A HISTORY OF PLOUGH DEVELOPMENT IN BRITISH FORESTRY

IV. MOUNTED PLOUGHS (AND OTHER REGENERATION EQUIPMENT)

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Reprinted from
SCOTTISH FORESTRY, Vol. 31, No. 1, January 1977

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The principle of directly mounting an implement onto a tractor has for long been common agricultural and civil engineering practice. In the forest it offers the merits of manoeuvrability, close control of the equipment, stability on steep slopes, and compactness for transportation. Its main disadvantage is unbalancing the weight distribution of the tractor when the implement is in the lift position, a feature of crucial importance on soft ground.

For these reasons the role of directly mounted equipment has been confined to the following conditions:

1. Small areas of dry ground, where the manoeuvrability of close coupled equipment is valued. As a tractor can exert a greater draw-bar-pull on trailed equipment due to better ground adhesion of its tracks, mounted ploughs on standard tractors have not competed on areas where trailed equipment can be used.
2. Steep slopes, especially where there is insufficient room above and below for trailed equipment to be turned. Outfits with mounted equipment reverse up-slope for stability.
3. Afforestation conditions with frequent large superficial or sub-surface boulders.
4. Regeneration conditions with firm stumps from the previous crop.

The first directly mounted tool was a single front-mounted disc built onto the near-side of the A-frame of a bulldozer (International TD9 Crawler, Pl. 1). Two were designed in 1950 by Woolridge and Pittendreigh, respectively divisional officer and mechanical engineer in east Scotland for clear-felled sites in north and east Scotland, where they produced what was essentially a series of shallow screefs at most eight inches deep between stumps over which the disc simply rolled. Little permanent site improvement could be expected from this treatment, and they were not replaced when a year's heavy repair costs resulted from broken track frames, discarded tracks, and worn steering clutches. (Blane and Oliver, personal communication).

The advent of the Le Tourneau Rooter in 1950 has already been referred to (Part III) as a precursor of the first tine plough; namely a mounted Begg beam with a rather complicated gantry system lifting the plough (Pl. 2). The method of mounting and control became gradually simplified until by 1960 it was basically hydraulic (Pl. 3). Throughout this period

