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SOIL and water

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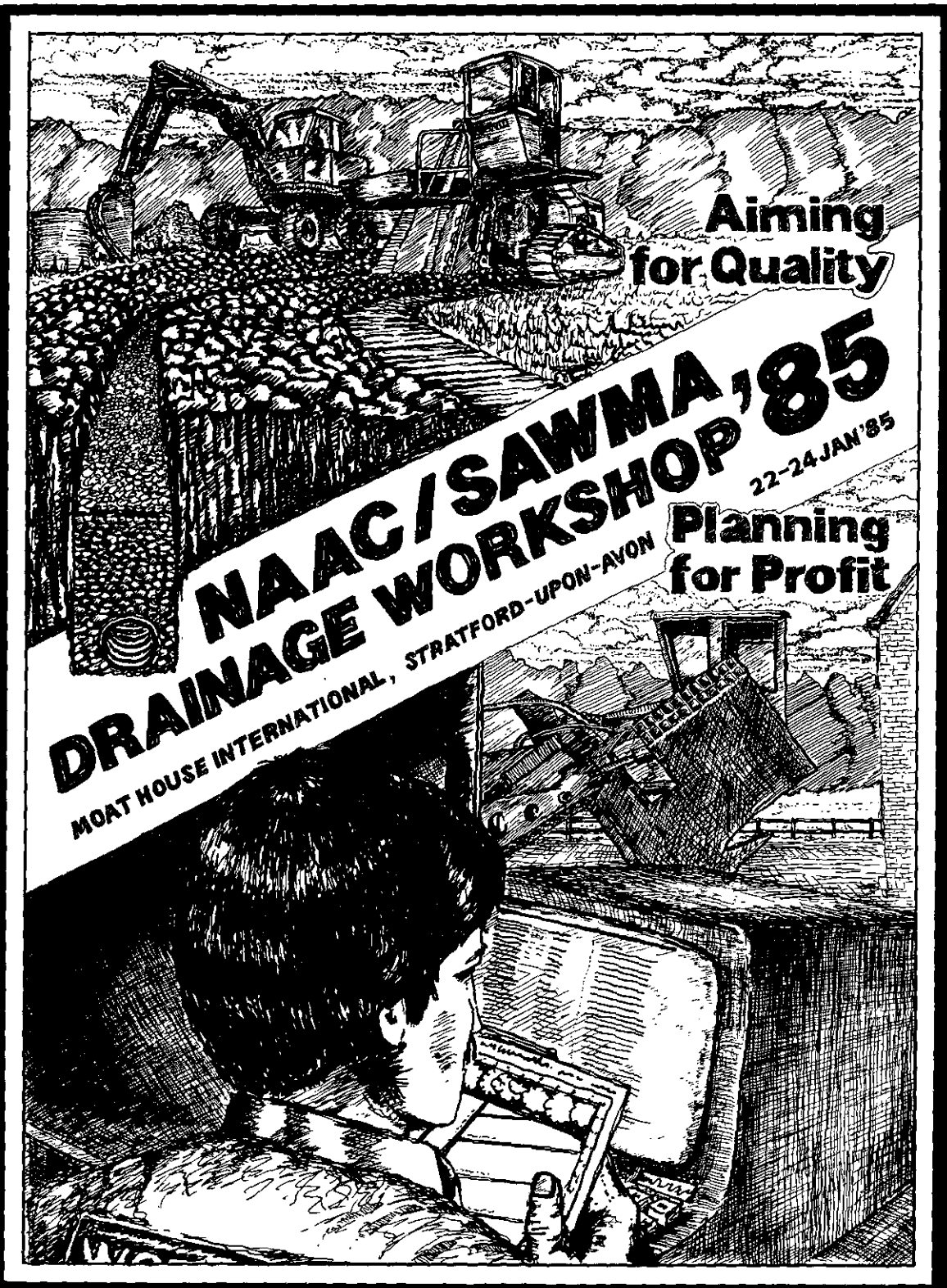

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SOIL and water
THE MAGAZINE ON SOIL CONDITION AND FERTILITY

Volume 12 No 2, November 1984

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The Association is a charity whose main objective is to promote the highest standards in the care of the soil: Britain's basic asset.

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Sail and Water is SAWMA's principal means of promoting ever-improving standards of soil care and management, through the publication of research findings, scientific articles and practical information on the soil, its drainage, cultivation, irrigation and fertility. It is published far the benefit of the researchers, advisers, consultants, manufacturers, contractars and others making up the membership of SAWMA.

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COMMENT

Our more positive approach

ALTHOUGH preparations for the Drainage Workshop in January are dominating affairs in the SaWMA office, time has been found to complete the up-dating of membership records. We regret having had to seek clarification of details from some Members and Corporate Members, but in a number of cases, this has been the only certain way to ensure that our records are complete and accurate. Members' co-operation and help has been much appreciated.

Next year's events

It is not possible to give details in this issue of the events in which SaWMA will participate next year, but details will be available for the January issue, since the proposals to be put forward will be discussed at the Council meeting at the end of November. The proposed demonstrations, show appearances, conferences and visits, however, make up the most comprehensive programme this Association has yet contemplated.

Monitoring of subjects

At all SaWMA displays at shows, conferences and demonstrations, it has always been noticeable that there are farmers and farm managers — in surprisingly large numbers — who ask us to help them in finding scientific information relevant to the practical actions they must take. This is exactly what we want to be asked, what we exist for, and must encourage more positively.

