evaporation of intercepted water and transpiration showed that under the same atmospheric conditions the evaporation of intercepted rainfall was greater than the transpiration rate. This was due to the diffusive resistance of the stomata and a boundary layer of still air at the leaf surface (Anon. 1962). A Russian study also showed that water intercepted by the crowns of trees could reduce the water lost by transpiration (Rahmanov, 1958).

The relationship between transpiration and the evaporation of intercepted rainfall is important, but both are dependent on one factor: a supply of energy to transform liquid into vapour. It takes approximately 590 calories at ordinary air temperature to vaporise a gram of water and the amount of energy available, which is initially supplied by radiant sunshine, is limited and can not be increased.

If it is hoped that forests will help to dry out peat then full use must be made of the limited amount of energy available for evaporation. This could probably best be done by (1) planting species e.g. birch, and provenances of species which transpire heavily and (2) by developing large crowns on the trees to present as

large a surface for evaporation as possible thus making full use of the available energy. The importance of this is seen from figures for Glenamoy, Co. Mayo which indicate that out of a total rainfall of about 55 inches only 20 inches are evaporated, leaving an annual surplus of 35 inches.

The optimum depth of the watertable has been determined for different agricultural crops but no comparable data exists for trees. In Norway Thurmman-Moe (in Heikurainen, 1964) concluded that the ground water level should be at a depth of 30 cm. In Estonia it was considered that 40-50 cm. was the optimum. In Latvian swamps Sabo found the following ground water depths to be adequate:

Pine 18 cm. Norway spruce 29 cm. Birch 42 cm. (in Heikurainen, 1964).

Other investigators have found that Birch and Scots Pine were less sensitive to poor drainage than Norway spruce (Orlov, 1959: Meshechok, 1963). However, Yeatman (1955) concluded that tree roots will only freely exploit soil that is porous and well aerated.

It has been frequently stated that the root systems of swamp trees are shallow. This applies even to tree species which normally have a deeply penetrating tap root. On peat these species either have no tap root or at best, it is very poorly developed (Heikurainen, 1964). This was found to be the case with Scots Pine growing on sphagnum peats in Russia. Here, although the watertable was 50-60 cm. below the surface the trees had an entirely superficial root system (Ogievskij, 1958). One comparative study of seedlings of aspen, birch pine and spruce indicated that Scots pine had the greatest root development under wet conditions (Jarvis, 1963).

Heikurainen (1955) investigated the root systems of Scots pine stands on Finnish bogs and reached the conclusions that (1) the greater the mean annual increment the greater the root system (2) 85-90% of the roots were in the top ten centimetres of peat and even on effectively drained peats few roots penetrated below 20 cm. (3) the quantity of long roots found was large, the total length of roots often exceeding 1 km/cu.m. of soil. It was also found that 85% of the roots were greater than 1 mm. in diameter.

A detailed study of a 65 year old Scots pine stand gave the following figures:—

70% of the roots were in the top 5 cm.

20% of the roots were in the 5-10 cm. layer.

8% of the roots were in the 10-15 cm. layer and

2% of the roots were in the 15-20 cm. layer.

A correlation was also found to exist between the average ground water level and the depth of the root system. A drop of 10 cm. in the ground water level during the growing season meant a difference of about 1 cm. in the average depth of the root system (Heikurainen, 1964).

Another Finnish study indicated the existence of a correlation between drain spacing and average root depth. With a drain spacing of 80 metres the average rooting depth was 4.7 cm., with drains 40 metres apart the rooting depth increased to 5.4 cm. and when the drains were only 5 metres apart rooting depth increased to 6.8 cm. (Paavilainen, Heikurainen, 1964).

Hence, it would appear that even under Finnish conditions increased drainage does not greatly increase root depth. It has been stated that the advantages of a deep rooting system are more related to water supply than to nutrient supply and it has also been stated that there is no inherent need for a tree to have deep roots (Anon., 1960). Consideration of this evidence indicates (1) that the advantages of deep rooting are more connected with stability than with growth and (2) that the surface rooting of Sitka spruce under our conditions is only to be expected and does not indicate that growth will suffer because of shallow rooting.

This literature survey has indicated that under Irish conditions the following points are, at least, worth considering:—

(a) The effectiveness of any drainage system depends on the permeability of the material being drained. In view of the low permeability of most peats, especially in the deeper more humified layers, the value of deep drains is limited. The actual depth of drain which should be aimed at will vary with the type of peat and is, in any case, open to debate but deepening beyond three feet will apparently serve no useful purpose.

(b) Many forests are situated on areas endowed with surplus water. This is self evident as surplus water is essential for the formation of blanket bog. Any drainage system should aim at getting rid of as much surplus water as possible. On the Irish Grass Meal Company's farm at Gowla, Co. Galway which is situated on a raised bog the bog surface between the drains is cambered so that all surplus water is got rid of as soon as possible. Any drainage system on blanket bog should be designed with the same object in view.

(c) As was suggested previously full use must be made of the energy available for evaporation and, accordingly, the aim should be to develop large crowns on the trees to present as large a surface for evaporation as possible. If these crowns have a low centre of gravity the stability of the trees will improve, an advantage in view of the shallow rooting on blanket bog.

TABLE I

"Experiments with Afforestation on Peatland in Norway"

By B. MESHECHOK

International Peat Congress, Leningrad, 1963

Ditch intervals for different ditch depths for various, assumed drainage norms: the precipitation June-September=300 mm.

Drainage norm (i.e. mean distance from peat surface to ground water level) in cm.	Ditch depth in cm.					
	40	50	60	70	80	90
	Ditch intervals in meters					
<i>For ombrogenous peatland :</i>						
20	21	30	38	46	53	61
25	13	21	28	35	41	47
30	7	14	21	27	33	38
35	3	9	15	21	26	31
40		6	11	16	21	25
<i>For soligenous peatland :</i>						
20	29	41	53			
25	20	30	39	49		
30	13	21	30	38	46	
35	7	16	23	30	36	43
40		11	18	24	30	35

It is pointed out that the figures in the table are valid under conditions existing in the soil with precipitation in June-September being 300 mm. As normal precipitation varies greatly for various localities, it was useful to try to find a method for making corrections. From the material the following, simple, empirical formula was obtained :—

$$E = E \frac{\times 300}{N}$$

where E=effective ditch interval in metres for normal precipitation N

N for each specified place (for June-September).

E=effective ditch interval with precipitation June-September=300 mm

which was chosen for the ditch depth specified in the above table.

300=constant precipitation in mm. assumed for this table.

N=normal precipitation during June-September for the area under investigation.

That formula may be used for corrections in places with normal precipitation of about 200 to 500 mm during June-September.

TABLE II

*Vertical Permeability Values (Sarasto, 1963)*

The values are in litres per hour from samples having a basal area of 100 cm<sup>2</sup> and a height of 5 cm.

Sample	<i>Degree of humification (von Post, 1922)</i>							
	1	2	3	4	5	6	7	8
Sphagnum peat	14.9	9.4	2.1	0.9	0.7	0.2	0.2	0.1
Sedge peat	—	9.3	4.5	0.9	0.7	0.5	0.3	0.2

## BIBLIOGRAPHY

- Anon. (1960). "Effect of substrate depth on the growth of seedlings of *Picea moriana*, *Pinus banksiana*, *Larix laricina* and *Betula lutea*". Rep. For. Res. Fac. For. Univ. Toronto 1959-60. (For. Abstr. Vol. 22 (3): 2871).
- Anon. (1962). "A study of the water cycle in a plantation of Scots Pine". Res. Rep. Royal Coll. Sci., Imp. Coll. Sci. & Tech., London 1959-62.
- Aranda, J. M. and Coutts, J. R. H. (1963). "Micrometeorological observations in an afforested area in Aberdeenshire: rain-fall characteristics". J. Soil Sci. Vol. 14 (1); 124-33.
- Borjeson, P. (1957). "Studies of increment on drained peatlands, situated mostly in the coast districts of Västerbotten". Norrlands Skogsv. Förb. Tidskr. (1). (For. Abstr. Vol. 18 (4): 4039).
- Burke, W. and O'Hare, P. J. (1962). "Problems of Peatlands". International Soil Conference, New Zealand.
- Buss, K. and Sabo E. D. (1959). "The intensity and economic effectiveness of drainage in some forest types of Latvia". Metsak. Kusimusi. Eesti N.S.V. Teaduste Akadeemia, Tartu. p.p. 55-68. (For. Abstr. Vol. 21 (3): 3124).
- Dalton, J. (1954). "Air Drying of Peat". International Peat Symposium, Dublin.
- Eidmann, F. E. (1959). "Interception in beech and spruce stands; results of investigations over a number of years in the Rothaar Mountains (Sauerland)". Assoc. Inter. d'Hydrolog. Sci., Gentbrugge No. 48.
- Ferroniere, Y. (1954). "The Agricultural Utilisation of Vernier Bog". International Peat Symposium, Dublin.
- Forsee, W. T. (1963). "Crop production on peat and muck under sub-tropical conditions of the Florida Everglades". International Peat Congress, Leningrad.