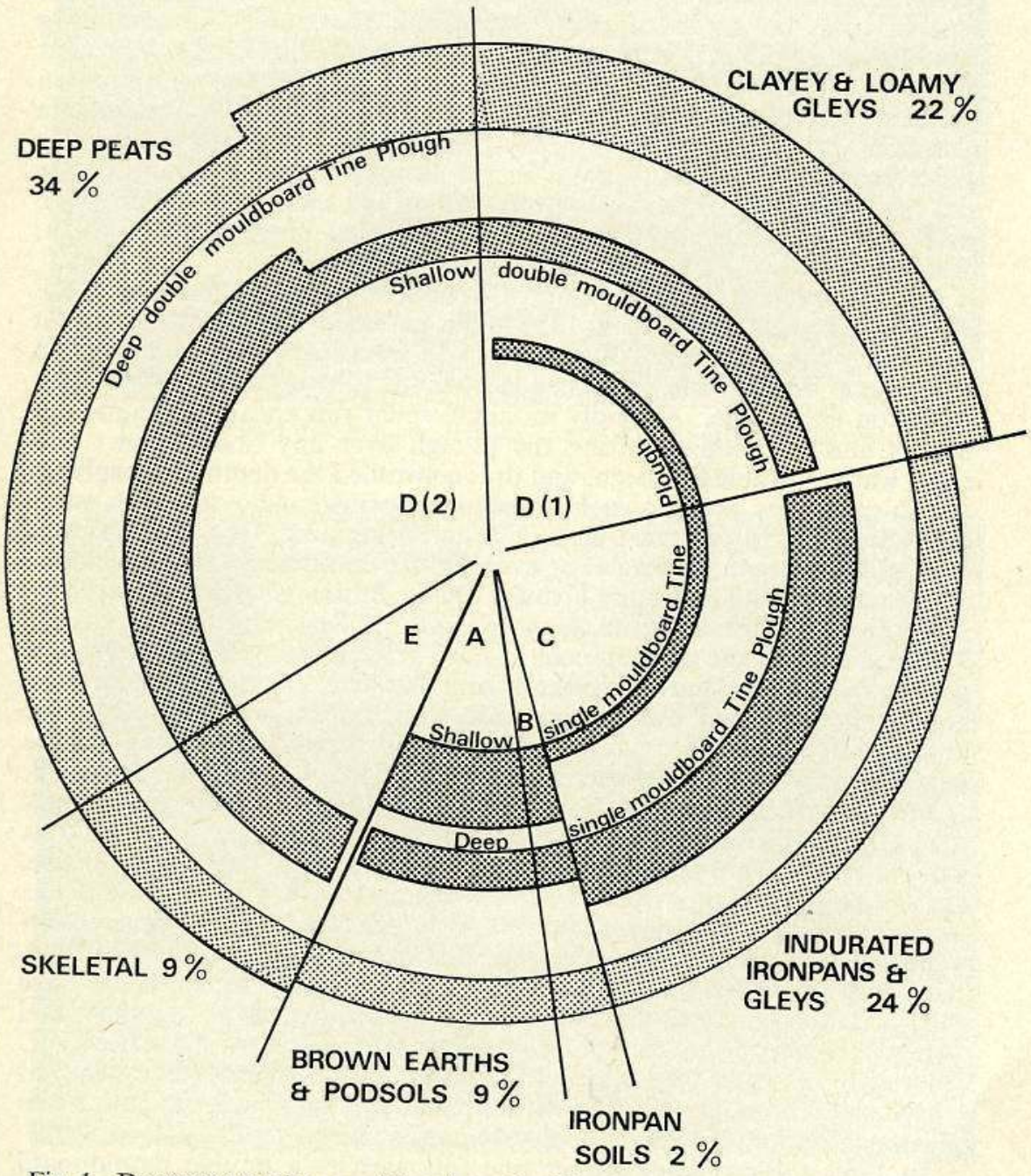


Fig. 1 Demonstrates the versatility of standard forest ploughs in ploughing a variety of soil types. (Forestry Commission training course chart).

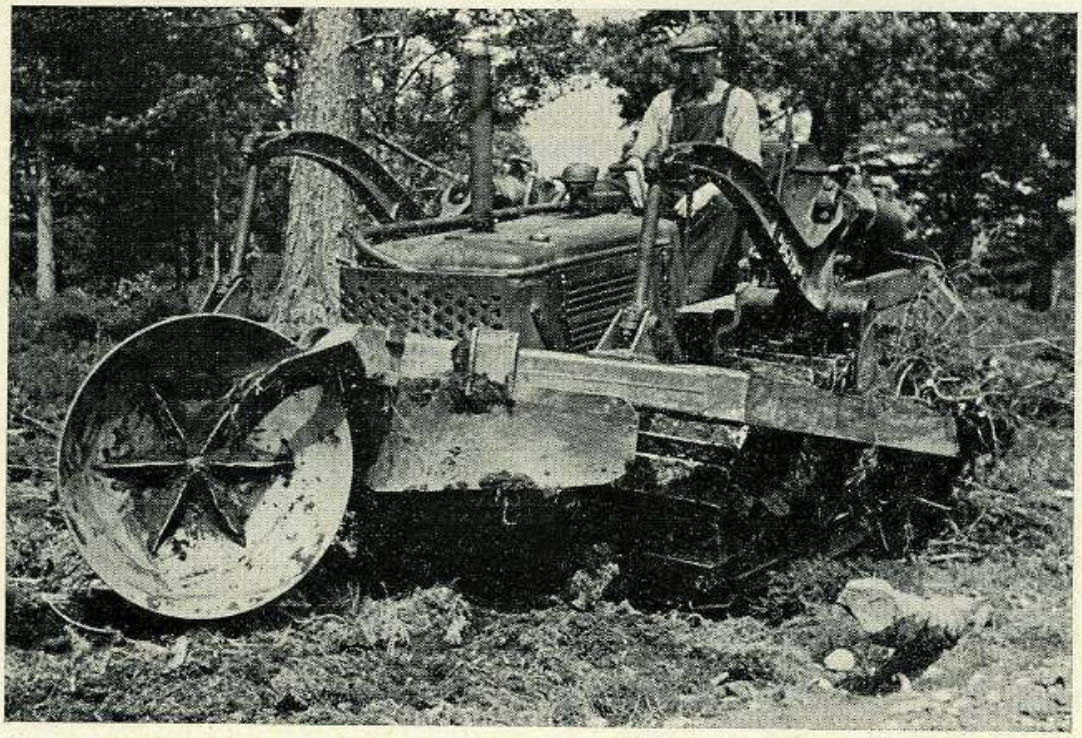
attempts were made to gain appropriate advantage from mounting each new pattern of plough. Thus there was at least one mounted RLR, mounted Cuthbertson Types F and P, and even a mounted deep drainer (Pl. 4) but only the tine ploughs enjoyed continuing popularity in the conditions listed above.