It has always been an important part of our purpose to give positive help with what may be termed the soils 'information gap'.

We aim to do this by publishing scientific information in a way that makes clear its practical importance and aids its assimilation by the farmer or manager to whom practical considerations are the main priorities. This publication has played the major part in this SaWMA function, and will continue to do so — with increasing efficiency, we intend, as we improve our techniques for identifying the subjects of most interest and concern, and the sources of scientific information on those subjects.

Assessing needs

As alv ; members are welcome to write and bring up scientific practical subjects on which scientific information would be useful to them, and we trust that this will happen increasingly. But a more positive approach to assessing practical information needs is important, and at all future public events, we will be playing particular attention to noting the subjects on which most questions are asked.

The priorities established in this way will be used in seeking and selecting reports and studies to publish. This system, we believe, will quickly improve our service to members, provide guidance for researchers on the practical questions that matter most, and make this journal even more positive in meeting needs for information that is both scientific and practical.

CONTENTS

STRAW INCORPORATION ON HEAVY LAND

A picture emerging

The choice of equipment for incorporation is large and is growing. Mr G. B. Sanders, mechanisation adviser for ADAS (Cambridge Area Office) reviews the considerations affecting the farmer's decisions.

NEW, often complex, multi-operational, one-pass machines are being offered for sale alongside more conventional equipment, modified to cope with straw. The potential buyer may be forgiven for being confused, there are many interrelated aspects of this subject that make it difficult to judge the merits of a machine from a field demonstration. He can assess for himself the implement's ability to mix, bury, and deal with chopped straw. He may be able to calculate its power requirement and work rate, but there are other questions which he will find difficulty in answering:

W h a t degree of chop is required for successful operation without blocking?
- Is the dilution of straw achieved satisfactory?
- What further cultivations are required?

Does the implement have the abilitv to work in a wide' range of soil conditions?
- Will pests and diseases, carried over in the absence of burning, be controlled?

Is there a net loss of yield compared to other systems?

Some of the answers to tbese questions are now being resolved. A few years ago we could draw only on experience from the Continent. Today, following 2 to 3 years of research, experimentation and on-farm observation, a picture for straw incorporation in the UK is beginning to emerge.

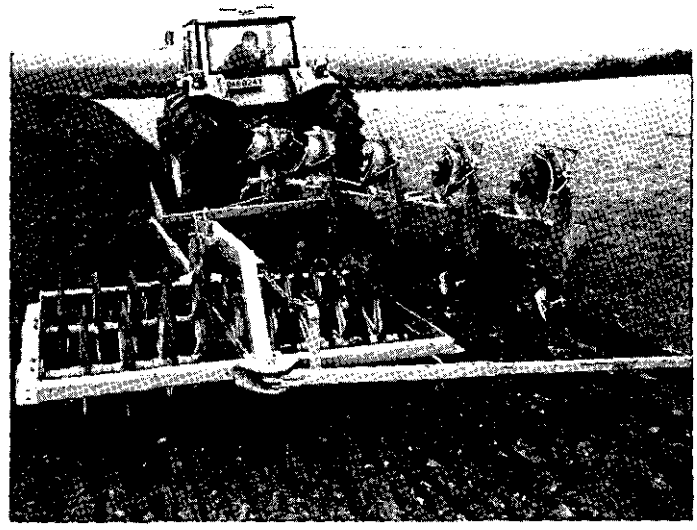
Figure 1 attempts to put a cost to a number of field operations relating to straw incorporation, The first part of the bar graph, up to the dotted line, is the cost pertaining to the tractor only, the second part is the implement's share of the cost. The following factors were built into the calculations:

W o r k rate, field efficiency, power requirement, as measured in ADAS trials. or on farms, or — in the absence of other data — that claimed by manufacturers. Figures were corrected to a standard output from a 75kw tractor

Machine price — current list price (in the case of the Rotadigger, estimated)

T r a c t o r cost — taken from the January 1984 issue of Farm Contractor magazine for a 75kw tractor and modified to a total annual usage of 500 hours

- Time available — maximum 200 hours per season, reducing to 140 hours, depending on the machine's ability to work in difficult conditions
- Repairs, maintenance, life — weighted to reflect the complexity of the machine.



Ploughing is currently our most widely used incorporation technique, and *although* it is relatively slow, there was no depression of yield by comparison with burning. This is a Dowdeswellplough with *Tigges* furrow press.

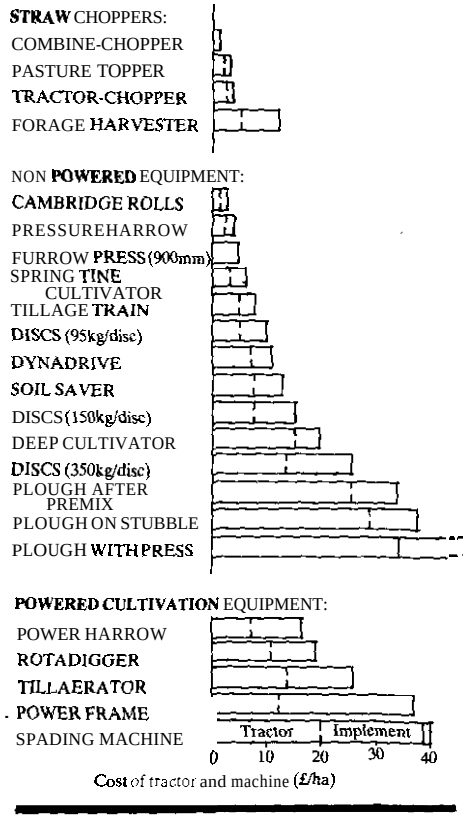
Some of the costs produced in figure 1 are interesting:

