NW. J. Cole
Eng. Div. HQ(B)

Bowen 60 Crow Drain.

Forestry Commission
Priestley Road
Basingstoke
Hants
RG24 9NS

Centurion.

Bath tubs
Demfurrow Front tube.
Power Shift.

My ref: S16/2/1

Tractor types
Standard Fwds

PLOUGHING SEMINAR/DEMONSTRATION

BTO 5.
Fiat 100.
Fiat 60S.
Bowen 60.
L.W. County

1. Details for this seminar have now been finalised, the objectives and programme are as follows:-

2. Objectives

2.1 To consider, in depth, actual performance/achievements with current machines and equipment, and the management problems associated with this operation;

2.2 To demonstrate ploughing equipment on relevant site types currently recommended for establishment work;

2.3 To indicate variations from recommended combinations of soil and plough which are acceptable silviculturally;

2.4 To consider future developments of machines and equipment.

3. Programme

Monday 18 March.	Spend night in Dumfries for those who indicated a hotel requirement. Name of hotel/hotels to be notified later.	
	S(S) 14000 acres/am.?	
Tuesday 19 March		
9.15 am	Assemble and Introduction at Ae Training Centre	N Dannatt
9.30 am	Current Experience R Harvey W(S). Maclean W(S). Bowens. Fiat 100. Something less than req'd. Peterson S(S) 5700 hect.? 2 tractors.	Various "Ploughing Managers"
11.15 am	Coffee	
11.30 am	Current Silviculture/Site Survey recommendations	D A Thompson R D L Toleman
12.30 pm	Packed Lunch	
1.30 pm • • 5.30 pm	Travel to Kyle Forest Demonstration Area See machines at work etc.	D A Thompson R D L Toleman
Wednesday 20 March		
9.15 am	Management implications of soil complexes	D A Thompson J Oakley
10.15 am	Developments in plough design	W Low D A Thompson R B Ross
11.15 am	Coffee	
11.30 am	Developments in Tractor Design - Centurion,	R B Ross
12.15 pm	Summary and Conclusion	N Dannatt
12.30 pm	Disperse	

W(S) Bowen Fiat. T.A. 15 Sept pl

Deep kat Shallow kat Shallow tooth pl

4. It is hoped that this programme will give managers the opportunity of exchanging experience and so help to improve efficiency, and to obtain the views of managers on future development trends. I would be grateful if you could come prepared to talk in detail about your current experiences, the information on FC 17s would be most useful together with any analysis you may have done of machine logs. I expect that we shall be talking in terms of outputs per hour by machine and soil types, and of percentage machine usage etc. I hope we shall have a most stimulating and instructive series of discussions.

N DANNATT
Forest Management Division

6 February 1974

DISTRIBUTION:

Conservators N(S), E(S), S(S), W(S)
NW(E), NE(E), E(E), N(W), S(W)
Chief Engineer
Chief Work Study Officer
CRC (N)

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Mr G G Stewart
CRO (S)
Conservators SE(E), SW(E)
Chief Education & Training Officer
Mr D J Perry - Ae Training Centre

DOUBLE THROW DEEP DRAINAGE MOULDBOARD

This plough was developed for two purposes:-

1. To examine the mechanical benefits, if any, of the double throw configuration as opposed to the usual single throw deep drainage plough.

2. To provide a cheaper and more effective tool for establishment of forest crops on large areas of deep peat.

In the former role it has already been demonstrated that a deep and clean drain profile can be produced more easily with this mouldboard than with the conventional pattern. Its use in cross drainage of existing ploughing and the problems posed by having drain spoil on the upper side of the ditch are still under investigation.

In the latter role earlier work has already demonstrated that good growth can be expected on the large/tough ridges provided and that drains of this type are likely to remain effective for a fairly long period (10 years plus). Field trials have already demonstrated that the cost per acre of using this tool for a combined drainage and ground preparation treatment are likely to be less than for conventional ploughing plus cross drainage. The local intensity of drainage is greater than with the conventional method and ploughing tractors are likely to encounter fewer bogging problems, as each run is made on undisturbed land.

The recommended practice is to align the ploughing roughly in the direction of maximum fall and to space furrows at about 16 feet centres. Average plant spacing would probably be 8 feet across the line of ploughing by 6 feet along the furrows (900 trees per acre). The furrows should be interrupted at intervals of 300 to 400 yards by lifting the plough. The line of interruption should be selected in advance to conform to a suitable location for a main drain to collect water from the plough furrows and lead it off the site. Main drains can either be prepared by ploughing with the deep single throw drainage plough or by back acting digger.

This form of treatment is recommended for use on large areas of deep peat in subdued topography. Its use on other sites has still to be investigated, but it is unlikely to be useful in broken topography, due to the need for more frequent main drain channels.