Although the mouldboard designs were usually similar to those of the trailed version, on stumpy ground they did not usually attain full depth, being frequently forced out by stumps or rocks. In 1953 Zehetmayr reported that the mounted plough with interchangeable tine and Begg mouldboard could deal with rapidly changing conditions from dry heather hillsides to local wet flushes and peat hollows. However this combination did not receive widespread acclaim. In 1958 and 1959 hydraulic tine ploughing was attempted on heavy textured surface water and peaty gleys on clear-felled spruce areas in the Borders but the task was slow and resulted in a battlefield of uptorn stumps and water-filled holes which gave no worthwhile advantage to the replanted crop (Stewart, 1959; Neustein, 1969).

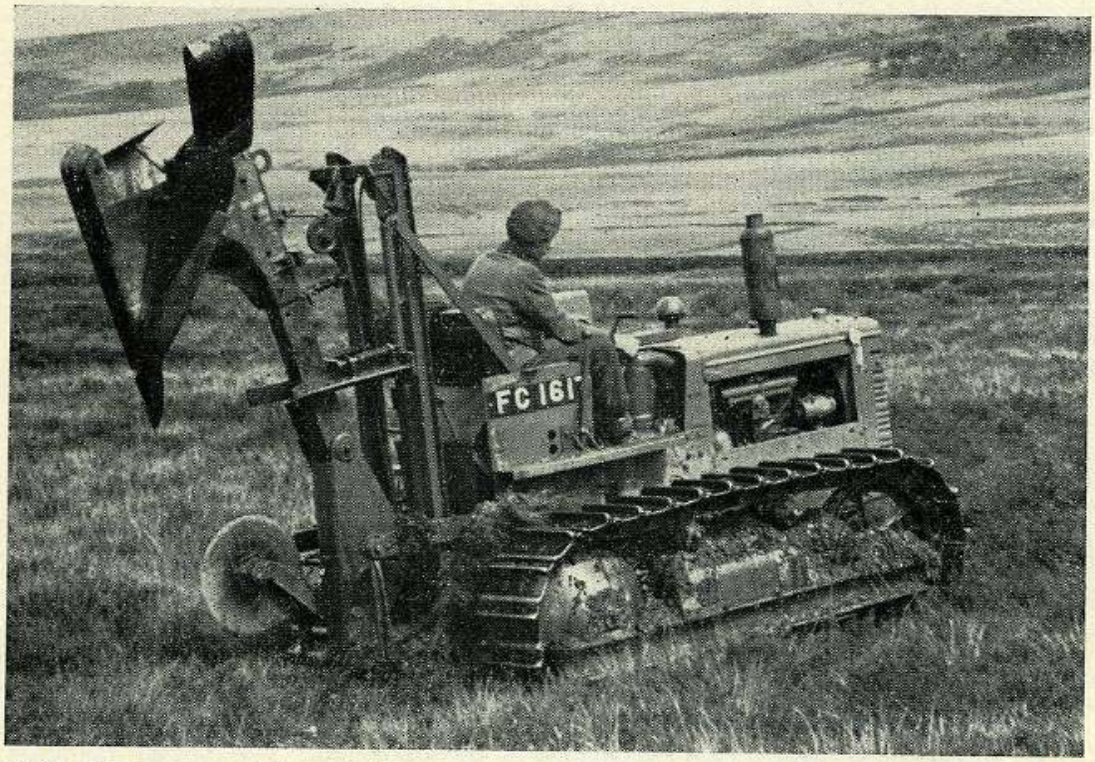
A novel method to avoid stumps was offered by the Danish TOLNE plough which was imported in 1956 and a modified version is still used at Thetford. The plough (Pl. 5) was fitted to the three point linkage of an agricultural tractor and produced a shallow furrow with inverted thin turves on either side. A rigidly mounted roller ran ahead of the mouldboards and disc coulter lifting the plough over any obstruction. This roller was adjustable for height and thus controlled the depth of ploughing. A sub-soiler was held down by a plough operator who sat, with some difficulties, on an extended arm of a parallelogram. This tool was not used outwith southern England; even lighter equipment (an agricultural disc plough on the hydraulic lift of a David Brown wheeled tractor) was in use from the late 1950s on the sandy soils of Tentsmuir (Fife).