- compared with following cultivations, chopping straw is a relatively inexpensive operation
- pasture topping to reduce stubble height is sensible if it saves a cultivation operation and reduces disease risk by enabling better incorporation
- a forage harvester used to chop straw looks attractive if it saves more than one tillage operation
- if incorporation to a depth of 15cm is required on heavy land, it is suggested that only machines below and including the Soil Saver are suitable.
- on this basis at least, one-pass, powered cultivators appear to be competitive with ploughing.

Ploughing, currently the most widely used technique for incorporation, has been investigated in more detail. Figure 1 shows costings for ploughing a stubble, after a premix and in conjunction with a furrow press.

There is some debate as to whether pre-mixing before ploughing is necessary. Experiments laid down this autumn on two sites in Cambridgeshire by Ransomes in conjunction with ADAS are aimed at clarifying this. However, measurements taken in September at both sites showed a consistently lower wheel slip when ploughing at 225mm on soil that had been previously cultivated to 125mm compared with ploughing unmoved soil at a similar depth. This advantage amounted

Fig 1. Relative cost per hectare of various machines, with 75kw tractor power available.



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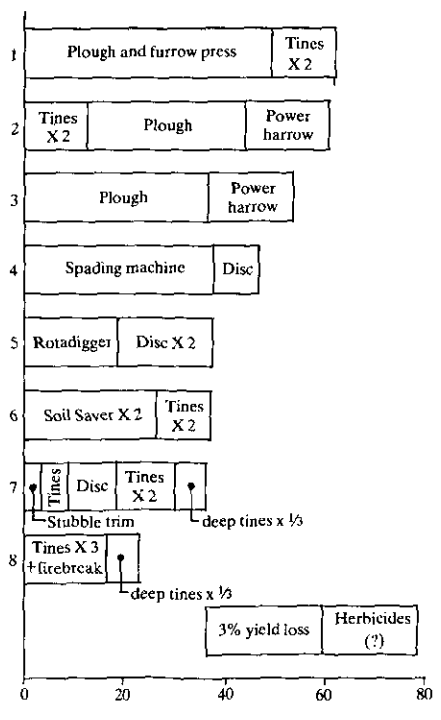
Reco Wil-Rich field cultivator in use. Use of a cultivator for a 'pre-mixing' operation before ploughing appears to reduce tractor wheel slip significantly during ploughing.

to about 15 per cent and may be explained by the reduced effort required to turn broken soil.

Conversely, attaching a furrow press will slow the plough down. Estimates vary as to how much. Some manufacturers state that the press will take the equivalent in draft of one furrow in four or five, others, including farmers, indicate "half a gear". A recent ADAS study showed, on one site, that the equivalent of about 10 per cent of the tractor power available was taken up by a 70cm dia press. A 90cm dia press wheel is required on heavy soil, the increased diameter doubling the weight per ring. A 15 per cent reduction in plough output is suggested in the calculations, however experimentation is required to validate this figure.

Fig 2. The relative costs of various cultivation systems.



Ploughing, deep cultivations and subsoiling are slow speed, high draught operations with relatively inexpensive implements. Tractor costs can be 75 per cent of the total. Labour costs, not included in these costings, are directly related to tractor cost and add a further 40 per cent. The need to operate these machines at their optimum capacity and efficiency is clearly demonstrated. With other implements, the tractor cost is normally 50 to 60 per cent of the total.

Operational costs for individual machines can now be put together into systems — the combinations are endless. Figure 2 compares seven systems. Of the three plough-based systems, numbers 1 and 3 were used on two heavy land experimental sites in Cambridgeshire. Number 2 is a typical "pre-mix" system, as used in Germany.

Systems 4 and 6 are currently used by farmers who incorporate straw on the whole farm, while system 5, the Rotadigger, has performed well as Boxworth and other Experimental Husbandry Farms.

System 7 is a non-plough cultivation system used for comparison with the plough-based systems in the experiments quoted above. Number 8 is typical of a minimum cultivation system under a straw burning regime. One-third of a deep-tine cultivation cost has been added to 7 and 8, as it is now common practice to subsoil or deep-loosen every third year on heavy land. It is assumed in all cases the straw has been chopped on the combine.

In the past two years, following very different autumns, the yields from experiments on five EHFs have shown a typical reduction in yield of 3 per cent where straw has been incorporated solely with tine and disc systems. There has been little or no depression in yield with plough-based systems compared with burning. To allow comparison with cultivation costs, Figure 2 includes a value representing 3 per cent yield loss (7.5 t/ha @ £100/t).

Experimental work has also shown the benefit of ploughing in reducing the populations of grass weeds. Agronomy colleagues suggest savings in chemicals may be as high as £40/ha. Assuming half the farm will have such a weed problem, an additional cost of herbicides of £20/ha can be set against minimum cultivations as indicated in figure 2.