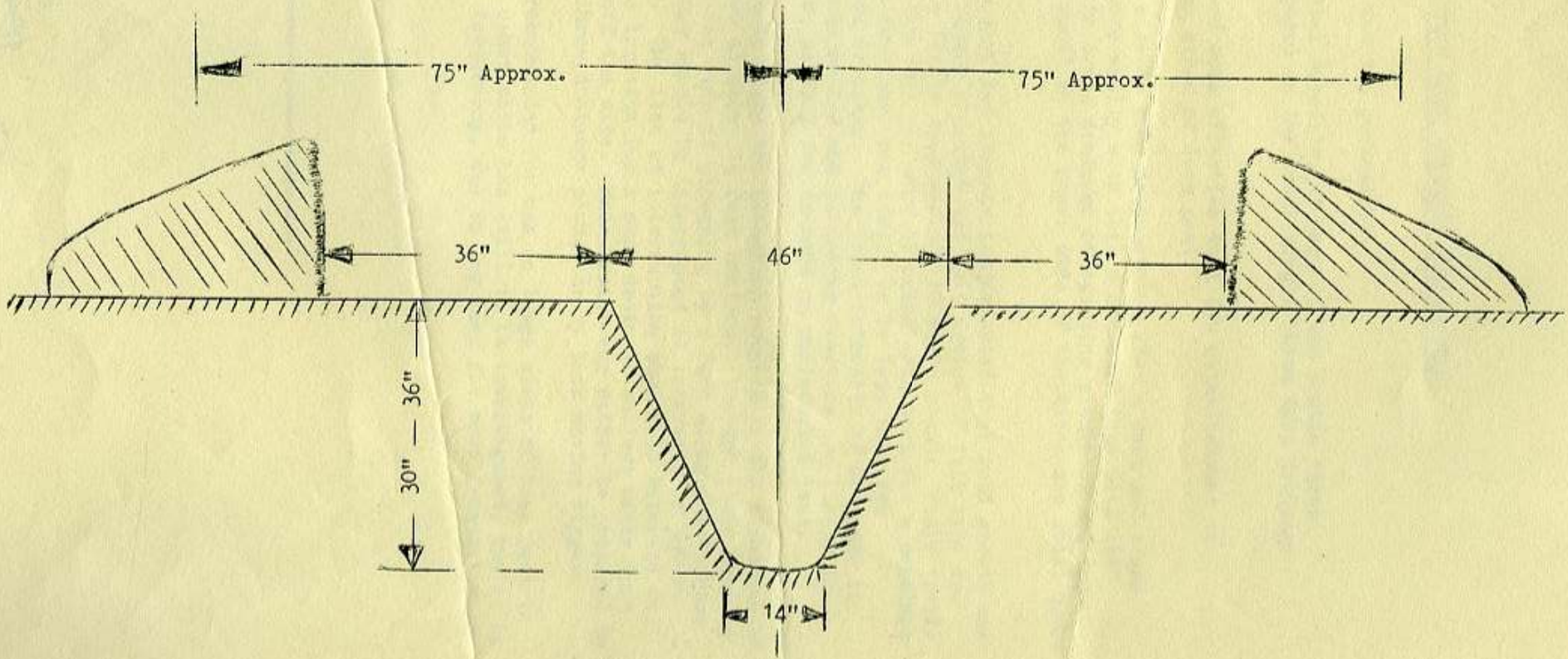
DOUBLE THROW DEEP DRAINAGE MOULDBOARD

MANUFACTURER: W. Clark & Son, Agricultural & Forestry Engineers, Parkgate, Dumfries.

(1) DOUBLE THROW DEEP DRAINAGE MOULDBOARD - Extra large and reinforced double throw mouldboard for deep drainage operations, with adjustable trailing moulds, laying the removed turves equidistantly on either side of the drain provided as shown generally on the sketch below.

(2) CENTRE DISC EQUIPMENT - Large centre disc mounted on spring loaded disc sheers to plough beam. ($\frac{\cdot}{\cdot}$ 480)

NOTE The above equipment is used with the Parkgate Deep Draining Forestry Plough by replacement of the Single Throw Deep Drainage Mouldboard with the Double Throw Mouldboard, item (1) above, and the addition of the Centre Disc, item (2) above.



SEMINAR - AE MANAGEMENT TRAINING CENTRE 19-20 MARCH 1974

PLOUGHING SOIL COMPLEXES

1. The 'Art' of Ploughing for Forestry

Unlike the farmer, the forester has no real opportunity to 'suck it and see' when it comes to ploughing. He is in the position of estimating the probable result of his efforts. Years of experimenting by Research Division can only produce very broad principles which must leave large questions as to expected results when extrapolating to new techniques. It is not surprising that such confusion exists in Forestry for when one looks at Agricultural practice, great confusion reigns where results of ploughing practice are described in terms of yields.

Early forest ploughing established the two basic principles that a large turf on wet ground and the breaking up of Ironpans by tine ploughing increased early growth. These two benefits are still the main consideration in forest ploughing, for any forester can see the effects in terms of easy establishment of a crop. However, we are in an era when the forester expects ploughing to give him benefits in terms of easy establishment. What is not readily appreciated is that it is not only fast establishment which is important but the ultimate yield and stability of the crop. Lack of awareness of this latter point is mainly the result of a dearth of information on how different ploughing treatments may affect ultimate yield.

Because the ultimate result of a particular ploughing treatment is unknown the establishment of forester either assumes all treatments have the same end result therefore concentrates on finding ways to cheapen costs or he becomes an enthusiast for soil treatment on the assumption that by deduction the benefits of soil changes

can be predicted. Both types of forester have contributed to ploughing development.

2. Reducing costs

If costs were not limiting then each soil type could be ploughed to give maximum yield. But soils are not distributed in convenient large areas so it is inevitable that one plough will cross several soil types in the course of a ploughing run. It is important to know through which soils a plough can operate reasonably satisfactorily. And it is possible to draw up a chart to illustrate the soils on which certain ploughs can work; one such chart is shown in diagram 1.

If a plough can be used on many soils, not only is the length of plough run increased but the proportion of planting area ploughed also is increased thereby reducing the cost of moving outfits into the area.

3. Maximising Benefits

It is easy to forget that a forester in ploughing should be just as concerned to maximise benefits as one engaged in fertilising, or thinning. To do this he must be aware of costs and yields.

Discounted Revenue Figures have been produced by Economics Branch (albeit for 1972) from which it is possible to obtain figures for a given age and yield class. In table I, I have attempted to associate ploughs with yield for spruce. These figures are not rigorously proved but represent an estimate based on experiment results, some going back 40 years. And it must be remembered that experiments do not cover all combinations of ploughs and site types.

It is not possible to say accurately what Yield Class can be expected with every site. So table I assumes that a local prediction is made based on best ploughing alternative and subsequent silviculture and anything less than the best ploughing will represent a lower yield which may or may not be significant. A drop in yield is reflected as reduced Discounted Revenue.

Where stability is a factor then ploughing which will allow wide root plate development is expected to increase the critical height by 5 metres, which will represent varying numbers of years depending on Yield Class. If a realistic estimate is made of the age when windthrow might occur then a discounted revenue figure can be estimated.

There appear to be two easily measurable costs in ploughing: namely the cost per hectare of moving a plough outfit into an area and the cost per hectare of plough runs of different lengths for one way or two way ploughing. For a particular outfit and Site Region these figures may be fairly consistent. There is a third factor associated with ploughing of detailed areas and that is one of supervision time. Work Study can produce figures which represent the costs associated with ploughing small areas.

By comparing costs with yields for different combinations of ploughs on a particular planting area a maximum benefit combination can be determined (See Example).

4. Implications The operation for calculating a maximum benefit combination of ploughs for a particular area is cumbersome and it ignores the fact that ploughing fleets have to be maintained on the Conservancy basis. However, it does draw attention to lost opportunity. I believe there is a place for this kind of calculation for Site Regions which can indicate minimum areas to be considered when ploughing a particular planting area. Moreover, it will indicate equipment requirements more precisely than is at present possible.

DONALD A THOMPSON
13 3 74

TABLE I

ESTIMATED INTERACTION OF PLOUGHING AND SOILS FOR SPRUCE

PLOUGHING				SOIL CLASSES FOR PLOUGHING (see Table II)						
				A	B	C	D	E	F	G
TYPE	DEPTH	MOULDBOARD								
Tine	Shallow	Single	Spaced	I	I/IIIb	III	III	III	III a	I d
			Complete	I	I/IIIb	IIIS	IV S	IV S	IV S	I d
		Double	Spaced	I	III	IIIS	IIIS	IIIS	IIISa	ISd
		Twin Furrow	Complete	I	I/IIIb	IIIS	IIIS	IV S	IV S	I d
		Twin Tine	Spaced Mole	I	I/IIIb	III	I S	III	II a	I d
	Deep	Single	Spaced	I	I	II S	II	I	I a	I d
			Complete	I	I	I S	IIIS	IIIS	IV S	I d
		Double	Spaced	I	III	IIIS	II S	I S	I S	ISd
Turf	Shallow	Single	Spaced	I d	IV d	IV d	II	I	I a	I d
		Double	Spaced	I d	V d	IV Sd	II S	I S	I Sa	ISd
	Deep	Single (Draining)	Spaced	I d	IV d	IV d	II	I d	I	I d
		Double	Spaced	I d	IV d	IV Sd	IIIS	I Sd	I S	ISd