- Grinsted, B. (1954). "The Mechanical Dewatering of Peat by Means of Pressure". International Peat Symposium, Dublin.
- Hedin, L. and Lefebure, J. M. (1954). "Investigation on the formation of Grassland in the Vernier Bog". International Peat Symposium, Dublin.
- Heikurainen, L. (1955). "Structure of the root systems of Pine stands on wet peat moors and the effect of drainage on these systems". *Acta For. Fenn.* 65 (3).
- Heikurainen, L. (1960). "The possibilities of Forest Drainage in Finland". *Metsät. Aikat.* (12), 439-42.
- Heikurainen, L. (1963). "Results of draining peat lands for forestry in Finland". International Peat Congress, Leningrad.
- Heikurainen, L. (1964). "Improvement of Forest Growth on Poorly Drained Peat Soils". *Inter. Rev. For. Research*, Vol. I.
- Heikurainen, L. Kuusela, K. (1962). "Revival of the tree growth after drainage and its dependence on the tree size and age". *Commun. Inst. for. Fenn.* Vol. 55 (8).
- Heikurainen, L., Paivanen, J. and Sarasto, J. (1964). "Groundwater table and water content in peat soil". *Acta For. Fenn.* 77 (1).
- Holstener-Jorgen, H. (1959). "Investigations of root system of Oak, Beech and Norway spruce on morainic soils affected by groundwater". *Forstl. Forsögsy. Danm.* 25 (3), 225-89. (*For. Abstr.* Vol. 20 (4), 4251).
- Huikari, O. (1960). "The hydrology of drained peat sites carrying forest, in relation particularly to ditch spacing and depth". *Metsä Aikak* 6-7).
- Jarvis, P. G. and Jarvis M. S. (1963). "The water relation of tree seedlings". *Physiol. Plant.*, Copenhagen 16 (1): 215-53.
- Kállay, K. (1966). "Water regime of the soil as affected by vegetation". Symposium on water in the unsaturated zone, Wageningen.
- Kivinen, E. (1954). "The Classification and Chemical Properties of Peat Soils in Finland". International Peat Symposium, Dublin.
- Kozhanov, K. Y. (1953). "Regulating the moisture of peat bog soils". *Trudy Inst. Melior, vodn. belotn. khoz. Akad. Nauk, Belarus. SSR* 3, (200-242).
- Kral, F. (1962). "Comparatively studies of transpiration of *Larix decidua* provenances". *Cbl. ges. Forstw.* 79 (4), 223-38.
- Krasulin, N. P. and Pankratova, N. M. (1957). "Transpiration as an indicator of water uptake by the roots of tree species". *Dokl. Akad. Nauk. SSR* 113 (4). (*For. Abstr.* Vol. 19 (1): 84).

- Ladefoged, K. (1956). "Studies on water consumption by trees". Dansk Shovforen. Tidsskr. 41 (10), 481-506.
- Law, F. (1956). "The effect of afforestation upon the yield of water catchment areas". For. Abstr. Vol. 19 (3), 2663.
- Löddesöl, A. (1948). "Peat Bogs in the Service of Economic Production". (p.p. 156-179). Gröndahl & Sons, Oslo.
- Meshechok, B. (1963). "From experiments with afforestation on peatland in Norway". International Peat Congress, Leningrad.
- Numminen, E. (1962). "Metsäojitustilastoja vuoden 1961 loppuun asti kerättynä". Suo (3), 41-47.
- Ogievskij, V. V. (1958). "The effect of site factors on the form of the root systems of 17 to 20 year *P. sylvestris* in plantations in Leningrad province". Bot. Z. 43 (11). (For. Abstr. Vol. 20 (3): 2934).
- Orlov, A. J. (1959). "Distribution of the absorbing roots in the layer of over-moist soils in Spruce forests, in relation to aeration". Bjulleten Monk. Obsc. Isp. Prirody 64 (1) (For. Abstr. Vol. 23 (1): 241).
- Penman, H. L. (1963). "Vegetation and Hydrology". Tech. Comm. No. 53, Comm. Bureau of Soil.
- Rahmanov, V. V. (1958). "Is precipitation intercepted by tree crowns lost to the forest" Bot. Z. 43 (II). (For. Abstr. Vol. 20 (3): 2717).
- Regel, C. (1947). "The Bogs and Swamps of White Russia". J. Ecology Vol. 35.
- Robertson, R. A., Nicholson, I. A. and Hughes, R. (1963). "Run-off studies on a peat catchment". International Peat Congress, Leningrad.
- Rutter, A. J. (1963). "Studies in the water relations of *Pinus sylvestris* in plantation conditions". J. Ecology Vol. 51; 191-203.
- Salmi, M. (1954). "Investigation of the Calorific Values of Peat in Finland". International Peat Symposium, Dublin.
- Sarasto, J. (1963). "A study of the water permeability of different kinds of peat". Suo (3).
- Satterland, D. E. R. (1961). "Some interrelationships between ground water and swamp forests in the western Upper Peninsula of Michigan". Abstr. of thesis in Dissent. Abstr. 21 (8). (For. Abstr. Vol. 23 (1): 210).
- Sijbolts, R. (1954). "The peat industry in Holland". International Peat Symposium, Dublin.

- Smirnov, V. V. and Odinokova, N. S. (1954). "The hydrological role of Aspen woods". *Dokl. Akad. Nauk SSR* 99 (5). (For. Abstr. Vol. 16 (3), 2620).
- Sütjaev, A. M. (1964). "The transpiration characteristics of various climatic types of *Quercus robur*". *Fiziol. Rost.* 11 (5): 906-11. (For. Abstr. Vol. 26 (2), 1789).
- Thorbjornson, B. (1954). "The General Aspects of Peat Development in Sweden". *International Peat Symposium*, Dublin.
- Thurmann-Moe, P. (1959). "Preliminary recommendations for applying fertilisers on wet peat soils, poor in nutrients, in order to grow trees". *Norsk. Skogbr.* 5 (1).
- Thurmann-Moe, P. (1963). "Climate and Forest Drainage". *Norsk. Skogbr.* 9 (9).
- Timofeev, A. F. (1959). "Shading drainage ditches to control overgrowing by ground vegetation". *Lesn. Hoz.* 12 (9). (For. Abstr. Vol. 23 (2): 2001).
- Vomperskij, S. E. (1958). "Methods of assessing wet peatland in surveys with a view to forest site improvement". *Lesn. Hoz.* 11 (11). (For. Abstr. Vol. 21 (2) 1346).
- Wendover, R. F. (1950). "Observations on the effect on stream flow of transpiration from the forest cover". *Philipp. J. For.* 7 (1-4). (For. Abstr. Vol. 14 (3), 1903).
- Yeatman, C. W. (1955). "Tree root development on upland heaths". *For. Comm. Bull.* No. 21.

## Notes on Eighteenth Century Irish Nurserymen

By EILEEN MCCrackEN

**P**LANTING in Ireland began in the eighteenth century. There was of course ornamental planting long before; the mention in old records of such species as elm, lime or chestnut which are not native shows that there was some and during the seventeenth century the occasional landlord inserted a clause in his leases binding the tenants to put in some trees, often in hedgerows. But planting as we understand it, the growing of trees alone on a number of acres as a crop as opposed to an amenity, began in the eighteenth century. It is true that the acreages involved were very small: towards the end of the century when the Dublin Society (the Royal Dublin Society after 1820) was paying premiums of £4 an acre to encourage planting the largest amount claimed in any one year was £132 on 33 acres and this was a very exceptional figure—practically all claims were for 10 acres.

It is not difficult to find reasons why the eighteenth century saw the commencement of Irish planting. The native woods, which had sustained the export timber trade during the previous century, were becoming exhausted and sometime between 1696 and 1711 Ireland ceased to be a timber exporting country and became, in part at least, dependent on imported wood.<sup>1</sup> Between 1689 and 1791 fourteen acts of parliament were passed relating to planting all of which had as their object either enforcement of preservation or compulsory planting or safeguarding of tenants' rights over timber they themselves had planted. The number of trees to be planted was prescribed for each country and the onus was laid on tenants to make a return of the numbers which they put in. It is extremely unfortunate from the point of view of the history of planting in Ireland that these records, which covered the greater part of the eighteenth century and the whole of the nineteenth century, were destroyed in the Four Courts, Dublin, in 1922; only the volume for Londonderry has survived. Apart from the legal obligation to plant, after the Williamite war Ireland had a hundred years of peace, in contrast to the turbulence of the previous century, and landowners could feel reasonably secure in the possession of their estates and reasonably confident that their families would reap the fruit of any planting they undertook. The eighteenth century landowner was not unaware that trees were a capital investment: Edward Cooke writing from Kilkenny in 1724 says 'My father (in law), who is an oracle in everything that does not concern himself, lays it down . . . that no wood is worth preserving which will not pay interest upon interest, and this I heard often before I knew him, and believe to

be true . . . I take it, trees do not grow in equal value yearly, I do not know what value to put on an acorn and yet I am fully convinced that sowed in proper soils and preserved would produce in forty years £10 (?) and I fancy you think so too especially if planted in the county of Wicklow'.<sup>2</sup>

That the Irish suffered from a chronic inability to enclose the plantations they made and protect them from cattle is beside the point: trees were put in the ground even if they failed to mature and those trees had to be obtained from somewhere. Some estates had their own nurseries but these were usually for the use of the estate, and sometimes the tenants, and the general public could not buy from them. The need for public nurseries was underlined by an act of 1710 (9 Anne c.5) which laid down that the compulsory planting had to be done with trees out of nurseries and not to be taken from an existing wood or other places as was frequently 'practised to the destruction of woods and timber'. To protect nurseries from theft an act of 1776 (15 and 16 Geo. 111 c.26) imposed a penalty of £5 fine or six months imprisonment for stealing plants from one.