In conclusion, the main points emerging appear to be:

- Even a small reduction in yield is significant in relation to cultivation costs.
- Straw on the surface, and in the seedbed, may cause a significant loss in yield. The reasons for this may be a combination of a poor seedbed and pest and disease carry-over. Further work is required to identify the principal factors.
- Complete inversion will reduce yield penalties and herbicide costs; the plough is the only complete inversion tool at present.
- The plough is highly sensitive to inefficient use and must be worked to its optimum capacity.
- Plough attachments may, in some cases, significantly reduce performance.
- Timeliness of post-plough operations on heavy land is important.
- Poor management of soils can significantly increase costs
- One-pass machines, although appearing slow and expensive, can compete on costs with plough-based systems. Their reliability and performance on heavy soils and in difficult conditions has yet to be proven.

This paper attempts to put the various aspects of the subject into context. These thoughts reflect the "state of the art" today and are offered as a contribution to a debate likely to continue for some time to come.

This paper was presented at the NAC Arable Unit Straw Incorporation on Heavy Soils Workshop held at the De Vere Hotel, Coventry on November 14-15, 1984. It is reproduced with kind permission of the authors and organisers. Copies of the paper sets which were presented at the Workshop are available from Mrs M. Richardson, NAC Arable Unit, NAC, Stoneleigh CV8 2LZ. Tel: Coventry (0203) 555100 Ext 246. Prices £12.00 + £1.50 p&p.

Erosion in discussion

The Winter meeting of the South-East England Soil Discussion Group (SEESOIL) will concentrate on 'Soil erosion on agricultural land' and will be held at Silsoe College, Silsoe, Bedford on 12 December, (SAWMA members are welcome and should contact Dr J. Boardman on [0273] 606622).

Soil erosion will be discussed in depth during the day with particular reference to examples in Southern England, but will also include methods of controlling and reducing the problem.

The SEESOIL's Spring field meeting, organised by R. G. Sturdy (0732 845663) for 1 May 1985, will be on 'Saline soils on the North Kent Marshes'.

Drainage course at Silsoe College

'Agricultural drainage design and evalution' will be run at Silsoe College, Silsoe, Bedford from 17-20 December 1984 and aims to introduce the principles, terminology and practical applications of agricultural drainage design and evaluation to river engineers and agriculturalists.

Corrections

In the last paragraph of our article on the economics of grassland drainage, Sept '84 issue, the figure for extra dry matter needed to break even on drainage costs, should have been 1.2 *tonnes/ha*, not 12 tonnes/ha.

It has been pointed out that the restoration work at Greenham Sand and Ballast Co Ltd, reported on page 13 of the last issue was not based on any French example. We expect to include a fuller description of the restoration techniques used in the work at the Shepperton Pits site in a future issue.

The British Hydrological Society

SAWMA members are invited to attend any of the meetings arranged by the British Hydrological Society (Midlands and Southern Sections), Westminster, London (01-222 7722).

Amongst a long list of meetings those that may appeal to members are 'Operating surface water under drought conditions' on 5 December, 'Floods in Scotland — a hydrological and geomorphic analysis' on 7 December, 'Acid rain' on 18 January, 'The effects of upland management practices on water resources' on 8 March and 'Management of wetlands' held on 8 May.

Biotechnology and waste

An innovative approach to the problems of contaminated land, which involves the first ever use in the UK of biotechnology for this purpose, is planned by two British companies. The Contracts Division of the Miller Buckley civil engineering group of Rugby, together with BioTechnica Ltd of Cardiff, have formed an association to offer biotechnological services for the clean-up of contaminated land and fluid toxic waste. The methods will combine the use of specially developed bacteria and biotechnology with engineering skills.

BioTechnica Ltd, based in Cardiff, is a British Biotechnology company affiliated with a major genetic engineering company in the USA (BioTechnica International Inc) and specialises in the development of microbes for decontaminating land and waste products. Other microbial development processes are designed to enhance both methane production from landfill sites and plant growth.

One of the services provided by the new consortium is the design and implementation of an in-situ microbial process to decontaminate landfill sites.

The process involves taking indigenous microbes from the site, development in a laboratory environment and re-introduction into the contaminated ground. Validation systems are used to prove the effectiveness of the treatment to reduce the contaminants to a safe level.

More adaptability in irrigation systems

More varieties of irrigation strip lengths and hose diameters have been added to the Piston and Turbine drive Bauer Rainstar mobile irrigators from British & General Tube Co Ltd, Slough, Berks.

New to the range are two 100mm machines with a maximum strip length of 420m and to the 85mm range, the 85-370 configuration. The new 50mm Rainstar, capable of irrigating 25 acre/inches on a 10 day cycle was designed for the small farmer and market gardener.

All Bauer Rainstars now have a turntable, enabling easy machine positioning on the headland, prior to irrigation.

Gabions for fanners

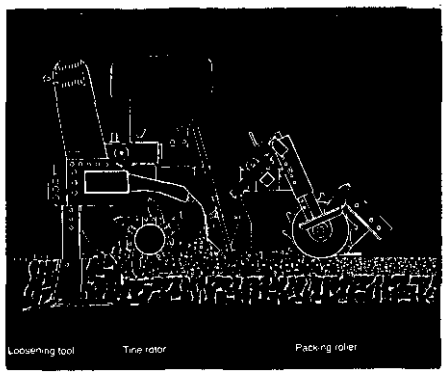
Welded mesh gabions for controlling streams and rivers, or stabilising slopes are now being supplied direct from Tinsley Wire (Sheffield) Ltd, Shepcote Lane. Sheffield.