KEY

I = Expected Yield Class from preferred treatments

II = $\frac{1}{2}$ Yield Class less than I

III = 1 Yield Class " " "

IV = $1\frac{1}{2}$ Yield Classes less than I

V = 2 Yield Classes " " "

S = 5 m extra height Stability Increased

a = Plough furrows may not reach optimum depth for drainage

b. = Effectiveness will depend on depth of pan

d = There may be difficulties in ploughing resulting in poor turf production, loss in planting positions and weed control

TABLE II

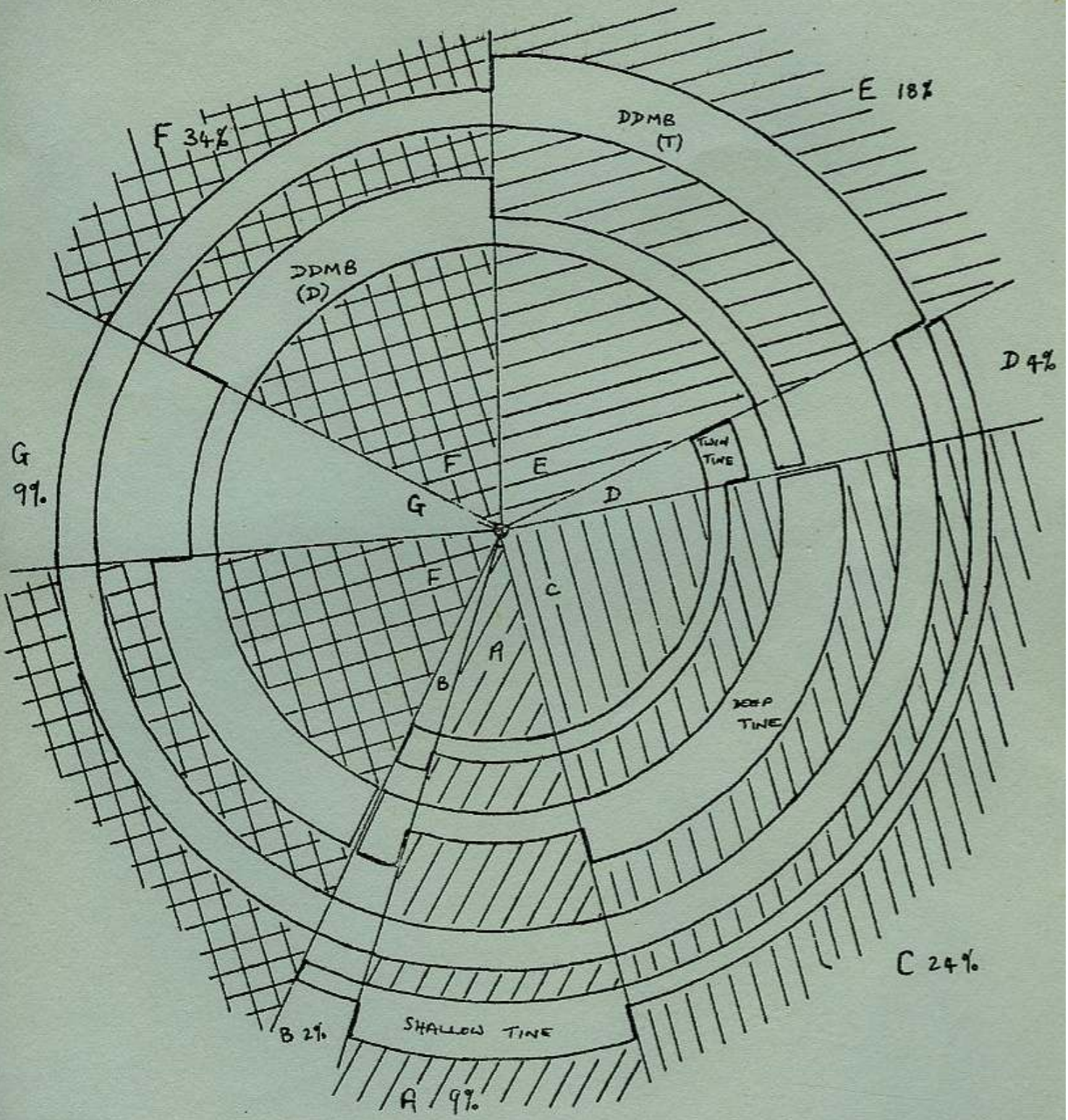
CLASSES OF SOIL FOR PLOUGHING

CLASS	SOIL
A	10 Brown Earth 20 Podzol 21 Peaty Podzol 50 Calcareous Soil
B	30 Ironpan Soil (without Induration) 31 Peaty Ironpan Soil (without Induration) 53 Man-Made Soils
C	In Dry Uplands and Steep Sloping Wet Uplands both with Induration less than 90 cm (3 ft) 30 Ironpan Soil 31 Peaty Ironpan Soil 41 Surface Water Gley 42 Peaty Gley 6 Deep Peat
D	In Dry Uplands and Steep Sloping Wet Uplands both without Induration less than 75 cm ($2\frac{1}{2}$ ft) 41 Surface Water Gley (Loamy) 42 Peaty Gley (Loamy)
E	In Wet Uplands not on Steep Slopes 30 Ironpan Soil 31 Peaty Ironpan Soil 41 Surface Water Gley (Loamy and Clay) 42 Peaty Gley (Loamy) Also 40 Ground Water Gleys 6 Deep Peat 45-90 cm ($1\frac{1}{2}$-3 ft) (without Induration or Ironpan)
F	41 Peaty Gley (Clay) 6 Deep Peat 45-90 cm ($1\frac{1}{2}$-3 ft) (with clay) 6 Deep Peat more than 90 cm (3 ft)
G	52 Skeletal Soils and Rock

PLOUGHS. FOR USE ON DIFFERENT PLOUGHING CLASSES

DISTRIBUTION OF CLASSES FOR SCOTLAND AND NORTHERN ENGLAND

WIDTH OF BAND INDICATES THE PREFERRED PLOUGH



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SEMINAR. AE MANAGEMENT TRAINING CENTRE 19-20 MARCH 1974

SITE CLASSIFICATION AND PLOUGHING RECOMMENDATIONS

1. SITE DESCRIPTION.
2. SITE IMPROVEMENT BY PLOUGHING.
3. SOIL TYPES FOR PLOUGHING
4. OBJECTS OF PLOUGHING IN RESPECT OF DIFFERENT SOIL TYPES.
5. DRAINAGE CLASSIFICATION OF UPLANDS.
6. PLOUGHING DEFINITIONS.
7. RECOMMENDATIONS.

APPENDIX I. NATIONAL SOIL TYPE CLASSIFICATION.

APPENDIX II. 2 EXAMPLES OF REGIONAL CLASSIFICATION.

D A THOMPSON
Northern Research Station
13 3 74

DAT/HL

1. SITE DESCRIPTION

WHY SOIL TYPES?