Reference to the list of public nurserymen at the end of this article will show that many nurserymen, particularly in towns, were also seedsmen and that in country towns they sometimes sold other quite unrelated things. This duplication of trades was common practice during the eighteenth century. But the combination of seedsman and apothecary was not surprising in view of the close connection between medical remedies and plants. The nurserymen were not essentially specialists in trees, they sold many other sorts of plants<sup>3</sup> but it is clear from their price lists that young trees were an important part of their stock. Even allowing for the fact that it is more likely for evidence of the existence of a Dublin nurseryman to survive than one in the depths of the country it is reasonably certain that the area around the capital was much better served with nurseries than the outlying areas. It was a common complaint during the eighteenth century that outside of Dublin young plants were hard to come by and this complaint seems justified, few countries had more than three or four public nurseries. The importance of country customers to Dublin nurserymen is borne out by their frequent assertion that they paid particular attention to their country trade. Even so the plants usually arrived at their destination in poor condition having travelled for a number of days and been roughly handled by the carmen.

Several of the more prominent nurserymen issued price sheets or catalogues. Until recently the only price lists available were a few published in the newspapers but Edward Bray's Catalogue, which is a small booklet of several pages published during the 1780's, has turned up in the Fingall collection<sup>4</sup> of papers in the National Library, Dublin. Price lists that are also in the Fingall collection include

those of Patrick Adams,, George Cottingham, John McEvoy and the Foundling Hospital. There are also the catalogues of some English nurserymen and a bill heading of Edward Bray's.

Practically all the information on Dublin, Cork and Limerick nurserymen comes from advertisements in newspapers. Outside of the towns the chief sources are the county surveys published at the end of the eighteenth century under the aegis of the Dublin Society and the premiums offered to nurserymen during the eighteenth century. The latter source tends to be unsatisfactory in that frequently only the name of the nurseryman is given without any indication of his location in the county.

The Dublin Society endeavoured to encourage the establishment of public nurseries in three different ways: by offering premiums for new nurseries or extensions of existing ones,, by offering premiums on young trees sold from nurseries and by providing a fee for boys taken by nurserymen to train as apprentices. The Dublin Society was founded in 1731 and one of its first premiums was in the early 1740's for seedlings raised in nurseries. In 1741 £10 was offered for the greatest number of forest trees (to distinguish them from fruit trees) raised in nurseries and in 1744 and 1746 £20 and £10 were offered to the growers of the two greatest numbers, over a minimum of 15,000, of oak, ash, elm, beech, chestnut or walnut 'planted out from the nurseries'. During the 1750's premiums were given for sowing the greatest areas with acorns at the rate of half a barrel per acre and this was increased to a barrel (3½ bushels) in 1760. In 1764 new nurserymen were offered premiums of £10, £7 and £5 for sowing not less than 1 lb. of Scots fir seed.

Recognizing the difficulty that country people had in obtaining plants the Society from 1760 onwards offered special premiums to country nurserymen. In 1763 premiums of £10, £7, and £5 were offered to the first three men, who had been trained as nurserymen but had not yet opened their own nursery, who sowed and enclosed an Irish acre\* with a bushel of seed. The nurseries were to be more than ten miles from the sea and over forty miles from Dublin with a rent under £20 annually and a lease of three lives or thirty one years. Security had to be given that the nurseries would continue to be operated.

Changes in the method of awarding premiums were made in subsequent years. In 1765 the first person in each county to offer two year old plants for sale in a nursery within three miles of a country town could claim a bounty of £1 an acre on a maximum of three acres for three years. In other words a nurseryman could claim a maximum of £9 and the Society was prepared to pay out a total of £288. The following year, 1766, the bounty was increased to 30/- a year and the acreage to five acres so the Dublin Society was now committed to an outlay of £720 over the following three years.

The premium was increased in 1769 to £5 a year for three years for one acre and £2 for every succeeding acre and in 1770 the premium to any one nursery was limited to £13. After 1781 the premium was fixed at £4 an acre for every acre of new nursery ground in each county except Dublin, a provision which reflects the fact that Dublin was well served by the nurserymen in and around the capital. The last premium to nurserymen under this scheme was paid to Patrick Carroll of Meath in 1791.

\* All acreages in this article are in Irish or plantation measure of which one was equivalent to 1.6 English acres.

In all the Dublin Society paid out £987 on 217 acres between 1769 and 1791. Of this sum £477 was paid on 163 acres after 1781 when the flat rate of £4 an acre was introduced.

The second way in which a public nurseryman could obtain help from the Society was by applying for a premium on the number of trees he sold. This type of premium was introduced in 1780 and was given on young trees between two and five years old at the rate of 4/- per thousand for oak, beech, hornbeam, chestnut, walnut, elm, plane and Norway maple; 2/- per thousand for larch, Scots pine and spruce and 1/- per thousand for ash and birch. The Society was prepared to spend £400 annually on this type of premium and if the claims exceeded this amount preference would be given to the nurserymen who sold their plants most cheaply. Between 1780 and 1795, when the premiums were discontinued, £3,035 was paid to nurserymen.

The Dublin Society expended just over £18,000 on planting in all its aspects between 1766 and 1806. Of this £4,000 went directly to nurserymen, £8,500 to planters and £6,000 to 'fringe planting'—that is on fencing coppice, setting quicks for hedges or raising willows, sallows etc. for basket-makers, coopers or hop growers etc. The following table shows how the money in the first two categories (nurserymen and planting) was distributed over Ireland.

<i>County</i>	<i>To nurserymen</i>	<i>To planters</i>
	<i>(To the nearest £)</i>	
Antrim	11	35
Armagh	10	141
Carlow	8	54
Cavan	11	89
Clare	50	353
Cork	34	260
Donegal	14	285
Down	29	60
Dublin	342	146
Fermanagh	12	86
Galway	1,887	1,794

<i>County</i>	<i>To nurserymen</i>	<i>To planters</i>
	<i>(To the nearest £)</i>	
Kerry	712	322
Kildare	16	138
Kilkenny	34	252
Leitrim	137	49
Leix	137	195
Limerick	5	31
Londonderry	22	—
Longford	5	275
Louth	526	212
Mayo	23	306
Meath	222	57
Monaghan	—	—
Offaly	32	191
Roscommon	18	39
Sligo	—	83
Tipperary	68	840
Tyrone	24	540
Waterford	63	126
Westmeath	18	237
Wexford	54	145
Wicklow	40	684

\* Exclusive of fee for apprentices.

It can be seen that in five counties, Galway, Kerry, Louth, Dublin and Meath, nurserymen received more than planters. About two-thirds of the premium money for nurserymen fell into the hands of the two Maddens in Galway, O'Brien in Kerry and M'Evoy in Meath.

A form of premium was introduced by the Dublin Society in 1800 which indirectly could have been to the advantage of nurserymen if it had been widely used but this type of premium does not appear to have attracted planters. This was planting by contract. Under this scheme six premiums were offered yearly until 1807. The first three were of £100 each for the three greatest acreages over a minimum of 20 acres. The planter was to enter into a written contract with a public nurseryman who was to plant at least 8,000 trees to the acre and replace loses for three years. Species had to include at least 3,000 oak or larch, and sallow, poplar, birch and horse chestnut were excluded. The nurseryman's obligation ended at the end of the third year but the planter had to have at least 6,000 trees on an acre at the end of ten years.

After 1789 the Dublin Society offered £10 as a fee for each apprentice taken by a nurseryman, provided he paid an equal sum to the apprentice on the completion of his course which was to include instruction in grafting, planting and rearing of trees. The

Society was prepared to expend £500 this way limiting the amount any one nurseryman could claim to £20 a time. Preference was to be given to boys from the Charter Schools, the Foundling Hospital and the Hibernian Hospital. The fee was raised to £12 in 1784 to nurserymen with over five acres and the amount to be paid to an apprentice at the end of his term was reduced to £6. As can be seen from the appended list of nurserymen only seven made use of the scheme, taking fourteen apprentices between them.

The special mention of Charter Schools, the Foundling Hospital and the Hibernian Hospital is of some interest. Special premiums for planting were offered at different periods to these bodies and the latter two ran their own nurseries, partly for income and partly to train boys as gardeners.