Periodically in the development of hard ground ploughs, foresters have sought inspiration and equipment from the civil engineer. In fact the equipment borrowed was virtually the same on each occasion, but the consequences differed as foresters gradually became convinced of the benefits of more intensive and deeper cultivation. As already mentioned, Blane borrowed an International TD18 Crawler and Blaw Knox tines from the Rosyth Naval Dockyards in 1950. The tine principle was extended from this and scaled down to suit tractors then in forest use. In 1960 a Blaw Knox ripper (using two tines) on a Caterpillar D8 was again tried experimentally at Allerston on a felled larch site where conventional ploughs had proved inadequate (Marshall and Weatherell, 1960). The tines reached a mean depth of 16 inches, a figure which would have been exceeded if a single tine had been used, because Marshall and Weatherell record that the rooter frame was lifted by torn out stumps etc. Although the ease with which this powerful equipment proceeded was impressive, foresters were not yet prepared to apply such expenditure to site amelioration of relatively infertile hard soils.

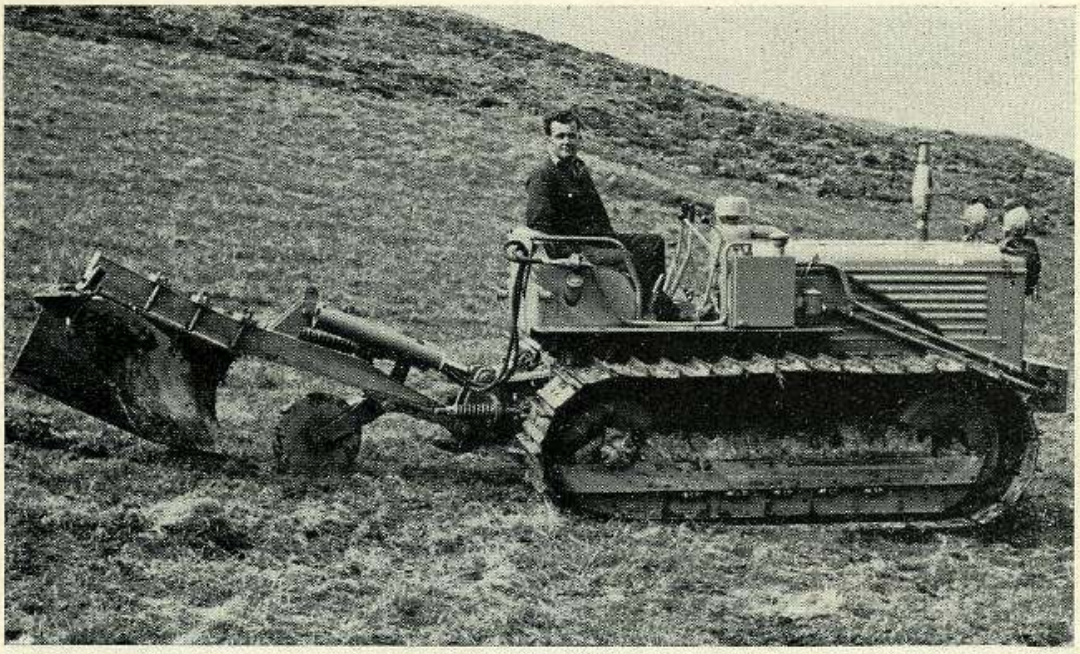
In 1966 a Blaw Knox ripper tine followed by a double mouldboard deep drainer plough was towed by three tractors in series (200 horsepower