Managerial treatments of forest land are wasteful if they are not curtailed beyond their effective limits. Therefore it is essential that a system of identification when applied to forest land should be meaningful in terms of treatment responses. Soil classification presents an ideal means of subdividing land because natural soils reflect features of parent material and climate which are likely to be of importance when considering tree growth and because soil with all its limitations is the environment of the tree root system. Moreover, it has been found that treatment responses can be recognised as being similar on similar soils.

NATIONAL CLASSIFICATION

The description of soils by easily recognisable features imposes restrictions on a system of soil classification. Also a particular treatment will demand a classification specifically for its own use. The benefits to be accrued from difficult soil description techniques and special classifications limit the extent to which this can be done. For these reasons and because higher management require information on a broad scale for planning and yield prediction purposes a national classification of soils is in use by the Forestry Commission. This has been recently rationalised and is described in Appendix I.

REGIONAL CLASSIFICATION

At a local level this broad classification has to be elaborated in order to make it meaningful; and this is done by describing the Regional Soils which are important. From the two examples given in Appendix II you will see that Regional Soil Types are not necessarily the same. Regions are defined as areas with the same Lithologies and similar climate.

When ploughing is considered some of the detail found in the National Classification is unnecessary and even irrelevant: in the case of Deep Peat it is not necessary to know what level of fertility is to be expected but it is important to know what the depth of peat may be. (Deep peat is normally defined as being 45 cm (18 in) or more in depth and is classified by its fertility.) On the other hand the presence of Induration is of great interest but may only be of importance in particular regions and so does not appear in the National Classification.

2. SITE IMPROVEMENT BY PLOUGHING

ADVANTAGES

Weed Suppression: It has long been recognised that the upturned turf can inhibit weed competition in the vital early stages of tree growth. From this it is assumed that complete ploughing should give better benefits than spaced ploughing.

Planting Position: The presence of a line of turf makes for ease in the organising and carrying out of planting. This orderliness can be lost in complete ploughing.

Drainage: The removal of water from saturated soils is most effectively achieved by plough furrows. The furrows represent an intensive drainage system. This is particularly important on heavy soils where removal of water from the upper horizons allows shallow rooting to take place - in these circumstances a wide root plate is required for stability. In other soils where vertical drainage is impeded reducing the impedence enables rooting to go deeper. Reduced impedence may achieve deeper rooting quickly in the case of Ironpan Soils or in the long term where soils are Indurated.

Aeration: The action of drainage is remove water from soil pores which exist naturally. This inevitably means that these pores become gas filled and it is expected that the composition of gas will include a good proportion of oxygen. Drainage is a major feature of turf ploughing where the turf in particular becomes aerated.

It is expected that the action of cultivation by tine ploughs will create new pores and fissures in the soil; this and accompanying drainage should increase aeration of the soil. However, much depends on the texture, for example heavy clays when wet will not fissure, while there are forms of Induration which crumble when broken.

A feature of soil aeration is a drop in thermal capacity and a corresponding rise in soil thermal flux. This means that soil temperature maximums will increase with obvious benefits in terms of root growth.

Nutrition: By increasing drainage and aeration it is expected that there will be an increase in the number of sites where microbial activity and oxidation of soil minerals take place thereby an increase in nutrition available to roots. But another feature of ploughing which may be important is that of mixing soil constituents together. By increasing the number of places where soil constituents are in juxtaposition soil processes could be increased leading to increased nutrition. Moreover in the long term this may be an essential feature for real improvement in soil structure.

DISADVANTAGES

Root Alignment: Spaced ploughing inevitably limits the shape of root systems, first by the preferable conditions to be found in the turf and second by the physical limitation of the furrow. Where rooting is of necessity shallow such conditions can lead to instability.

Erosion: Although not yet recognised as important the wider spacing of cross drains now recommended will increase the incidence of erosion in spaced ploughing especially on slopes of till with high sand and gravel contents.

Slow Growth: Trees planted in sub-soils particularly where clay content is high, suffer from slow rates of early growth for up to 3 years in comparison with trees on humous planting sites.

Exposure: A raised turf is an exposed position for planting and this is particularly critical where tubed seedlings are being used.

Physical Obstruction: Deep plough furrows limit the extent to which cross-country machinery can be used immediately after ploughing. Witness difficulties in cross draining. Although extraction techniques may have drastically changed by the time thinning or felling takes place deep furrows must limit the type of operation possible at that time.

3. SOIL TYPES FOR PLOUGHING

A Broad Classification

IMPERFECT SOILS — These soils are recognised as having no obstacle to drainage or rooting down through the profile to the parent material.

IMPEDED SOILS — These are soils in which there is a distinct obstruction to either or both drainage and rooting down the profile. This obstruction can take the form of either an Ironpan or Induration or Compaction.

IMPERVIOUS SOILS — Where the basic soil material is one with low porosity, drainage will exert little influence in removing water from the soil. Extreme examples of this type of soil are the Carboniferous Clay Soils of the Border area or the Black humic peats.

IMPLACABLE SOILS — These soils are basically unploughable and represent in particular the Skeletal soils and Rock which is found inside the plantable area.

4. OBJECTS OF PLOUGHING IN RESPECT OF DIFFERENT SOIL TYPES

SOIL SUB GROUP		PLOUGHING ADVANTAGES
10 Brown Earth 20 Podzol 21 Peaty Podzol 50 Calcerous Soil	Imperfect	1. Weed Suppression 2. Planting Position 3. Mixing (for degraded soils)
31 Ironpan soils 32 Peaty Ironpan soils 41 Surface Water gley (with Induration 0-90 cm) 42 Peaty gley (with Induration 0-90 cm) 53 Man-made soil 6 Deep Peat (with Ironpan or Induration 0-90 cm)	Impeded	1. Weed Suppression 2. Planting Position 3. Aeration 4. Mixing 5. Drainage
40 Ground water gley 41 Surface water gley (Loamy or clay) 42 Peaty gley (Loamy or clay) 6 Deep Peat (except with IPS or Induration 0-90 cm)	Impervious	1. Weed Suppression 2. Planting Position 3. Drainage 4. Aeration

5. DRAINAGE CLASSIFICATION OF UPLANDS

POTENTIAL WATER DEFICIT

It is normal to expect that water will be lost from a site by transpiration through the leaves of vegetation and evaporation from the ground and wet surfaces. The warmer the weather the greater will be the loss of moisture in this way. During summer months it is possible for more water to be lost this way than falls as rain.

An estimate of the amount lost by evapotranspiration can be made using measurements of sunshine, wind and temperatures. If at the same time rainfall is measured then it is possible by subtraction to say if more or less water has been lost by evapotranspiration than has fallen as rain.

If over the course of a year there appears to be a net loss of water but no obvious drought then it must be assumed that water has been taken from a reservoir in the soil and the soil is drying out. If the reverse is true and more rain fell than water was lost as evapotranspiration then it cannot be assumed the soil is wetter for it could have been lost as run-off.