Although the practice of offering fees for apprentices lapsed at the end of the century a modified form of training young men was introduced by the Dublin Society in the early years of the nineteenth century. The Society established the Botanic Gardens at Glasnevin in 1796 and at first the staff consisted of a head gardener, John Underwood a Scot brought over by Speaker John Foster in 1798, and two under gardeners together with twelve labourers who were paid 9/9 a week plus uniform. This wage was raised to 12/- a week in 1808 to compensate for the increased cost of living due to the Anglo-French wars. It was reduced to 9/9 in 1816 and the issue of jackets and caps was limited to those who showed industry and were of good conduct. By 1812 the increasing amount of work at the Gardens led the Committee of Botany which ran the Gardens to conclude that a labour force of eighteen labourers was necessary. Instead of getting more labourers they decided to bring in six boys of about seventeen years of age as apprentices who would be paid 9/- a week. As well as this wage they would receive 5 gn. a year for three years if their work was satisfactory and Underwood, whose salary was £100 a year, was allowed £5 a year for the tuition of each apprentice. In 1816 the number of apprentices was reduced to four. Then in 1820 the Committee decided that the apprentices were an unnecessary expense and it resolved to take no more and to make do with ten labourers. When Dr. Wade, the Society's Professor of Botany, declared that if apprentices were not used the Gardens would need twelve labourers the taking of apprentices was continued.

The example of the Dublin Society in offering premiums to nurserymen was followed by some of the Farmers' Societies which were widespread in the eighteenth century. Two examples from the north of Ireland may be quoted. In September 1756 the Down Society of Downpatrick offered a total of £60 a year (in premiums) to new nurserymen in each of the following groups of baronies: 1. Lecale, Kinalarty and Dufferin; 2. Ards and Castlereagh; 3. Upper and Lower Iveagh north of the Bann; 4. Upper and Lower Iveagh

south of the Bann together with Newry and Mourne. Two premiums of £10 and £5 were offered in each division to whoever would enclose the largest nursery of at least half an acre and stock it with forest trees, crabs and quicks. The premiums were to be continued to the winners for four succeeding years if the nurseries were kept in good order.

The second example is from county Antrim and was concerned, not with forest trees, but with providing a supply of quicks for the hedging and ditching that was so widely undertaken during the eighteenth century and which formed the basis of the present landscape of Ireland. The Farmers' Society of the four lower baronies of Antrim in 1760 offer £6 to the person raising the greatest number, not less than half a million, and entering into security to sell them at two years old; £5 for the second greatest number, not less than 400,000 and £4 for not less than 300,000 and £3 for not less than 200,000 quicks.<sup>5</sup>

The list of Irish public nurserymen which follows has been divided into two parts. The first part is of those found in Dublin city and the second part lists country nurserymen. While the list of Dublin nurserymen is probably reasonably complete there is no doubt that there were others operating outside of Dublin who have not been traced. The dates following a man's name are the years during which he is known to have operated his nursery.

#### DUBLIN NURSERYMEN AND SEEDSMEN

BRAY, EDWARD. 1775-after 1801. Merchant's Quay and nursery at Island Bridge. Served time with Daniel Bullen. Imported from Samuel Wor of Rotterdam and Eddie and Dupin of London and from Edinburgh. Premiums from Dublin Society of £65 on 470,000 trees\* between 1790 and 1795. Helped dispose of Lord Trimbleton's collection of exotics in 1780 which had taken 40 years to build up and which included bananas and pineapples. One of the most prominent Dublin nurserymen and supplied Dublin Society with plants and seeds for the Botanic Gardens, Glasnevin. His catalogue and price lists published during the 1780's are representative of what a well stocked nursery contained at that period. The deciduous trees for sale were: ash (entire leafed, weeping, and flowering), birch, beech, purple beech, horse chestnut (gold striped, silver striped, scarlet striped and yellow striped), Spanish chestnut, elm (wych, striped and Canadian), alder, hornbeam, scarlet maple, black and balsam, poplar, lime, oak (scarlet, evergreen, mossy acorn, American, striped), sycamore, walnut; conifers: balm of Gilead, Scots pine, silver fir, spruce fir, American fir, Weymouth pine, larch, arbour vitae, yew, cedar of Lebanon, cypress.

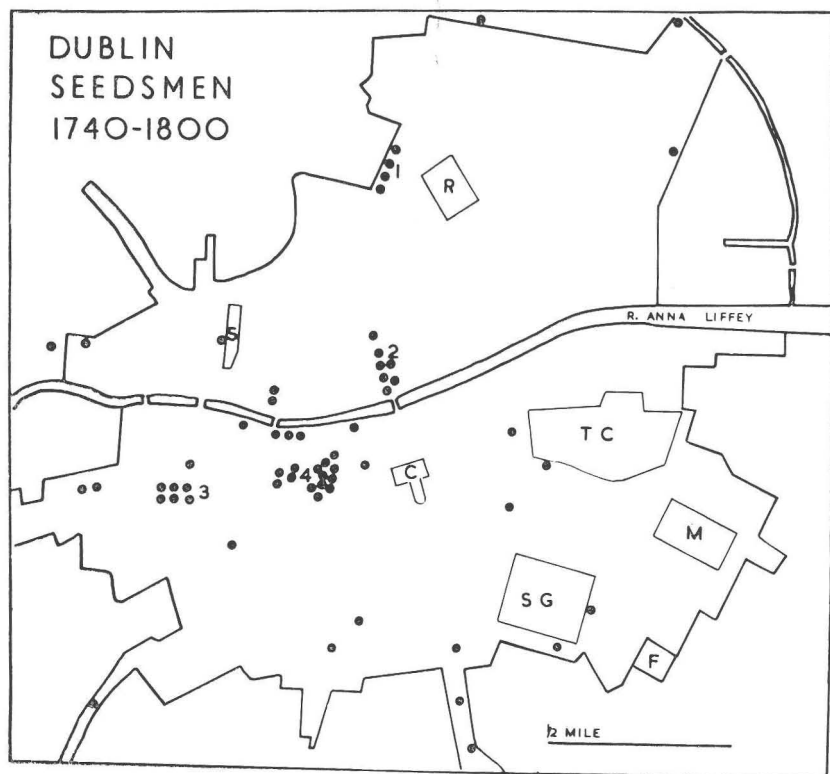
---

\* The term 'trees' in the following lists means plants between two and five years old.

BRUCE, GEORGE. 1745-68. The Lamb, Old Corn Market, near New Gate, nursery at Butterfield Lane, Rathfarnham. Imported from Holland and England. Died 1768.

BRUCE, GEORGE AND ELIZABETH. 1768-79. Succeeded their father. Imported. Supplied gardeners. Stock in 1768 included black, red and white American spruce, Gilead fir, Stone pine, red Virginian cedar, spreading and upright cedar, Chinese and common arbor vitae, arbutus, savin, holly, Portuguese laurel, spruce fir.

BULLEN DANIEL. 1765-79. Christchurch Lane, nursery at Bullen's Gardens, New St. Imported from Holland and England.



BULLEN AND FACON. 1789-94. 28 Smithfield. Received premiums on 7 acres of nursery from Dublin Society.

BURNETT, RICHARD AND FOLEY. 1780-97. Richmond, Ballyborough Bridge. Imported from Holland and London. Supplied unusual plants as a gift to Botanic Gardens.

CARROLL, PATRICK. 1786-post 1800. Possibly same man as Patrick Carol of county Meath. Michael's Lane, nursery at Mount Pelier Hill near barracks. Succeeded Robert Quin. Helped by Kenny, former gardener to Rt. Hon. David Latouche. Sold asparagus for Sheehan of Cork. Issued a catalogue.

COSTA, LAURENCE. 1754-55. A cellar at The Peacock, Capel St. an Italian gardener. Sold exotics including orange, lemon, lime and fig trees and cypress seed.

COSTELLO, PATRICK. 1790-95. 29 Merchants Quay, nursery at his father-in-law's in Co. Wicklow. (Edward Hodgins?).

COSTELLO, ROBERT. 1790.

CULLIN, DANIEL. 1755. Next door to The Cherry Tree, Dolphin's Barn. Land sold for building.

DODD, FRANCIS AND JOSEPH. 1784-85. Thomas St.

DODD, JAMES JOSEPH. 1786-post 1800. Thomas St.

DONEGAN, PATRICK. 1793-1810. Christchurch Lane and later Capel St. Supplied seed to Botanic Gardens.

DUTTON, HELY. 1783-88. Dorset St. Also florist.

EDGAR, PATRICK. 1722-95. James St. Joined by William Edgar 1785-86.

GRIMWOOD, JOHN. 1789-post 1800. Charlemont St. Supplied seeds to Botanic Gardens.

GUNITON, THOMAS. 1787-92. Corn Market.

HANLON, CABEL. 1746. The Three Tons and Bunch of Grapes, Thomas St. Wholesale and retail. Imported from England and Holland.

HARVEY, WILLIAM. 1778-90. Dorset St. later Christchurch Lane. Fee from Dublin Society for taking an apprentice.

HAY, ANNE. 1782-post 1800. Church St.

HAY, EDWARD. 1760-80. Capel St. later Church St. and Merchant Quay. Imported from Holland and England. Issued catalogue. Supplied gardeners.

HENDERSON, HUGH. 1764-78. The Orange Tree, corner of Capel St. and Upper Ormond Quay, nursery at North Strand. Imported from Holland and England. Died 1778, succeeded by daughters who sold lease of nursery immediately and in 1780 sold shop to Luke Peppard.

JONES, JOHN. c. 1720-c. 1760. Cut Purse Row.

JONES, JAMES. c. 1760-76. Moved in 1763 from Cut Purse Row to The Seed Warehouse, Ussher's Quay. Imported. Wholesale and retail. 1774 Sheriff's peer. Specialised in seeds.