The advantages of using gabions are: cost and ease of erection; settlement without fracture, ease of transport and their ability to function without stopping natural drainage.

Cut and mix machines

Implements to see and consider for straw incorporation

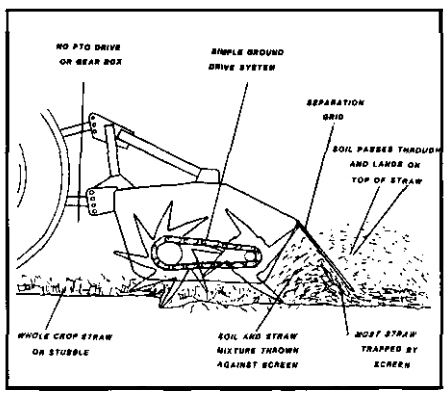
Bill Bennett Engineering Ltd, Horton, Chipping Sodbury, Bristol BS17 6QH.



The RDZ Dutzi KR system — a combination for incorporation, seedbed production and seeding.

The RDZ Dutzi KR system, using a combination of soil loosener tines, horizontal shaft rotary cultivator, seeder and packer roll, aims to produce a seedbed and put in the seed in either one or two passes. Organic trash, including straw, is incorporated in the upper layers of the soil. Depth of work with the soil lossening tines may he as great as 40cm where necessary to get below pans. Working widths range from 1.6 to 4.1m. As an example, the price of a 2.6m working width unit with three subsoiling legs, requiring a 120hp four wheel drive tractor, is £8,000 without the seeder unit and £9,362 including seeder.

Bomford & Evershed Ltd, Salford Priors, Evesham, Worcs WR11 5SW.

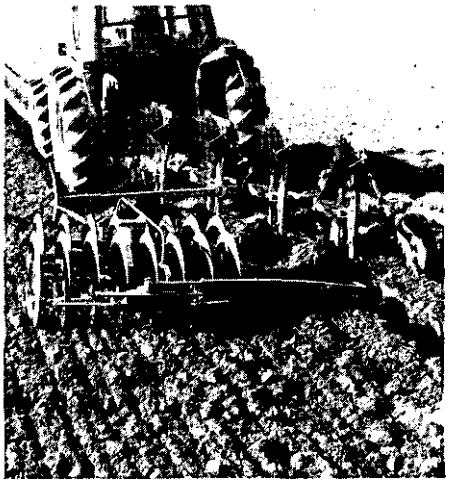


The Bomford & Evershed Dyna-drive with straw incorporation screen. The leading rotor is ground-driven.

The Dyna-drive ground powered cultivator, now provided with a straw screen for incorporation. The Dyna-drive has two horizontal axis rotors, the first being driven by the ground, the second driven by the first.

Straw incorporation may he started, Bomfords say,-on a first pass with the two rotors level, when the front rotor does not engage positively with the ground and as a result, neither set of tines isviolent in action. The screen is used for a second, deeper pass, with the front rotor lower and making firm contact, when it drives the following rotor at three times ground speed. Pulverised soil passes through the screen, which is placed behind the second rotor, while longer pieces of straw and trash are held down, to be covered by the soil passing through the screen.

Colchester Tillage Ltd, Hythe Hill, Colchester. Essex. CO1 2NL.

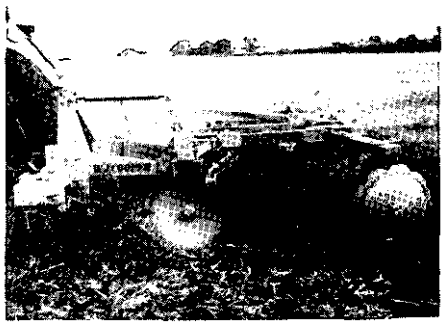


Lemken DL110 reversible plough with furrow presses. Trash boards are available for the full range of Lemken ploughs.

Ferri mounted straw choppers and a range of cultivators and disc harrows are offered by the company as providing a multi-stage system for straw and trash incorporation. As an alternative approach, there are now trash boards suitahlc for all existing and new Lemken ploughs, and furrow presses for use while ploughing. The effect of trash hoards, which increase between-body clearances on standard ploughs when fitted in place of skim coulters, is to 'layer' the trash down the furrow slice, helping to incorporate straw throughout the full depth of the ploughing.

Supplied in working widths from I to 3m, the Lemken Variopack furrow presses can be varied in width by the removal or addition of rings.

W. J. Cooper & Sons (Phoenix Works) Ltd, High Street, Newport Pagnell, Bucks MK16 8EQ.



Cooper Stubbletiller — a combination of tines and discs. The tines are said to help the discs penetrate.

The Stubbletiller, a combination of a leading set of cultivator tines followed by tandem disc harrow gangs. The cultivator tines, say Coopers, loosen the soil surface to provide a 'bite' for the discs, and at the same time draw the discs down into their work, reducing or eliminating the need for ballast. A model of 2.9m working width, with 6in box section toolbar carrying five tines, linked to a tandem disc harrow frame with two pairs of gangs with 12 discs each of 24in diameter at 9in spacings is priced at £3,128. The front and rear gangs of discs are adjustable independently, and the cultivator tine depth is adjustable in 1½in steps.

Dowdeswell Engineering Co Ltd, Blue Lias Works, Stockton, nr Rugby, Warks.