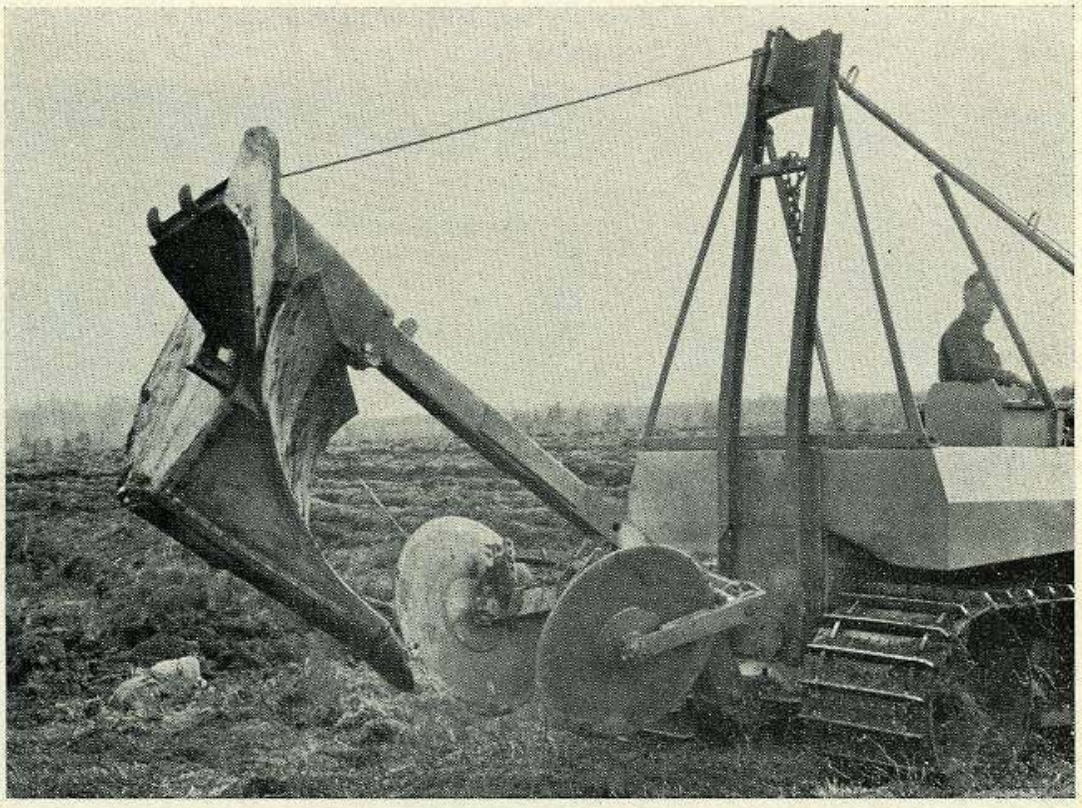
Pl. 1 Front mounted disc plough. Rosarie Forest 1952 (Forestry Commission A45).



Pl. 2 First mounted tine. A tine on Begg beam mounted on a TD9. Wauchope Forest 1950. (Forestry Commission A470).



Pl. 3 Prototype plough with hydraulic lift. To avoid overloading in the rear end of tractor by fitting a winch, a hydraulic ram is used to operate the plough. Greskine Forest. (Forestry Commission A2826).



Pl. 4 Cuthbertson deep drainer mounted on a Buffalo tractor. The plough was lifted using a front mounted winch. Jordonlaw Moss Edgarhope Forest 1955. (Forestry Commission B2768).

in total) through a very indurated soil on the Black Isle. Again in 1967 at Allerston, purely for experimental purposes, adjacent to the site ripped in 1960, a deep single hydraulically mounted Kelly ripper was used (Pl. 6). In spite of stumps up to 13 inches in diameter it had no difficulty in reaching depths of 52 inches (Weatherell, 1967). In 1969 the effectiveness of heavier tractors was again demonstrated on the Black Isle when the Lokomo drainage plough winched by an International BTD20 produced a three feet deep furrow in the most strongly indurated fragigley conditions.

This succession of trials, plus an increasing awareness of the extent and nature of indurated soils, and the benefits of deeper cultivation which were being demonstrated by Research Division made the time now opportune for developing a new deeper phase of heathland ploughs. In 1968 a D7 with heavy A-frame was fitted with a large sickle-shaped tine and tested successfully in heathland regeneration areas. The sickle was intended to aid the shedding of debris which had hindered the Blaw Knox. The next stages were the addition of a curved beam and heavy mouldboard (Pl. 7). The actual beam of this so-called "Sickle" plough was costly to make and the several production models which followed incorporated a straight beam. Clark of Parkgate manufactured this plough to designs prepared by W. C. Anderson (Blane's Scottish successor) while the silvicultural specifications and guidance were provided by G. M. Taylor as Silviculturist (N).