JONES, JOHN. 1776-79. First Bridge Foot St. and then Thomas St. near the Market House. Joined 1776-8 by Kaven. Issued catalogue. Connected with Dickson, the Scottish nurseryman.

KEEGAN, HENRY. 1793. Redmond's Hill.

LANDRE, PETER AND JAMES. 1740. St. Stephen's Green. Lease expired and stock sold off.

MADDEN, BARTHOLOMEW. 1776-78. Thomas St. Imported. Specialised in seeds.

MATTHEWS, JOHN. 1783-99. Dorset St.

MIDDLEWOOD, WILLIAM. 1789-98. Grafton St. nursery at Rathmines. Wholesale and retail, also fruit merchant.

MCDONALD, HENRY. 1747. Nursery at turnpike, Drumcondra Lane. Imported.

MOODY, ROBERT. 1730. Gardener to the Honorable City of Dublin. Seed shop next door to the New Inn, Queen's St.

MORAN, ANN. 1776-92. Thomas St.

MORAN, JACOB. 1776-89. Thomas St.

MURPHY, EDWARD. 1791-post 1800. Christchurch Lane, later Nassau St.

NUGENT, JOSEPH. 1788-90. Wood Quay.

PEPPARD, LUKE. 1766-93. Cut Purse Row and also Capel St. Imported from Holland, Scotland and England. Supplied gardeners. Connected with Anderson's of Edinburgh. Imported fruit trees from Royal Gardens, Hampton Court.

PETERS, MATTHEWS. 1746. Capel St. Succeeded George Sweetman.

PHELAN, JOHN. 1749-89. The Sign of the Pineapple. Christchurch Lane, nursery at Harold's Cross where he also had stove and hot houses. Grew pineapples extensively. Imported from England and Holland and exported to England and Wales. Designed gardens. Stock in 1758 included Weymouth pine, tulip trees, Spanish plane, American cypress, cedar of Lebanon, red and white Virginian cedar, black spruce fir. A very prominent nurseryman.

QUIN, ROBERT. 1753-84. Michael's Lane. Succeeded by P. Carroll.

REILLY, JAMES. 1786-94. Cut Purse Row. Succeeded by Peppard.

ROCQUE, JOHN. 1777-88. Milltown Road.

RONEY, EDWARD. 1776-83. Thomas St.

SHINE, WILLIAM. 1786-93. Skinner's Rd. Imported from Bordeaux

SIMPSON, BENJAMIN AND SIBBERT. 1785-post 1805. College Green, Cork Hill, nursery at Inchicore. £45 premium on 288,000 young trees 1785 to 1791. Gave rare plants as gift to Botanic Gardens 1797. Supplied seeds to Botanic Gardens until 1805. From 1812 the nursery was run by Thomas Simpson until at least 1834.

SMITTEN, GEORGE. 1785-post 1800. Capel St. Imported from England. Nursery. Supplied Botanic Gardens with trees.

SPRING, MATTHEW. 1791-92. Arbour Hill.

STEVENSON, ROBERT. 1734-56. The Orange Tree, east side of St. Stephen's Green. Connected with Dublin Society.

SWEETENHAM, GEORGE. Died 1746. Capel St. Succeeded by Peters. TAYLOR, JOSEPH. 1740. The Cherry Tree, Cut Purse Row. Visited England and Holland every year.

TIERNAN, JOHN. 1793-post 1800. Camden St., later Meath St. Also florist.

TOOLE, CHARLES AND LUKE. In 1753 there was a Toole selling clover seed in Francis St. The Toole's nursery at Cullenwood may have been in existence by 1777. In 1790 they opened a shop in Kevin St. After 1808 but before 1825 the Tooles were joined by S. Mackey. By 1888 the partners had separated and the Tooles were at 22 D'Olier St. and Mackeys were at 23 Upper Sackville St. Since then the Tooles have gone out of business but Mackey's Seeds Ltd. is now at the same address (renamed Upper O'Connell St. since 1922). This, so far as is known, is the only nursery which has survived since the eighteenth century in Dublin. Tooles gave a gift of plants to the Botanic Gardens in 1797 and themselves received premiums from the Dublin Society for sowing imported sweet chestnuts 'not kiln dried' and imported acorns. They continued to supply the Botanic Gardens with seeds and plants. Imported from America 1801. £15 premium on 75,000 trees in 1793.

WALKER, ROBERT. 1762. Marybone Lane, near Thomas Court.

WALSH, GEORGE. 1774. Cut Purse Row.

WALSH, JAMES. 1778-post 1800. High St. Imported.

THE FOUNDLING HOSPITAL NURSERY. James St. Established in 1776. 'more for the health and education of the children in the said hospital, than for profit'. Issued catalogue. Selling trees by auction 1795.

THE HIBERNIAN SOCIETY NURSERY. Phoenix Park near Hibernian House. Established in 1777 to train protestant boys as gardeners. Appealed for gifts of plants and seeds to start nursery. Three acres of walled garden. List of plants obtainable at Mr. Burrows, Arran Quay. Selling trees by auction 1790.

## COUNTRY NURSERYMEN AND SEEDSMEN.

### ANTRIM

By 1800 there were few nurseries in the county and those not of great extent'. Plants were brought considerable distances and sold in the markets in the spring.

M'CALLEN, CHARLES. Premium in 1769 from Dublin Society on 4 acres.

NELSON, ROBERT. Premium in 1805 on 355,000 fir.

**ARMAGH**

A well established nursery near Armagh town in 1800 with considerable sales.

BOWERS, WILLIAM. Premium on 1 acre, 1770-72.

DICK, WILLIAMS. 1755. Nursery near Portadown. Specialised in fruit trees.

PUE, SAMUEL. 1749.

**CARLOW**

FOSTER, HENRY. Premium in 1784 on 3 acres.

GRIFFITH, WILLIAM. Carlow town. Died 1742 or 1743. Widow continued business. Imported from Holland. Stock included silver fir, spruce fir 'also local seeds and trees'.

HACKET, PATRICK. Premium on 2 acres in 1789.

**CAVAN**

PIERS, JOHN. Raheny. Premium in 1790 on two acres and 54/- on 17,000 trees.

**CLARE**

Plants usually brought from Galway, Limerick, Dublin or Scotland. HALLINAN, THOMAS. 1771. Ennis. Seedsman. Also sold 'Mr. Thomson of Banagher's genuine whisky fit for punch at 4/- the gallon', minimum quantity sold 3 gallons.

O'BRIEN, CHARLES. Premium on 6 acres, 1786-87.

RAMSAY, ROBERT. Premium on 6 acres 1783-88. Fee for two apprentices, James Ramsay and John Cantrel.

**CORK**

JOHN HENSHAW, supervisor of the nursery on the Kenmare estate, bought 2,000 yew in 1727 from ANDREW BRIDGES, nurseryman in Mallow, for 1½d. each. Henshaw and Lord Kenmare quarrelled over the correct way to grow yew—whether from seed or from cuttings—and he went to work for Lord Barrymore. Henshaw wrote to Kenmare, 'It is impossible for an Englishman to live in your lordship's family if he was a saint' and promised to pray for him.

AHERN, GARRET. 1769-87. Cat Lane, Cork city, later Castle St. Joined by John Ahern. Imported from London and carried a large stock.

BOYLAN OR BALOE, WILLIAM. Premium on 900,00 larch and Scots pine, 1803-7.

DAVIS, SAMUEL. 1750. Englishtown, Cork. Apothecary and seedsman.

HARLAND, RICHARD. Premium on 3 acres, 1789.

KEMPLIN, HUGH. 1749. Meeting House Lane, Cork. Nurseryman and seedsman. Stock included fruit trees, 2 to 3 year old oak, beech, hornbeam, silver, Scots and spruce fir, yew, quicks.

LAFFAN, ANDREW. 1787. Castle St., Cork.

LAFFEN, T. 1787. Castle St., Cork. In 1810 there was a T. and A.

MCLEAN, THOMAS. 1749. Seedsman. Cork.

SHEEHAN, JEREMIAH. Cork. Premium on 4 acres 1768-71.

SHEEHAN, MICHAEL. 1794. Grand Parade Cork. (See also Limerick).

SHEEHAN, THOMAS. 1787-1810. Grand Parade, Cork. Connected with Carroll of Dublin.

SMITH, WILLIAM. 1750. Doneraile. Stock included seeds of beech and hornbeam.

SULLIVAN, DENNIS. 1749-69. The White House, Cat Lane, Cork. Nurseryman. Stock included silver fir and arbutus. Sent arbutus to any part of the British Isles at from 2/2 to 11/4½ each. Also cork oak, mulberry and cedar of Lebanon.

## DONEGAL

A large nursery at Nadir near Ballyshannon in 1800 supplying Leitrim, Sligo and Fermanagh.

CUNO, PATRICK. Premium on 2 acres, 1772.

## DOWN

BELL, WILLIAM. Premium on 4 acres, 1784-89.

FULTON, ALEXANDER. Premium on 2 acres, 1784-89.

HAMILTON, JAMES. 1756. The Maze, near Hillsborough.

WALLACE, JOHN. 1760. Hollymount, Lecale.

WILKIE, DAVID. Moira. Premium on 2 acres, 1768-71.