A net loss between rainfall and evapotranspiration is called the Potential Water Deficit.

WET AND DRY UPLANDS

The 'Upland' area of Britain, in general, does not exhibit a significant Potential Water Deficit, in comparison with 'Lowland' Britain. After trees close canopy they markedly intercept rainfall in their crowns which subsequently is evaporated directly back to the air. This interception can reduce the rainfall on the ground surface by as much as 30%. By doing this in a marginal area closure of canopy can so modify conditions that it develops a Potential Water Deficit. If this develops, drying of the site can occur.

The distinction is made between those areas where this cannot happen because rainfall is too high or evapotranspiration low and those where it can. The former are called Wet Uplands and the latter Dry Uplands.

6. PLOUGHING DEFINITIONS

TINE Subsoiler, where a turf is produced the ridge is usually hinged.

TURFING No subsoiler. A distinct shape to ridge turf.

SHALLOW At the present day this represents less than 60 cm (2 ft) maximum depth.

DEEP At present day this represents between 60 and 90 cm (2 ft to 3 ft) depth.

SPACED Original surface still visible.

COMPLETE Original surface completely disturbed or buried.

SINGLE MOULDBOARD One furrow and one ridge at each pass.

DOUBLE MOULDBOARD One furrow and two ridges, one on each side of the furrow at each pass.

TWIN Two mountings on the same carriage.

TWIN FURROW Two subsoil furrows and two ridges at each pass.

TWIN TINE One subsoil furrow and one ridge plus one subsoiler at each pass.

7. RECOMMENDATIONS

10 **Brown Earth** 20 Podzol 21 Peaty Podzol 50 Calcareous Soil	Shallow Spaced Ploughing - For weed suppression and planting position. A tine will aid mixing in those sites which are degraded and a double mouldboard can reduce costs on those sites which are not degraded.
31 Ironpan Soils 32 Peaty Ironpan Soils (without Induration) 53 Man-made Soils	Spaced Furrow Tine Ploughing - To break impedence. The depth of ploughing will depend on the depth to the B horizon. Although complete ploughing may be best the advantage at the 20 years is not significant. Complete ploughing can give more rapid early growth which may be associated with weed control but this is offset in some cases by slower growth in the first 3 years when plants are growing only in subsoil. Twin tine ploughing appears to be as good as complete ploughing although only limited evidence available.
In Dry Uplands and Steep Sloping Wet Uplands both with Induration less than 90 cm (3 ft) 3 Ironpan Soils 41 Surface Water Gley 42 Peaty Gley 6 Deep Peat	Complete Deep Tine Ploughing - The objective is to increase rooting depth available and maximum benefit will be expected after closure of canopy when drying out of the soil by the crop should become significant. Evidence suggests that should an alternative be needed it is preferable to plough deep spaced rather than shallow complete.
In Dry Uplands and Steep Sloping Wet Uplands both without Induration less than 75 cm ($2\frac{1}{2}$ ft) 41 Surface Water Gley (Loamy) 42 Peaty Gley (Loamy)	Twin Tine Ploughing - Where the structure of 'Loam' includes small pieces of broken rock and clay the mole channel produced by this plough can maintain its shape. The objective is to deepen rooting by aiding the run-off from the site during the period up to closure of canopy; thereafter the site should be influenced by the drying effect of the trees.

In Wet Uplands not on Steep Slopes, ~~8 Deep Peat~~ Induration 3 Ironpan Soils 41 Surface Water Gley (Loamy and Clay) 42 Peaty Gley (Loamy) Also 40 Ground Water Gleys 6 Deep Peat 45-90 cm (1½-3 ft) (without Induration or Ironpan)	Deep Double Tine Ploughing - The objective is to encourage rapid early growth and to permit the development of a wide root plate in order to aid stability. Also to maximise drainage of surface water from the Site.
41 Peaty Gley (Clay) 6 Deep Peat 45-90 cm (1½-3 ft) with Clay 6 Deep Peat (90 cm (3 ft))	Deep Double Mouldboard Turf (Draining) Ploughing - The objective is to obtain rapid early growth and permit the development of wide root plates for stability. Also it is intended to maximise drainage from the site of surplus water.
52 Skeletal Soils and Rock	Very Shallow Double Mouldboard Ploughing - To allow maximum width of rooting.

APPENDIX I

NATIONAL SOIL TYPE CLASSIFICATION

The National group and sub group classifications are given below:-

No	Major Soil Group	No	Soil Sub Groups
1	Brown Earths	10	Brown Earths
2	Podzols	20	Podzols
		21	Peaty podzols
3	Ironpan Soils	30	Ironpan soils
		32	Peaty ironpan soils
4	Gley soils	40	Groundwater gley
		41	Surface water gley
		42	Peaty gley
5	Other Mineral Soils	50	Calcareous Soils
		51	Littoral Soils
		52	Skeletal Soils and Rock
		53	Man-made soils (Mining spoil)
6	Deep peats	60	Flush bogs
		61	Molinia bogs
		62	Unflushed bogs
		63	Eroded bogs

APPENDIX II

Example 1

Regional Soil Type Classification
Eastern and Central Southern Uplands
Ordovician Shales and Greywacke

The following soil type key is suitable for all forests in this site region from Ae in the west to Duns in the east.

Soil Sub Groups and Nos	Regional Soil Types and Nos
10 Brown earths	10 Acid brown earth 10s Brown earth - stony phase 10x Brown earth over induration 10e Brown earth - ericaceous phase
NB Small areas of upland B.e. and imperfectly drained B.e. are included in Acid B.e.	
30 Ironpan soils	30 Ironpan soil 30e Ironpan soil - ericaceous phase 30n Intergrade to I.P.S. 30ne Intergrade to I.P.S. - ericaceous phase
NB Small areas of podzol are included in the Intergrade to I.P.S.	
31 Peaty Ironpan soils	31 Peaty ironpan soil
40 Groundwater gleys	40 Groundwater gley
41 Surface water gley	41o Loamy surface water gley 41y Clayey S.W.G. 41x Seepage gley over induration
42 Peaty gley	42y Clayey peaty gley 42x Indurated peaty gley
52 Skeletal soils & rock	52r Rock/scree 52 Skeletal soil complex
NB Skeletal soil complex includes various very shallow stony profiles, the majority of which are freely drained.	
60 Flush bogs	60 Juncus flushed bog
61 Molinia bogs	61b Molinia bog 61c Molinia/Eriophorum bog
62 Unflushed bogs	62c Sphagnum/Calluna upland contained bog 62d Calluna/Eriophorum blanket bog (Hill peat)
TOTALS 10	22

Within this key 10 soil sub groups have been recognised as important at the level of Conservancy planning and forecasting while 22 are recognised at the Forest and District level for local planning and forecasting.

Example 2

Regional Soil Type Classification

Central Midland Valley of Scotland

Carboniferous Shales and Sand Stones with Basic Igneous Intrusions

The following key is suitable for all forests from Kyle in the west to Blairadam in the east, but excludes forests lying wholly on basic igenous bedrock. (eg Whitelee, Carron Valley.