Dowdeswell trash boards in action. The latest version **has exrra** *curvature.*

A two-piece trash-kit, comprising an extended shin and curved, forged steel trash board, is produced to fit the entire ranee

Continued

Cut and mix machines

continued

of Dowdeswell ploughs. A new design will be seen at the Royal Smithfield Show, with increased curvature to improve its cutting action. The new version is also concave in cross section to prevent material going over the top when ploughing in large quantities of straw. The Dowdeswell Tigges range of furrow presses assists in consolidating the work when incorporating straw.

The first Dowdeswell-Pettit development, the 84 series heavy duty, single offset discs, are due to be shown at Smithfield for the first time. Weight per disc is 130kg.

Econ Tasker Ltd, Boroughbridge Road, Ripon, North Yorks.

The Tillage Train, a combination machine using both tines and discs, is available in versions with different layouts and a range of widths. A 3m wide model, with two rows of spring tines followed by two rows of scalloped discs, costs £4,800. Power requirement for that model may be between 100 and 140hp.

Ferrag Ltd, PO Box **78,** Victoria Road, Gt Sankey, Warrington WA5 2SW.

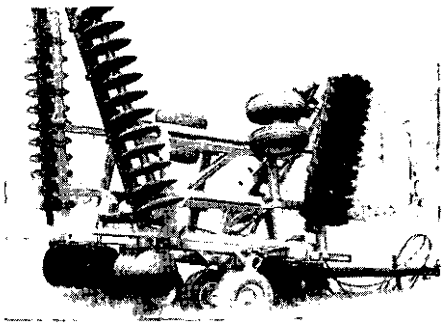
"Decrease costs by minimum tillage," is the message from Ferrag Ltd, whose Horsch SE-4 direct seeder incorporates a rotary cultivator working only to the required drilling depth. Grain from the combined seed and fertiliser hopper is fed pneumatically to a seeding bar with trailing rubber flap. This leaves the seed on the ground while the surface soil and trash lifted by the rotary cultivator are airborne.

This way, Ferrag say, the straw is no problem. The airborne soil covers the seed, and the straw and trash land on top.

Work rates can be as high as 2ha/hr with the 4m wide cultivator-seeder combination behind a tractor with 150hp. The price for the complete outfit is £27,500.

Flexi-coil (UK) Ltd, Seaton Ross York Y0 4 4NF.

Heavy disc harrows in widths up to 32ft 6in, intended for primary rather than secondary cultivation duties. The company also claims that its helical Flexi-coil land packer implements, which may he used either front or rear mounted, may be used for broadly the same purposes as furrow presses, but have advantages over the conventional cast iron type. Primary cultivation disc prices range from f4.050 for a 6ft 6in working width offset set from the 1200 series to £22,660 for a 32ft working width double offset tandem set of the 3600 series. A single gang Flexi-coil plough packer for a 4 x 14in furrow plough costs £1,085, a double gang version £1,555. They range in working width from 48 to 120in.



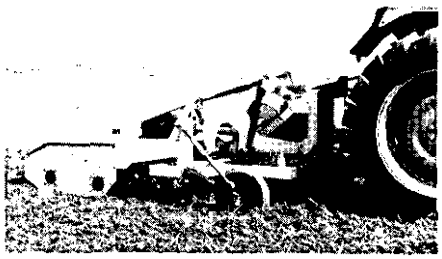
The Flexi-Coil3590 series Straw Dog tandem discs.

F. W. McConnel Ltd, Temeside Works, Ludlow, Salop.

The Disc-Tine cultivator, a combination of discs and tines, as the name implies, with the vibrating frame Shakaerator providing the tines. There is a single leading row of scalloped 28in diameter discs, followed by a close-coupled two-row Commando Shakaerator frame with up to 13 shanks and a rear roller. The aim of the machine is to mix straw into the top 6in of soil.

The Disc-Tine is made in 12ft and 14ft 9in widths, and may be fitted with either 18in or 24in tines.

The company's Tillaerator horizontal-axis powered cultivator and Shakaerator combination may also be used for straw incorporation.

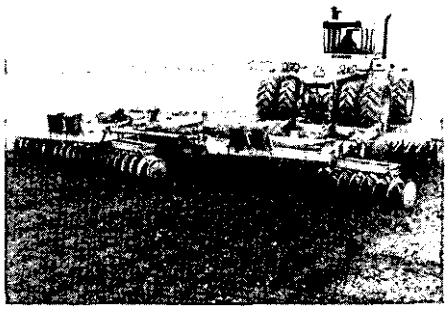


McConnel Shakaerator-Tillaerator ***combination.***

Opico (UK) Ltd, South Road, Bourne, Lincs PE10 9LG.

The Glencoe Soil Saver, a heavy implement combining the action of 20in diameter slicer discs with following 4in wide, spring-loaded tines with helical 'wings' which turn in straw and trash. The Soil Saver is claimed to be capable of mixing as much as 75 per cent of straw residues into the top 10in of soil, even in the hardest of conditions.

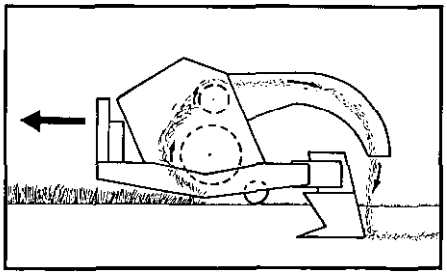
P. J. Parmiter & Sons Ltd, Tisbury, Salisbury, Wilts.