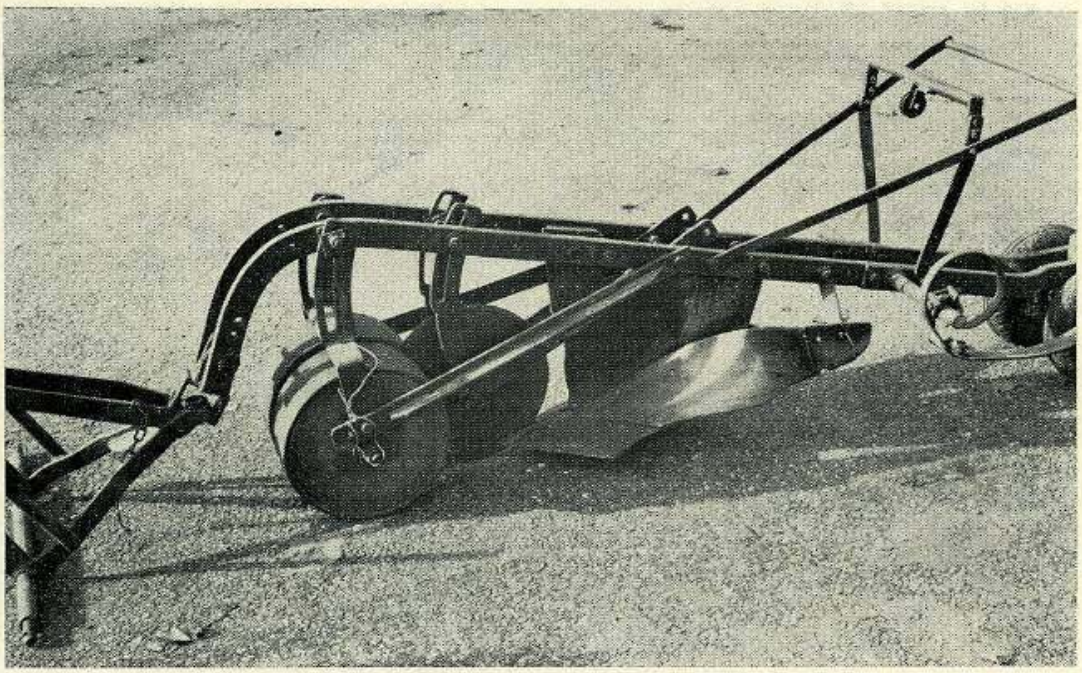
By 1972-73 several such deep tine ploughs were in existence (in east and north Scotland) and one itinerant under Research Division's control which has worked at least on a small scale in most Conservancies. With tractive power provided by Challenger 33 or Caterpillar D7 tractors hard heaths are now capable of being ploughed to depths down to 30 inches. These ploughs are confined mainly to clearfelled sites. In east Scotland they draw their furrows as closely as possible whereas in north Scotland normal spacing may continue to be the rule until the financial benefits of such high investment is confirmed by experiment.

In 1973, thanks to the enthusiasm of the Forestry Commission's new Scottish Press Officer, this equipment received quite extensive press and TV coverage, being "billed" as the first plough to reach layers of soil undisturbed since the ice age (Pl. 8)! Since that time the equipment has proved very reliable especially after the mounting was redesigned.

Latterly this large deep tine plough has been adapted for use with the Parkgate (Humpy) draining carriage but there is still some doubt about its role. A double mouldboard version is now available but it is used on gley soils as a turfing plough. It is not the writer's intention to detail current practice, which was fairly recently done by Everard (1972) but Fig. 1 illustrates the choices of equipment available on the main upland soil types.