## DUBLIN

CARTER, CHARLES. 1728. His Majesty's Gardener at Chapelizod. 'Having since the decease of Robert Moody his late partner carried on the seed trade by himself'. Stock included seeds, fruit trees, forest trees, flowering shrubs, evergreens. Imported. Orders taken by Christopher Warrens at The Holy Lamb, High St., Dublin.

COTTINGHAM, GEORGE. Nursery opposite the Six Mile Stone on the Grand Canal. £130 premium on 2 acres and 859,000 trees between 1783 and 1786. Issued a price list with the following note: 'As these plants have all been raised in an open piece of ground Gentlemen may be assured they are not forced, or drawn beyond their

proper growth, either by shelter or manure. The distance from Dublin is so eligible, that Gentlemen, or their planters, have an opportunity of convincing themselves of the truth of these assertions, and of seeing them in their seedbeds, where they grow; and that none of them had been imported, or lay'd by the heels, as is too often the case, for months together, to the no small loss, and disappointment of the purchaser.

He requests when any order for Trees is intended, that it may be sent to him two or three days before carriers are sent for them, that time may be given to take up the trees, have them properly packed and brought to town.

It is too obvious to be doubted, the great advantage that would arise to gentlemen, if they would form small nurseries near the grounds intended to be planted and stocking them with Seedling trees, until fit to be planted out, in preference to the purchasing of grown trees; the very carriage speaks the utility, besides the certainty of success.

He hopes no Gentleman will take it ill, that he cannot execute any order without payment, as the prices are reduced as low as possible, in order to encourage a Ready Money Sale. The price of Matts, for packing, to be paid by the purchaser.'

GAHAN, JOHN. £12 premium on 59,000 trees, 1783.

GALVIN, JOHN. Black Horse Lane. Premium on 2 acres in 1768 and £3 bounty from the Dublin Society 'it appearing that he has merit as a nurseryman and particularly in the propagation of elm'.

HANWAY, JOHN. Premium of 36/- on 9,000 beech in 1785.

RUSSELL, JAMES. 1781-93. £7 premium on 6 acres and 60,000 trees.

The following supplied the Dublin Society with plants in 1801 and were possibly situated in county Dublin: George Field, P. Duffe, Peter Walsh, William Coogan, George Lewis, Thomas Bawrin, Daniel Grenan.

## FERMANAGH

HAMILTON, RT. HON. ARTHUR COLE. Premium on 3 acres in 1789.

## GALWAY

CLARKE, GEORGE. Premium on 3 acres in 1784.

CLARKE, RICHARD. Shangarry. £240 premium on 3 acres and 1,690,000 trees and 25,000 Dutch alders, raised from seed, between 1783 and 1795.

CLARKE, THOMAS. Shangarry. £12 premium on 6 acres and 5,000 trees between 1768 and 1783.

KELLY, FRANCIS. £149 premium on 2 acres and 1,281,000 trees between 1789 and 1795.

MADDEN, FRANCIS. Ballinasloe. £737 premium on 8 acres and 4,460,000 trees between 1785 and 1795. Also fee for three apprentices, William Byrne, Denis Brien and Thomas Monke.

MADDEN, MICHAEL. Ballinasloe. 1768-95. £376 premium on 7 acres and 2,739,700 trees between 1786 and 1795. Fee for two apprentices, Patrick Madden and William Guinan.

MULLOWNEY, JAMES. £86 premium on 3 acres and 566,000 trees between 1787 and 1795.

POWER, ROBERT. Galway town. £228 premium on 14 acres and 943,000 trees, including 7,158 cedar of Lebanon, 1783 to 1790.

## KERRY

COURTNEY, DANIEL. 1773. Tralee. Nurseryman with experience at Kew and Richmond.

DOOLEY, DAVID. Ardfert. Premium on 2 acres, 1786 to 1790.

GALLWEY, RICHARD. 1724. Dronwickbane.

O'BRIEN, CHARLES. 1768-95. Tralee. £708 premium on 15 acres and 5,092,000 trees; the premium on trees between 1790 and 1795. Asked by Dublin Society to produce proof of raising Black oak and Athenian poplar. Imported from London and Holland.

## KILDARE

DALTON, EDWARD. Premium on 4 acres, 1786.

## KILKENNY

AUSTIN, NATHANIEL. The Three Flower Pots, High St., Kilkenny. Imported from Holland and England.

BROPHY, JAMES.. Premium on 2 acres, 1790.

BYRNE, PETER. Premium on 1 acre, 1784.

MAGRATH, JOHN. Premium on 6 acres, 1768 to 1770.

ROBERTSON. Established about 1756. It was, according to Loudon, in use in 1844. In 1800 the nursery occupied about 14 acres at a rent varying from £4 to £10 an acre. Its sales were chiefly in seedlings of which about a hundred thousand were sold annually, chiefly Scots pine, larch and beech. Possibly connected with John Robertson of Kilkenny, a member of the Royal Dublin Society, who died in 1839 and bequeathed his 400 books on botany and horticulture to the Botanic Gardens, Glasnevin which at that time belonged to the R.D.S.

## LEIX

There were three nurseries near Mountmellick in 1800 but stock of any one worth only about £300. Annual turnover about £100.

COSBY, POLE. 1742-60. Stradbally House, Stradbally. Premium in 1742 for planting 13,835 trees. Stock in 1760 included elm, oak, beech, ash, horse chestnut, sycamore, juniper, filbert and some flowering shrubs.

CUNNINGHAM, JOHN. £87 premium on 8 acres and 280,000 trees from 1768 to 1789. Fee for apprentice.

DOYLE, JOHN. 1752. Stradbally. Stock included English elm, beech, hornbeam, chestnut, oak, sycamore, juniper, Dutch alder.

GLENAN, MALACHY. £40 premium on 375,000 trees between 1789 and 1794.

GLENAN, PATRICK. £10 premium on anacre and 42,000 trees, 1789-1791.

### LIMERICK

ALLEN, JOSEPH. 1769-71. Limerick town. Seedsman and apothecary. Also sold 'fine London and battle gun powder'.

DAVIS, GEORGE. 1770-73. Near Ball's Bridge, Limerick. Seedsman and apothecary. Imported Weymouth pine seed from England 'guaranteed this year's importation and free from old or Irish seed'.

DAVIS, SAMUEL, 1771-77. Limerick. Seedsman and apothecary.

DAVIS, WILLIAM. 1750. Irishtown, Limerick. Seedsman and apothecary 1768-85. Newcastle.

DREW, PATRICK. 1768-85. Newcastle. Premium on 1 acre and fee for apprenticing his son Patrick.

FENNESY, WILLIAM. 1777-92. Beside Carr's tanyard, Limerick. Stock included horse and sweet chestnut, Lombardy poplar, Dutch and English elm, oak, beech, sycamore, larch, laburnum, Dutch alder, lime, Scots pine, Weymouth pine, balm of Gilead, holly, crab, quicks.

HARROLD, THOMAS. 1771. Sign of the Guinea, Irishtown, Limerick. Weymouth and Scots pine, spruce and silver fir, French furze seed.

JUDD, JOHN. 1773. Pestle and Mortar, next door to Exchange, Limerick. Seedsman and apothecary.

LEWIS, THOMAS. 1771. Mary St., Limerick. Nursery and seedsman.

O'LOUGHLIN. 1798. Rathkeal. Seedsman and apothecary.

PHILLIPS, JAMES HILL. 1773. Limerick. Seedsman and apothecary. Succeeded Joseph Allen.

RAHILLY, EUSTACE. 1799. 2 Mungret St., Limerick. Seedsman and apothecary.

RAHILLY, THOMAS. 1799. 24 Broad St., Limerick. Seedsman and apothecary.

RICHARDSON, WILLIAM. 1771. Seedsman and apothecary. Imported from Holland and England.

ROWE, LUKE. 1773. Irishtown, Limerick. Seedsman and apothecary.

SHEEHAN, MICHAEL. Nurseryman from Cork. Purchased in 1794 the nursery belonging to Sir Vere Hunt, Curragh, near Limerick; the stock of this nursery included beech, larch, quickbeam, sycamore, hornbeam, service, Weymouth, cluster and stone pine, ash, alders, oak, Chesterfield willow. Expected 'no gentleman will send for trees without money'.

WIGHT, EDWARD. 1750. Englishtown, Limerick. Seedsman and apothecary.

WILSON, JOHN AND RICHARD. 1803. Pallace, Kenry. Nurserymen and seedsmen.

### LONDONDERRY

There were nurseries kept by professional nurserymen at Portglenone and near Moneymore in 1800 but it was cheaper to buy plants from Scotland than from local nurseries. Local seedlings cost 6/- to 8/- a thousand and those from Scotland 5/-.

MAGENNIS, HAMILTON. Also surgeon and apothecary. †19 premium on 5 acres and 42,000 trees between 1784 and 1786.

STEWART, JOHN. 1774. Derry city.

STEWART, WILLIAM. 57/- premium on 16,900 trees, 1793.

### LONGFORD

LAW THOMAS. £5 premium on 40,000 trees, 1793.

### LOUTH

FOSTER, RT. HON. JOHN. Public nursery at Collon. Catalogue of 1797 lists 250 different trees and shrubs for sale.