Soil Sub Group and Nos	Regional Soil Types and Nos
10 Brown earths	10 Brown earth 10b Basic brown earth 10a " " " - shallow phase 10g " " " - imperfectly drained 10z Podzolised brown earth
NB Small areas of cultivated brown earth have been included in Basic brown earth, and podzol in podzolised brown earth. Brown earth includes clayey and loamy types.	
30 Ironpan soils	30 Ironpan soil
41 Surface Water Gleys	41y Clayey SWG 41yh Humic clayey SWG 41yc Cultivated clayey SWG 41yb Clayey brown gley
42 Peaty gleys	42y Clayey peaty gley 42yc " " " - cultivated 42yf " " " - flushed
52 Skeletal soils & rock	52p Peaty skeletal soils
NB Small areas of other skeletal soils are included.	
54 Man-made soils	54g Gleyed mining spoil
60 Flush bogs	60c Juncus flushed bog
61 Molinia bogs	61c Molinia/Eriophorum bog 61d Molinia/Trichophorum/ Eriophorum bog
NB Small areas of Molinia bog and cultivated peat are included in Molinia/Eriophorum bog.	

62	Unflushed bogs	62a Transitional bog 62c Upland sphagnum/Calluna contained bog 62d Calluna blanket bog (Hill peat) 62e Eriophorum blanket bog (Hill peat)
63	Eroded bogs	63h Deeply hagged bog 63f Stabilised and flushed hagged bog.
TOTAL	10	24

R. Door.
R. + Rds -
L Junction
A.76 N. to Kinnbeck
L B.741 supposed Dolmen
6 miles L.A.S. FRP90

PLOUGHING DEMONSTRATION

18-22 MARCH 1974

D A THOMPSON

DAT/MJF

KYLE FOREST 18-22 March 1974

PLOUGHING DEMONSTRATION NOTES

Rainfall & Elevation - Sites of ploughing vary in elevation from 950' to 1400' and rainfall from 60" to 70".

Climate Zone - Wet to very wet cool uplands.
Exposed to very exposed with rather severe winters.

Geology - The ploughing sites all lie immediately north of the Southern Upland fault line. Geology in Carboniferous but here consists of numerous Basalt/Andesite Intrusions.

SITE 1 TOPOGRAPHY: Steep slope

SOIL: Intergrade from Brown Earth to Ironpan Soil

PROFILE:	THICKNESS Min.	Mean	Max.	DESCRIPTION
A	5 (2")	7 (3")	10cm (4")	Shallow peat
				Narrow imperfectly drained grey material with incipient iron deposition
B	13 (5")	21 (8")	30cm (12")	Freely drained brown or ocherous material with faint iron desposition
C				Either indurated till at the foot of the slope or shattered Basalt/Andesite towards the top of the slope.

The soil changes to peaty Ironpan soil as the slope changes at the top while at the bottom it becomes flushed and changes to Humic Surface Water Gley.

OBJECT: To give Weed control and a planting position. In the Humic Surface Water Gley ploughing, slightly across the slope will increase drainage thereby allowing deeper rooting.

PLOUGH: A Hydraulically Mounted Single Mouldboard Tine plough. Depth of ploughing 60cm (24") Max. Attachments include a disc and packer.

TRACTOR: Fiat 70C

SITE 2 TOPOGRAPHY: Gentle to steep upper slopes.

SOIL: Peaty strong Ironpan Soil with some Induration.

PROFILE:	THICKNESS Min.	Mean	Max.	DESCRIPTION
O	25cm (10")	30cm (12")	45cm (18")	Peat
A	12cm (5")	17cm (6")	40cm (8")	Drab grey poorly draining mineral, Rooting impeded by well developed moderately indurating Ironpan.
B	- -	15cm (6")	20cm (8")	Shallow freely or imperfectly draining mineral soil. Occasional Induration
C	-	-	-	Glacial till on shoulders more frequently till and shattered rock.

The soil changes to Intergrade down the slope and Deep Peat on the more level upper slopes.

Both techniques of ploughing shown would normally only be associated with drier sites.

OBJECT 1: Complete cultivation to break Ironpan at frequent intervals and give maximum mixing of peat and mineral.

PLOUGH 1: A trailed Twin Furrow Plough. Two tine mouldboards capable of 60cm (24") depth are mounted on a carriage with two discs.

TRACTOR: Fowler Challanger 33

OBJECT 2: To completely plough through Induration, increasing drainage

PLOUGH 2: A Mounted Deep Spaced Tine plough. Maximum depth of ploughing 90cm (3ft). There is no disc attachment and mountings include a twin ram assembly with hydraulic accumulators.

TRACTOR: CAT D7

SITE 3 TOPOGRAPHY: Gentle to steep slopes.

SOIL: Complex from Brown Earth, Intergrade to Ironpan Soils and very shallow stony Brown Earths.

The Profiles are very similar to those at Site 1 - but there are included in this area small knolls with a stone free crumbly loam surface horizon averaging 20cm deep.

OBJECT 1: To completely plough Ironpan Soil for increased rooting depth, to weed suppression.

PLOUGH 1: A Trailed Twin Furrow Plough (as for Site 2)

TRACTOR: Fowler Challanger 33

OBJECT 2: To produce a planting position and weed suppression.

PLOUGH 2: A Trailed Spaced Tine Plough. Maximum depth 60cm (24")

Plough mounted on a Universal Carriage with discs.

TRACTOR: County 1124 with Terra Tyres.

PLOUGH 3: A Mounted Spaced Tine Plough. As for Plough 2 except the plough is mounted on the 3 point linkage.

SITE 4 TOPOGRAPHY: Long moderate slopes.

SOIL: Deep Peat - Eriophorum vaginatum.

PROFILE: The depth of peat varies over the site and generally decreases up the slope. However it has a large proportion 90cm (3ft) or more.

OBJECT: To plough for optimum drainage and a wide root plate.

PLOUGH 1: A Deep Double Mouldboard Draining Plough. - Maximum Depth 90cm (3ft)

Mounted on an Arched Beam Carriage with Discs including a Centre Disc in the Arch. Also a Depth Control Device is included on the plough.

TRACTORS: Track Marshall 55 and A Bowen 60

PLOUGH 2: A Deep Double Mouldboard Tine Plough - Maximum Depth 90cm (3ft)

Mounted on the same carriage as above.

TRACTORS: Fiat 70C Polder and a Fiat 80 CIP.

Also at this site will be ploughing by a Single Mouldboard Turf Plough Plough maximum depth 60cm (2ft). This will be pulled by first a Fiat 655 and second a County 754 with Finn Tracks.

SITE 5 TOPOGRAPHY: Moderately gentle even slopes.

SOILS: Humic flushed, Surface Water Gleys with stony Brown Earths on rises and deeper peat in depressions.

Parent material consists of glacial till derived from Greywacke which changes to frost shattered basalt rock infilled with humus and fine up the slope.

OBJECT 1: To increase run-off from the site and thereby allow drying by the crop with subsequent deeper rooting.