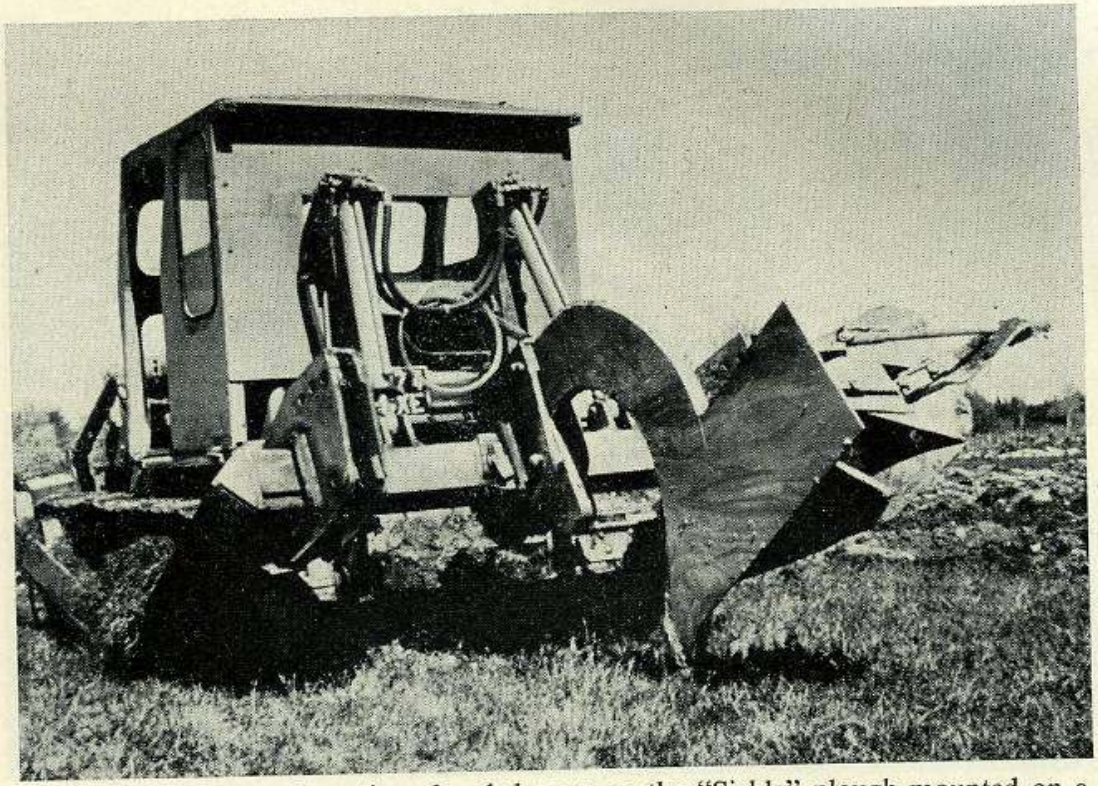
Future Developments

Apart from the minor modifications which will doubtless continue to be made in the construction of every new plough, four major lines of



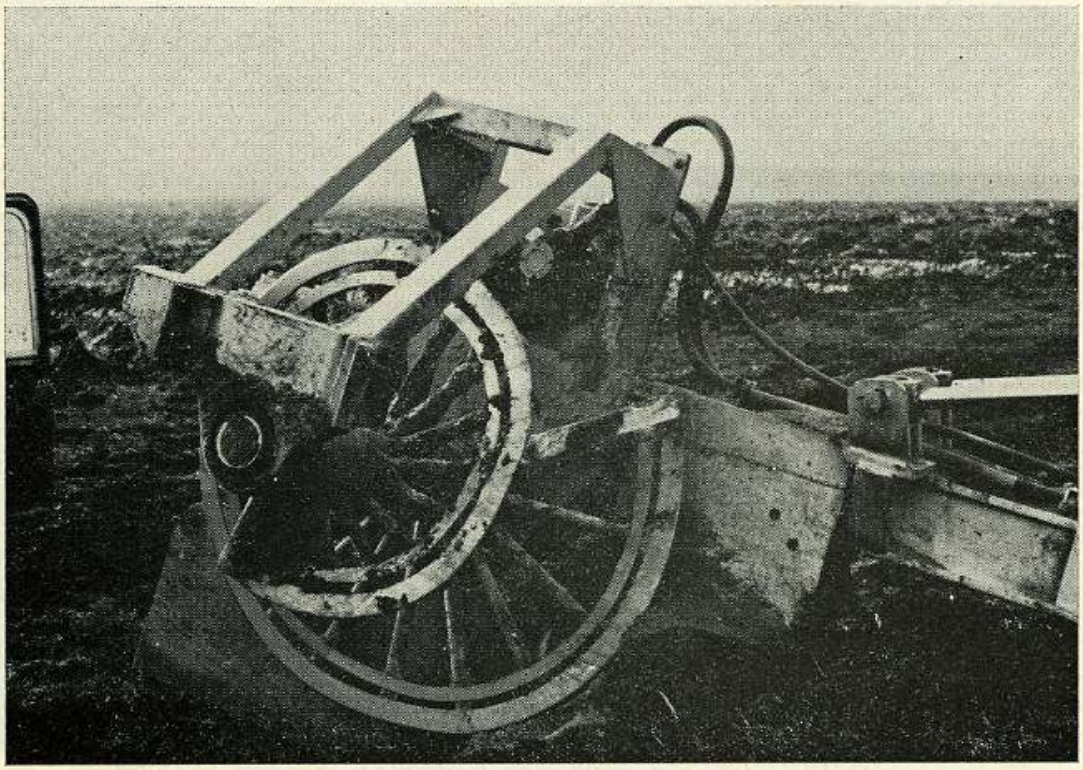
Pl. 5 The Danish Tolne plough. One of the original ploughs for which all but a seat for the operator have been reassembled. Thetford Forest 1975. (Forestry Commission).

Pl. 6 The Kelly ripper used at Wykeham Forest in 1967. The beam was mounted on a CAT D8 tractor. (Forestry Commission A3030).



Pl. 7 The prototype deep tine plough known as the "Sickle" plough mounted on a CAT D7. Culloden Forest 1969. (Forestry Commission).

Pl. 8 The standard deep tine plough mounted on a CAT D7. A clear felled site at Tulliallan Forest 1972. (Forestry Commission A4365).