M'EOY, JOHN. Collon. Joined after 1791 by Downey. M'Evoy was supplied with plants for his nursery by Foster and published his own catalogue which states 'He will provide Carrs properly constructed for the Carriage of Trees, with experienced Persons, who will deliver the Trees safe, at Ten Shillings a Carr to Dublin, being near Thirty Miles, or Four Pence a Mile to any part of the Kingdom'. £525 premium on 14 acres and 3,758,00 trees between 1783 and 1794.

### MAYO

BOURKE, THOMAS. Premium on 3 acres, 1771 to 1791.

**MEATH**

ADAMS, PATRICK. 1769-90. Gormanstown. £24 premium on 4 acres and 135,000 trees between 1769 and 1785.

CAROL, PATRICK. £114 premium on 6 acres and 721,000 trees between 1789 and 1795.

CURLEY, DANIEL. £7 premium on 158,000 trees in 1793.

FRAYNE, FRANCIS. Lusk. £8 premium on 1 acre and 39,000 trees between 1785 and 1789.

GREGAN, OLIVER. £36 premium on 264,000 trees between 1790 and 1795.

HAND, FARREL. 1785-86. Trim. Premium on 2 acres.

KELLY, PATRICK. Premium on 1 acre, 1789.

REILLY, PATRICK. Premium on 1 acre, 1789.

REILLY, TERENCE. 1784-post 1800. Ballybeg. Fee for two apprentices, Peter String and William Reilly. His nursery of 39 acres said to be one of the biggest in Ireland.

STAPLES, ROBERT. Fee for apprentice, 1783.

**MONAGHAN**

THOMAS WRIGHT. 1768-78. The Diamond, Monaghan. Nursery. Wholesale and retail. Imported from Holland and London. Stock included seeds, thorn quicks, crabs, fruit trees, ash, oak, sycamore, beech, Scots fir. Also stocked garden tools, groceries and ironmongery.

**OFFALY**

CLARKE, SIMON. £7 premium on 1 acre and 35,00 trees in 1787.

M'MULLEN, JOHN. Premium on 3 acres, 1768 to 1770.

**ROSCOMMON**

CLARKE, JOHN. Premium on 1 acre 1789.

CLARKE, SIMON. 1772-87. Tully. Premium on 2 acres and fee for two apprentices.

GALVIN, WILLIAM. Mount Talbot. Born 1756, died 1832. William was the son of Thomas Galvin, head gardener to the Crosbys of Ardfert, Co. Kerry. Thomas and William moved to the Talbot estate in Roscommon and obtained 46 acres on lease from the Talbots who were relatives of the Crosbys. The Galvins' lease was the only freehold lease on the estate. The Galvin nursery continued to operate, father to son, until a few years ago.

GIBBONS, J. AND L. £8 premium on 57,700 trees in 1793.

**SLIGO**

Nurseries at Oakfield and Ballytivnan in 1800.

**TIPPERARY**

BOURKE, PATRICK. 1773. Nenagh. Seedsman and apothecary.

FENNESSY, RICHARD. Ballynating. Premium on 9 acres between 1768 and 1784.

FENNESSY, THOMAS. Premium on 6 acres, 1784.

HARES, JOHN. 1756-59. Castle Otway. Plants 'on common pasture soil without dung or manure'. Stock included holm oak, beech, alder, ash, sycamore, lime, walnut, English elm.

QUAN, THOMAS. 1742. Carrick on Suir. A nursery of 3 acres.

ROBERTSON, WILLIAM. 1764. Thomastown. Imported from London. The nursery had belonged to his father and continued to operate until the nineteenth century.

ST. JOHN, THOMAS. 1771. Cashel. Seedsman.

TOLER. Solicitor-General. Premium on 11 acres 1790.

WALL, JAMES. 1749. Tipperary town. Seedsman and apothecary.

**TYRONE**

GARDINER, RT. HON. LUKE. Premium on 3 acres in 1787.

JOHNSTON, JAMES. Premium on 3 acres in 1786.

**WATERFORD**

KEEFE, DANIEL. Premium on 2 acres, 1787.

MULLAMPHY, BRYAN. £30 premium on 5 acres and 365,000 trees from 1789 to 1795.

**WESTMEATH**

ANDERSON, JOHN. £17 premium on 3 acres and 52,000 trees in 1789.

**WEXFORD**

EVANS, WILLIAM. Premium on 1 acre, 1790.

GOWAN, JOHN HUNTER. £39 premium on 3 acres and 32,000 trees between 1769 and 1790.

WEBSTER, WILLIAM. £14 premium on 1 acre and 28,400 trees between 1790 and 1793.

**WICKLOW**

BULLER, WILLIAM. Died 1757. Tinnahinch.

COLES, PHILIP. £3 premium on 17,000 oak in 1790.

FAULKNER, SAMUEL. Premium on 1 acre in 1790.

HODGINS, EDWARD. Dunganstown. Premium on 3 acres in 1786. Gave gift of plants to Botanic Gardens in 1797 and supplied plants in 1808. The nursery, under an Edward Hodgins, was still supplying plants to the Botanic Gardens in 1846.

KIRWAN, MARTIN. Premium on 1 acre in 1786.

LONG, WILLIAM. 48/- premium on 14,000 trees between 1785 and 1790.

REILLY, JAMES. £14 premium on 2 acres and 33,000 trees, 1790.

REILLY, JOHN. 28/- premium on 14,000 oak in 1790.

## BIBLIOGRAPHY

Most of the material on which this article is based was gathered from the printed *Proceedings of the Dublin Society*, 1765 to 1800,\* Faulker's *Dublin Journal* 1727 to 1800, various other eighteenth century newspapers and Wilson's *Dublin Directories* from 1752 to 1800.

1. McCracken, E., 'The Irish timber trade in the 18th century', in *Quarterly Journal of Forestry*, Jan. 1967, p.42.
2. Ainsworth reports, vol. x.p.2259, Tighe Papers. National Library, Dublin.
3. McCracken, E., 'Irish nurserymen and seedsmen, 1740 to 1800', in *Quarterly Journal of Forestry*, April 1965, p.135.
4. The Fingall (Plunket) Papers, MS 8036, National Library, Dublin.  
I am grateful to Mr. Robert Hunter, B.A., for pointing out to me the existence of these papers.
5. *Belfast Newsletter*, 24 Sept. 1756 and 20 Jan. 1760.

I would like to thank Mr. Desmond Clarke, M.A., librarian to the Royal Dublin Society, for the great help which he gave me in preparing this and other papers.

---

\* The Transaction of the Dublin Society, 1806.

## *Society's Activities*

### **Talk at Strabane on Landscape Planning**

About 60 members met at the Commercial Hotel, Strabane, on Wednesday evening 16th November, 1966, to hear a talk on Landscape and Recreation Planning in Forestry by Mr. Jim Busby, B.Sc. (For.) M.F.

Mr. Busby, formerly of the Forestry Division, has recently spent a year studying his subject at Berkeley, California, and has just taken up an appointment with the New City (Craigavon) planning staff.

Mr. Busby outlined the tremendous build-up of urban pressures and the need for outdoor recreation. Foresters find this difficult to understand as their work concerns natural and basic things, yet they manage the large areas of the countryside which can play a vital part in maintaining the mental health of the population.

We need not forego our harvest of timber which we need so badly but can easily kill two or three birds with the one stone.

#### *Landscaping*

Large areas of one species are not out of place in areas which were rather monotonous before, but in broken country, the reverse is the case.

We had a beautiful country before state forestry began, and we have a responsibility to treat it with respect.

Artificial planting boundaries between P years and species should be avoided especially if up and down a hillside. Generally, a good road line follows physical land features, but often compartment boundaries run off at right angles, thereby cutting across the lie of the land.

Narrow belts of hardwood for amenity or firebreaks, unless integrated into the landscape by following streams, can lead to artificial fringes, which in no way enhance the landscape.

The economics of growing hardwoods are questionable, so the compromise of growing hardwoods in groups through a matrix of conifers is welcomed. The groups however should not be regular in size and spacing. Line planting of hardwood conifer mixtures is bad from the landscaping point of view.

For landscape planning, the forest as seen by most visitors, may be zoned into the foreground middle distance and background. In the first of these, only carefully selective felling should be allowed, and the ground vegetation should be protected.

In the middle area, clear felling is permissible, but the shape and size of the felling coup is important, except on flat ground.

In the background, large scale normal cutting practices may be followed.

*Recreation*

It is difficult for foresters to appreciate the real needs of the masses as regards outdoor recreation. We tend to provide what we think is good for people rather than what is really necessary.

The task is one for specially trained sociologists.

A big question is who pays for the capital investment and maintenance of forest recreation. If there is a real demand, people will be willing to pay, and the cost to the consumer should be related to the cost of providing the service.

However, landscaping can have no direct return in £ s. d. so it seems that at least part of the development must be in terms of a social service.

In conclusion, forestry has the means to provide for this growing demand, and we should have no hesitation about meeting our responsibility to the community.

C.S.K.

---

## **Lecture on B.F.C. Management Tables**

A meeting of the Society of Irish Foresters was convened in Arklow on the 10th of December, 1966. It was held under the Chairmanship of the Vice-President of the Society—Mr. O. V. Mooney.