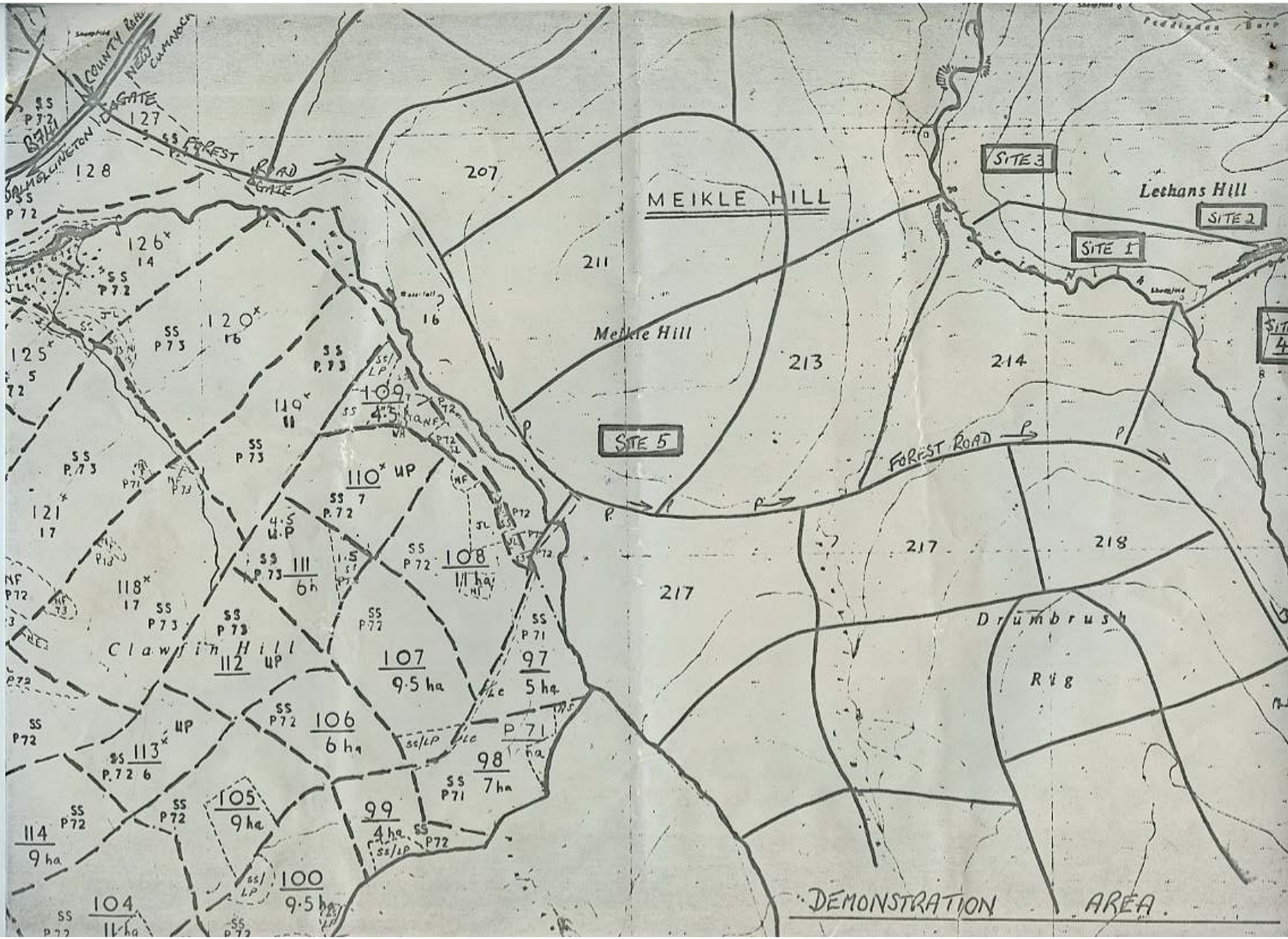
PLOUGH 1: A Trailed Twin Tine Plough. Maximum depth of tines 60cm (2ft). The tine with mouldboard has a ball sock and the tine without a mouldboard has a ball and chain, both intended to produce a form of mole drain.

TRACTOR 1: Fiat 100

OBJECT 2: To plough for optimum drainage and maximum root plate width.

PLOUGH 2: A Deep Double Mouldboard Tine Plough.

TRACTORS: Fiat 70C Polder and a Fiat 80 CIP.


MEIKLE HILL
Meikle Hill
Lethans Hill
SITE 1
SITE 2
SITE 3
SITE 5
FOREST ROAD
Clawfin Hill
Drumbrush
Rig
DEMONSTRATION AREA
COUNTY RD
GATE
127
128
207
211
213
214
217
218
126*
14
120*
16
125*
5
121*
17
118*
17
110* UP
7
109
4.5
111
6h
108
11 ha
112 UP
107
9.5 ha
97
5 ha
106
6 ha
113*
6
98
7 ha
105
9 ha
99
4 ha
114
9 ha
100
9.5 ha
104
11 ha

PLOUGHING SEMINAR/DEMONSTRATION 18/3/74 - 20/3/74. S.SCOTLAND

THE PLANNING & UTILISATION OF PLOUGHING/DRAINING IN THE WEST SCOTLAND CONSERVANCY

APPENDIX I

1. The Tractors/Plough type and Draining Equipment used in West Scotland.

APPENDIX II

2. Forms used by the District Forest Officers and submitted to Conservancy showing their programme and machine requirements, by Forests, by 30th November each year.

APPENDIX III

3. Detailed District programme showing machine type/driver and dates are returned to DFO's by December 21st.

APPENDIX IV

4. Analysis of A141 Tractor Logs carried out every 6 months. Copies to C.M.E. and Assist Conservator (Afforestation).
In April each year an Annual Analysis is presented to C.M.E. and A.C. Afforestation. The 'In Use' and '% In Use' Data for all types of machines are sent to DFO's along with their machine Utilisation by 21st December. This information is helpful when FC17's and Budgets are made up.

APPENDIX V

5. Chart kept by Assistant Conservator Afforestation showing Programme/Achievement by Forest and Conservancy.

6. The Ploughing Manager uses a Magnetic Board to keep a running record of Machine Deployment/Programme and achievement by Forests.