***Parmiter 18ft Utah discs coupled abreast to cover a width** of 36ft.*

Utah, Super Utah and Portland series of disc harrows, including models with weights per disc from 150 to as much as 270lb. Working widths are up to 18ft, and couplers are available to link two sets abreast. A 12ft Super Utah offset trailed model with one row of cut-away discs and one row of plain costs £6,842.

Parmiters have also produced a straw burying machine, the Strawgon, which was undergoing field trials this autumn in the expectation of production models being available for 1985. The Strawgon picks up a combine swath and mows stubble across its working width of 8ft, chopping all the straw and blowing it into an opening made by two subsoiling tines. Parmiters reckon that 90 per cent of the straw residue of the crop is buried at a depth below 200mm.

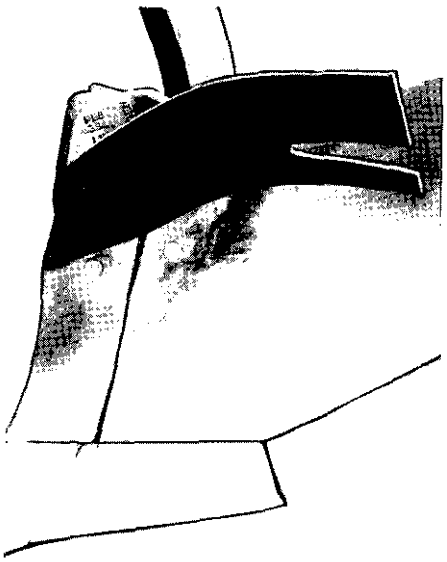


Parmiter Strawgon — picks up combine swaths, mows the stubble and chops all the straw before blowing it into an opening in the soil made by subsoiling tines.

Ransomes Sims & Jefferies plc, Ipswich, **IP3** 9QG.

For re-mixing before ploughing or for preparing a seedbed using minimal tillage techniques, there are heavy dutydisc harrows with up to 94kg per disc in widths from 3 to 4.8m. When fitted with cutaway discs on the front gang and plain on the rear, HR46A prices range from £4,665 to £7,630. This series is designed for tractors with from 75 to 200hp.

The company has ploughs available with continental type clearances of 100cm



The Ransomes UCN bash board.

interbody and 76cm underbeam, but standard clearances of 86cm interbody and 65cm underbeam are suitable for straw incorporation, they say, at the relatively shallow ploughing depths normal in the UK.

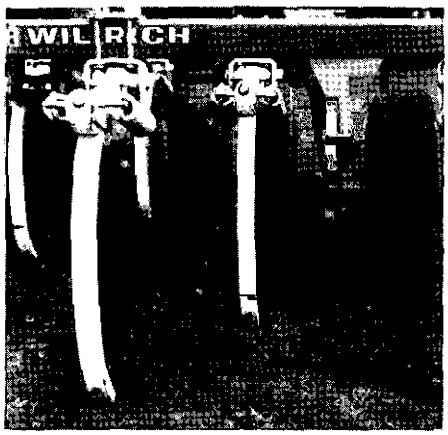
Both their conventional skims and their trashboards are suitable for straw incorporation, Ransomes say, but conditions determine which should be used. Their experience indicates that skims are better on heavy land. They supply two types of trashboard — the SCN for use with digger bodies at £35 per furrow and the adjustable UCN for semi-digger bodies at £50 per furrow.

Ruston's Engineering **Co** Ltd, St Germain St, Huntingdon PE18 6JT.

The RECO Wil-rich straw incorporator, one of four machines offered by the company for this purpose, is a combined disc and chisel cultivator which comes in widths up to 26ft. Originally imported from the US. it is now made in the UK in a version with folding wings for transport. The implement's action is to slice through surface straw with a row of spring loaded discs at 12in centres, and to incorporate the pieces in the soil shattered by the following sprung chisel tines.

The even wider RECO Wil-rich field cultivator, which has a lighter form of sprung tine and is made in widths up to 40ft for tractors of more than 130hp, is also being used for incorporation, reports Mr Harold Ruston, as are the two powered cultivators in the company's range: the horizontal rotor Recovator and the vertical rotor Recotiller, both made by Maschio.

Prices for the straw incorporator start at £6,995 for the 10ft model; field cultivators range in price from £1,395 for an 8ft 9in mounted model to £11,330 for a 40ft trailed unit.



The blades of the RECO Wil-rich straw incorporator tines are designed to turn in trash and straw.

Smallford Planters Ltd, Hatfield Road, St Albans, Herts AL4 OLN.

The Strawbury concave revolving disc, designed to fit most makes of plough in place of the conventional disc coulter, has been adapted from a New Zealand design and is now offered in the UK by Smallford. Positioned with its leading edge in line with the plough furrow, the Strawbury makes the necessary straight cut on the surface, but also carries out a skimming and burying action, it is claimed, incorporating the straw into the top 6in of soil. Smallford say that the disc will deal with straw that has been laid, as well as chopped and spread straw. Each disc costs £120, and for some ploughs, there is an extra charge for special brackets.

T & F Equipment Ltd, Spalding Road, Sutterton, Boston, Lincs PE20 2ET.