*The Subject*—Forest Management Tables—their development and use.

The speakers were Mr. P. M. Joyce, Mr. G. Gallagher, Mr. M. Cassidy and Mr. N. O Muirgheasa.

Mr. Joyce gave an historical account of Yield Tables with particular reference to German contributions. He dealt with their theoretical concept, leading up to the Master Table.

Mr. Gallagher gave a synopsis of the Management Tables. He defined and explained the more recent innovations and terminology. He pointed out the background to the tables while emphasising the fact that they were not a revolutionary departure from those of the revised Yield Tables, but a further expansion of the same basic material. This was set out in a more refined way to perform a greater range of functions. The term Quality Class was subject to misinterpretation, this resulted in its replacement by the term Yield Class.

The maximum M.A.I. is the basis of the Yield Class Classification. This is the point where C.A.I. and M.A.I. curves cross and is the point at which the maximum average annual production is reached.

Mr. Cassidy detailed his experience in the application of the Tables in Kinnitty Forest in relation to the Working Plan for that area. He recalled that the concept of marginal thinning intensity was adopted in this pilot project. Comparing the figures found in the Forest Management Tables with his findings, he found Norway spruce compared favourably while those of Sitka spruce showed a divergence. The Tables for *Pinus contora* were of little relevance since they were constructed for the inland variety.

Mr. O Muirgheasa said Forestry was a primary industry. He gave a break-down of the costs under various headings of bringing this industry to fruition. One of the factors affecting costs was the choice of species or provenance of a species best suited for the site. Oak, may be the natural tree of the country, yet at eighty cu. ft. M.A.I. as against over three times that for *Abies grandis* and Sitka spruce, he felt we would have to make a compromise between the tree best adapted and that which will outstrip the other in production.

How are we to find this out? Perhaps through the Management Tables. In practice in the past we were influenced consciously or unconsciously by the Revised Yield Tables in our thinnings.

Tables have been produced in Finland based on vegetation. Here with present practice of manurial treatment, such tables would be of limited use.

Finally Mr. O Murgheasa felt that thinnings were a very critical issue in making Forestry as a primary industry a more lucrative enterprise.

A short discussion followed and as time was running out Mr. Mooney called on Mr. F. Watson to propose a vote of thanks to the speakers.

F.A.W.

# **IRISH FOREST PRODUCTS LIMITED**

We have now increased our technical staff and are in a position to extend our operations on private estates.

Landowners in any part of Ireland with timber or thinings for sale, or with neglected woodlands or scrub areas requiring rehabilitation can get best prices for their forest produce, while at the same time having the benefit of expert technical guidance. Where necessary, we undertake skilled replanting of cleared areas. It will pay you to contact us if you have timber of any kind for disposal.

## **OUR FORESTRY SERVICES INCLUDE :—**

- ★ Supply and planting of trees by contract on new or old areas; also fencing, drainage and other development work.
- ★ Woodland management, post planting maintenance, consultancy service, financial and investment advice.
- ★ Timber valuation, forest land valuation, preparation of production and marketing plans.

**OUR WICKLOW NURSERIES CARRY A STOCK OF OVER 5,000,000 YOUNG TREES, SHRUBS AND CANCER RESISTANT POPLARS FOR DIRECT SALE ALL OVER IRELAND AND FOR EXPORT. WRITE FOR FREE CATALOGUE.**

# **IRISH FOREST PRODUCTS LIMITED**

**28/30 UPPER BAGGOT STREET, DUBLIN 4.**

**'Phone 65471.**



# **Toughest and most advanced**

Toughest, that's how farmers have been describing  
Ford tractors for 50 years. Now they are the most advanced too...  
See your Ford Tractor Main Dealer for details.

**GET POWER—GET FORD**

*Model Range: 39 B.H.P. - 46 B.H.P. - 56 B.H.P. - 67 B.H.P.*



# TIMBER PRESERVATION

by

**Protim**

Regd. Trade Mark

**A GUARANTEED SERVICE FOR THE ERADICATION OF  
WOODWORM and DRY ROT**

**FOR NEW WORK SPECIFY PROTIMISED TIMBER**

*The approved Knapen System Successfully Eliminates*  
**RIISING DAMP**

*Backed by 35 years' experience in the U.K.*

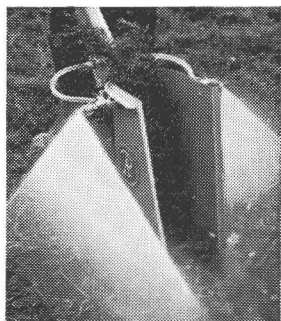
Literature on request from :

**PROTIM (IRELAND) LTD.,**  
WELLINGTON HOUSE, ARTANE, DUBLIN, 5  
Tel. 332216 (5 lines)

## THE Mk II ARBOGARD

sprays all around the  
tree in one operation

Newly planted conifers and forest saplings can be efficiently weeded with 'GRAMOXONE'. Complete protection of a young tree is achieved by the unique Mk II Arbogard which applies the chemical to the whole ground base in a quick circular movement. One man should be able to ring weed  $3\frac{1}{4}$  acres in a day. Recommended price £23.15.0.



Our new 'MINISPRAY', a light knapsack applicator for herbicides around buildings, hedges, fences, ditches etc., is a little marvel for only £9.15.0.

*Write for details of these two new products.*



**ALLMAN PATENTS LTD**

ALLMAN PATENTS LTD., BIRDHAM ROAD, CHICHESTER, SUSSEX. Phone BIRDHAM 511



## **FORESTRY COMMISSION PUBLICATIONS**

**Report on Forest Research 1966**  
12s. 6d. (post 8d.).

**Booklet No. 16. Forest Manage-  
ment Tables**  
30s. (post 1s. 1d.).

**Leaflet 52. The Fallow Deer.**  
2s. 6d. (post 5d.).

Obtainable from H.M. Stationery Office, London, W.C., and Eason  
& Son, Ltd., 40 Lower O'Connell St., Dublin, 1.

**Publications List No. 31 free from :**  
**The Secretary, Forestry Commission, 25 Saville Row, London, W.1.**

## **BEFORE PLANTING TREES**

*consult an experienced firm*

## **POWERS of WATERFORD**

With over 100 years' experience have established  
a reputation for quality in trees.

An inspection will prove that the quality of our  
trees is unrivalled.

We carry the largest stocks in the country.

Contracts of all types undertaken.

# **POWERS NURSERIES**

## **WATERFORD**

'Phone 4881.

Enquiries Invited.

## NOTES

Telephone: Athlone 3321.

### **P. McCARTAN & CO. LTD.** **BALLYMAHON - CO. LONGFORD**

Makers of all type of Packing Cases, Bread Trays, Beer and Mineral Cases, Brush Stocks and other Brush Making Materials, Oak Wagon Scantlings and Sheeting, Bottom Boards, Sleepers, etc. Kiln Dried Native Boards and Scantlings. :: Pitwood Exporters, etc.

### **FORESTRY TOOLS**

GIRTHING TAPES, SCRIBES, MARKING CRAYONS, NUMBER TAGS, CALLIPERS  
BARK STRIPPERS, TEST BORERS, PRUNING SAWS, MARKING HAMMERS, etc  
Free List on Request

### **FORESTRY BOOKS**

400 titles of the world's books are contained in our 24 page catalogue — free on request

**STOBART & SON, LTD.**  
**22 UPPER THAMES ST., LONDON, E.C.4.**

## NOTES

# SOCIETY OF IRISH FORESTERS

---

## Certificate Examinations

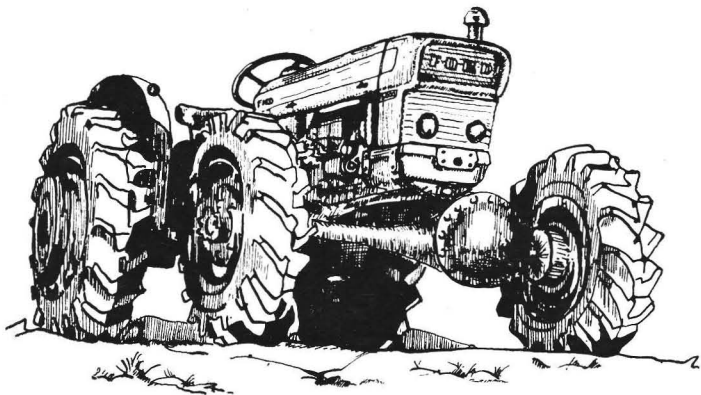
The Society holds examinations each year for Forester's and Woodman's certificates. Applications to sit for these examinations must be in the Secretary's hands not later than 1st July of the year in which the candidate will sit.

Application forms are available from:—

The Secretary,  
Society of Irish Foresters,  
6 Taney Avenue,  
Goatstown,  
Dublin 14.

# **FORD / MANUEL**

## **4 WHEEL DRIVE TRACTORS**



The Timberman's Tractor

**COOKE WINCHES**

**'SUIR' LOADER**

**TRACTOR FORK-LIFT**

*Sole Irish Distributors*

# **CAHIR HOUSE GARAGE**

**CAHIR, CO. TIPPERARY**

**'Phone : Cahir 316**

---

## **VIGZOL**

---

### **STOCKISTS**