APPENDIX I

Ploughing and Draining Equipment
West Scotland Conservancy

5 Fiat 70C1 with mounted Parkgate Tine

2 BTD 8 with Parkgate trailed Forestry plough (SMB for Tine and turfing)

3 Fiat 655 with Parkgate trailed Forestry ploughs (SMB for Tine and turfing)

6 B60's (3 teams) with Parkgate trailed deep draining plough

2 TM70's (1 team) " " " " "

4 C.S.4 wheeled Back Acters with M/F 242 diggers

1 T500 with Parkgate trailed Forestry plough (SMB turfing). Only used to plough very soft areas.

APPENDIX II

PLANNING RETURN

PLOUGHING PROGRAMME F.Y. 74 / 75 LORNE DISTRICT

Forest	Area to by ploughed by										Ancillary work	Total Duration of work	Entry available to ground	Remarks
	Mtd. tine		Trailed tine		S.M.B. B.T.D.		S.M.B. Long Wide		Total					
	(ha)	(wks)	(ha)	(wks)	(ha)	(wks)	(ha)	(wks)	(ha)	(wks)	(weeks)	(weeks)	(date)	
GLENORCHY	250	36	75	10					325	47	-	47	JUNE/JULY	JUST AFTER PLANTIN
GLENCOE	70	11	-	-	30	4			100	15	-	15	OCT	NEW AQUISITION EN DATE NOT FINALIS
BARCALDINE	50	10	-	-	.	.			50	10	-	10	ANY TIME.	
Totals	370	57	75	11	30	4			425	72	-	72		

LORNE DISTRICT **DRAINING PROGRAMME** FY 74/75 APPENDIX II

FOREST	DEEP DRAINING PLOUGH						WHEELED B/ACTER				TERRA TIRED B/ACTER				REMARKS
	Crops over 6ft		Crops under 6ft		New Drains		Felled Areas		Other		Felled Areas		Other		
	Ha	Wks	Ha	Wks	Ha	Wks	Ha	Wks	Ha	Wks	Ha	Wks	Ha	Wks	Entry Dates Etc.
Glenorchy					220	8									Deep Drainer Team
									250	19			50	4	C.S.4 Linking up and New Leaders
Glencoe					130	6									Deep Drainer Team
							-	8							Felled Area/Roadside Drains
Barcaldine							-	8	100	3					Felled Area/Linking Up

Forestry Commission

EXAMPLE :FOR MACHINE PROGRAMMING

APPENDIX II

DETAILED BUDGET OF V M E REQUIREMENTS

Conservancy West Scotland

District/Area Glenorchy Forest

000's Hrs to one decimal place

Cat.	Machine Type	Operation Type of Work or Account	Total Work (qty)	Units	Output per Hour In Use	Required Hours in Use					Number of Machines Required in each quarter (months if necessary)												Total Machine Months Required	Total Machine Hours required (hours) Col 9x0.16	Hours in use %
						Total	Quarters 1	2	3	4	A	M	J	J	A	S	O	N	D	J	F	M			
(1)	(2)	(3)	(4)	(5)	(6)		(7)										(8)						(9)	(10)	(11)
	Fiat 70C1 Mtd Plough	01110	250	ha	0.21	1200						JUNE ENTRY												1750	68%
	BTD8	01110	75	ha	0.28	270																		425	63%
	B60) B60) Deep Drainer	01160	220	ha	1.25	180) 180)						SEPTEMBER												(330 (330	55%
	C.S.4	01160	50	ha	0.5	100						TERRA TIRRED												180	55%
	B/ACT	01310	50	ha	0.5	100																		180	55%
		01320	150	ha	0.5	300																		545	55%

FC 17 (Revd 11/73)

FY 74/75 PLOUGHING / DRAINING PROGRAMME LORNE DISTRICT

FOREST	AREA (Ha's)	APRIL MAY JUNE JULY AUG SEPT OCT NOV DEC
GLENORCHY	325	FIAT 70 C1 P CUMMINGS (H/S) FIAT 70 C1 A. DONALD BTD 8 W. DONALD T.M. 70's (TEAM) KELLY / CAMA
	DRAINING	C.S.4. B/A CRAIG / GRAHAM
BARCALDINE	50	FIAT 70 C1 CUM FIAT 70 C1 A. DO
	DRAINING	C S 4 B/A GRAIG (H/S) / GRAHAM
GLENCOE	100	FIAT 70C1 CUMMINGS FIAT 70C1 A. DONALD BTD 8 W. DONALD TM 70 (T
	DRAINING	C S 4 B/A

HING / DRAINING PROGRAMME LORNE DISTRICT APPENDIX II

APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MA
		FIAT 70 C1 P. CUMMINGS (H/S) FIAT 70 C1 A. DONALD BTD 8 W. DONALD					T.M. 70's (TEAM) KELLY / CAMPBELL.				
C.S.4. B/A CRAIG / GRAHAM											
							FIAT 70 C1 CUMMINGS FIAT 70 C1 A. DONALD (H/S)				
					C S 4 B/A GRAIG (H/S) / GRAHAM						
							FIAT 70C1 CUMMINGS FIAT 70C1 A. DONALD BTD 8 W. DONALD				
								TM 70 (TEAM) KELLY / CAMPBELL C S 4 B/A GRAIG / GRAHAM			

PERIOD 2:10:72 TO 30:9:73

MACHINE TYPE / DATE	A/L ETC. NO DRIVER	TRAVEL	B/MAINT	WEATHER	BOGGED	TRANSFER	REPAIRS	OTHER	TOTAL HRS NOT IN USE	PLOUGHING HRS	PLOUGHING ha's QUANTITY	PLOUGHING HA PER HR	DRAINING HRS	DRAINING QUANTITY	DRAINING M'S PER HR	OTHER	HAULING	APP IV TOTAL HRS IN USE
FIAT 70 C1	(5 MACHINES EACH WITH PARKGATE MOUNTED TINE.)																	
5 MACHINES	426	740	713	432	18	312	602	97	3340	6912	1475	0.21					149	7061
ER MACHINE	86	148	143	86	4	62	120	19	668	1382	295	0.21					30	1412
	4%	7%	7%	4%	-	3%	6%	1%	32%	67%							1%	68%
BTD 8	(5 MACHINES EACH WITH PARKGATE DUAL PURPOSE PLOUGH)																	
MACHINES	394	686	593	395	97	196	880	396	3637	5541	1577	0.28					659	6103
ER MACHINE	79	137	119	79	19	39	176	79	727	1088	315	0.28					132	1220
	4%	7%	6%	4%	1%	2%	9%	4%	37%	56%							7%	63%
FIAT 655	(3 MACHINES EACH WITH PARKGATE DUAL PURPOSE PLOUGH)																	
MACHINES	251	434	372	123	11	250	494	62	1997	3907	1074	0.27					367	4274
ER MACHINE	84	145	124	41	3	83	165	21	666	1302	358	0.27					122	1424
	4%	7%	6%	2%	-	4%	8%	1%	32%	62%							6%	68%
B 60	(2 MACHINES IN TANDEM WITH DEEP DOUBLE MOULDBOARD BOOT ON PARKGATE DEEP DRAINER CARRIAGE) 6 WEEK PERIOD ONLY																	
ER TEAM	3	5	9	-	-	-	7	2	26	188	262	1.39					60	248
	1%	2%	3%				3%	1%	10%	68%							22%	90%

CONSERVANCY PLOUGHING PROGRAMME 74/75

APPENDIX

KEY

1 SQ = 5 ha PROGRAMME

1 SQ = 5 ha. ACHIEVEMENT

FOREST	AREA	APRIL - JUNE	JULY - SEPT	OCT - DEC	JAN - MAR
EREDINE	350				
GLENORCHY	325				
GLENCOE	100				
BARCALDINE	50				
RAERA	325				