Pl. 9 Prototype rotary mouldboard for forest soils mounted on a CAT D7. The rotor power is delivered from the hydraulic pump of the tractor to a motor on the plough beam. Dalby Forest 1975. (Forestry Commission).

Pl. 10 A large motor grader creating Riggs and Furrs by successive sweeps. First trial on the site of the present M6 in Cumbria 1970. (Forestry Commission).

development are of interest. All are at a fairly early stage and hence it is probable that some or all will not be fruitful, for such risk is the essence of research.

1. *The ploughing machine*—As yet this concept is still on the drawing board of the Forestry Commission's Work Study Branch. Envisaged is an integral vehicle with six large wheels separately powered by hydraulic motors with a centrally placed plough, between the rear wheels, possibly with vibrating point to ease its passage through hard soils and make better use of available power. The National Engineering Laboratory is associated with this work. If sufficient mechanical advantage is gained, multiple ploughs might become a possibility. This form of vehicle does not directly influence the soil amelioration specification but a variety of cultivation methods could presumably be associated with it.

2. *The rotary mouldboard plough*—Following the production by the National Institute of Agricultural Engineering of a series of agricultural prototypes in the early 1960s the Forestry Commission's Forest Management Division in 1973 approved the manufacture of a scaled-up forestry version for experimental use. The principle offers two potential advantages. It improves the quality of the mix of organic and mineral soil constituents with the expectation of improved nutrient availability and rooting health and vigour. Secondly, it should reduce the draw-bar-pull required for deep cultivation. It is probable that future ploughing will be done with large tractors capable of delivering power to soil working through P.T.O. rather than simply by increasing traction. The proposed power source for the rotary mouldboard prototype is a D7 crawler and the main anticipated difficulty will probably be concerned with large stones and stumps (Pl. 9).

3. *Riggs and Furrs*—The system of broad ridges and furrows known by this mediaeval name was revived in recent years by J. Weatherell, Chief Research Forester at Allerston. Although several officers had previously conjectured whether some form of "lazy-bed" would yield benefits commensurate with the cost, it was undoubtedly his dedication to the principle that led to serious experiments being laid down in 1964 at Rosedale and later elsewhere in this district, and at Kielder (Northumberland), Helmsdale (Sutherland), Clocaenog (Denbighshire) and elsewhere. Weatherell (1965) described the basis of this departure from conventional cultivation. In brief, broad ridges alternating with furrows are made to run up and down the slope. The original soil for which this was considered appropriate was (peaty) ironpan soil but the method has also been tested on peaty gleys and fragi-gleys. The dimensions in later experiments have increased from a 25 foot wavelength and $2\frac{1}{2}$ foot amplitude up to a maximum of 45 foot wavelength and 6 foot amplitude. The theoretical benefits hoped for are better surface run-off, sub-surface drainage, improved nitrogen mineralisation leading to deeper rooting, good access for wheeled vehicles, much enhanced tree stability and, hopefully, better tree growth; in addition Riggs and Furrs should last with little maintenance for more than one rotation.

The first riggs were made by a bulldozer, but later it was found that hydraulic excavators could produce better work though costs were plainly excessive for large scale use. In 1971 the possibility of forming Riggs and Furrs on a field scale at reasonable cost was examined with reasonably encouraging results at Pickering Forest (Yorkshire) where a large motorised grader was employed (Pl. 10).

Read, Armstrong and Weatherell (1973) have summarised the edaphic effects of the earliest experiment eight years after establishment and at this stage Weatherell's hopes for the effectiveness of Riggs and Furrs in peaty gleys have been met. It is probable therefore that further work will soon be undertaken to facilitate large scale usage of this system of cultivation.

4. "*Ligniculture*"—The system encompassed by this term in France has as one of its aims to maximise the amount of mechanisation in afforestation and crop maintenance. To this end crop spacing and layout are geared to tractor access. Also "mini-riggs" or "raised beds" as used in SE United States silviculture allowing periodic inter-band or row cultivation for weed suppression may have a future in some areas. A few preliminary experiments have been established on non-indurated southern heaths, using disc ploughs. If silviculturally successful under southern English conditions which most resemble the Continental examples, further work may be justified on machinery development for this purpose.

Acknowledgements

This history could hardly have been written without the help of many persons who were actively involved in the developments. I am particularly grateful to the late Mr John Blane, the late Mr Willy Clark, Mr Murray Clark, Mr James Cuthbertson and Mr D. H. Ross, who all gave freely of their time. Mr D. A. Thompson kindly assisted me in the selection of photographs and a variety of other chores.

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