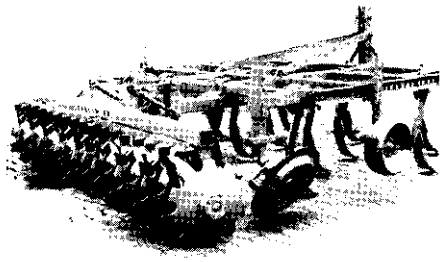
The Turbovator is a combination machine comprising a straw chopper, one row of spring tines and dual rows of discs on a trailed frame, and is claimed to incorporate straw from combine swaths into the top 3 or 4in of soil. The pto-powered chopper takes an unusual approach to its task, sucking the straw from the ground to be chopped into small pieces by two revolving drums with cutting blades mounted on them. The chopper may be bought as a separate unit, for use in combination with other cultivation equipment.

Turbovator from T & F Equipment. The first part of the combination comprises two revolving drums which lift and chop straw.

Twose of Tiverton Ltd, Lowman Green, Tiverton, Devon EX16 4JT.

The Twose Weichel pto powered combination implement, comprising four wide, winged shares slicing the soil at the chosen working depth, for a horizontal axis rotary cultivator to mix and work down into a tilth. The L-shaped tined cultivator is followed by a toothed roller with scrapers. The working width of the machine is 10ft.

Watveare Overseas **Ltd,** Headquarters Road, West Wilts Trading Estate, Westbury, Wilts, BA13 4JY.



One of the many combinations offered for pre-mixing and incorporation by Watveare Overseas. This is the Rabe EGS cultivator with following notched discs.

Many combinations of cultivators coupled with discs or powered tillage implements. Examples include the LGK, GK and GKF rigid and spring-tined cultivators, in widths up to 12ft 6in. These may be used — with front mounting as an option on a tractor with front linkage — in combination with either horizontal axis or vertical axis powered harrows mounted directly on to the cultivator frames on three point linkages. Further elements in the combinations can include crumbler harrows and seed drills, using bridge links where necessary to combine all the equipment for primary cultivation and drilling in 3 single pass.

Reseeding effect on mole drains

To follow an article on 'Restoring land to agriculture' in the October '83 edition of Soil and Water, Dr Neil Bragg, soil scientist for the Ministry of Agriculture, Fisheries and Food at Wolverhampton, now reviews work using unusual techniques in the restoration of an open cast coal site in S. Wales. A marked difference was found, he indicates, between the effect of conventional reseeding and rotary strip reseeding on the site's mole drains.

THE WORK reviewed in this article refen to MAFF experiments at Hirwaun opencast coal site, near Pencoed, S. Wales, the site of a previous SAWMA meeting in 1982. The work carried out at the site looks at drainage design, and includes the use of a modified mole plough and different reseeding techniques.

Soil type and climate

The soils of the S. Wales coalfield are generally derived from carboniferous shales and mudstones, with some glacially derived till deposits overlying. The series type at Hirwaun is Wilcocks 1 (SSEW 1983). On an area basis from the new 1:250,000 Soil Survey maps, Wilcocks 1 is the third most commonly occurring soil in Wales: it is typified by up to 30cm of oeat overlying a grey loamy subsurface horizon, which merges into a strongly mottled horizon and prismatic structure, becoming coarser at depth. At about 75cm, the soil passes abruptly into a hard, indurated layer, impermeable and massive. The area under restoration now has only 10 to 15cm of the grey loamy subsurface horizon (referred to above) before the very compact clay shales or rock overburden; it is down to rough pasture.

Climatically, the area being considered has an excess winter rainfall of at least 1200mm, and the heaviest expected rainfall on any one day a year is 42mm and over any 5 days in a year is 90mm (MAFF Tech Bull 34). Fig 1 shows the rainfall distribution throughout the year. According to Tech Bull No 34, the end of field capacity (FC) and the return to field capacity are indefinable as median values. But the earliest end of FC may he expected on May 15 and the latest return around August 5.

The important point to be noted from Fig 1 is that for successful secondary drainage treatments, particularly subsoiling, there appears to be no time when a soil moisture deficit (SMD) will be achieved, and without a suitable SMD, no real shattering can be achieved. Obviously there will be years when the soil is dry enough between June and August for some subsoiling to he effective, but safe prediction of these years is not possible from the data available.

Shallow moling and reseeding methods

The reasons for considering shallow moling arise because the eventual aim of the experimental work is to develop a drainage system and soil management package which can be undertaken by the farmer, using his existing tackle. Therefore there is no point in making the drawbar requirements beyond the capability of small to medium-sized tractors.

It is worth considering the reasons why moles are traditionally drawn at 60mm deep:

- To prevent subsequent damage by arable cultivations, causing caving-in of the roof and silting up by topsoil;
- Particularly, to prevent roots of arable crops blocking the channel;
- Possibly also because the operation is normally done after harvest it would probably be necessary to go to 60mm deep, in order to find soil at the desired moisture content. The moisture content must allow plastic deformation of the soil.

There will he some truth in all the above. Nicholson (1942) generally favours the use of the deeper mole, but indicates that shallow moles may be of value under grassland.

As regards the use of an expander, there is conflicting opinion on the subject. Both moles with and without an expander yield a channel, and at present the use is one of personal preference.

The major concern over the reseeding of any established pasture on an opencast site should be one of preserving what little soil development may have occurred since reinstatement. Therefore it is necessary to consider what alternative equipment is suitable. Following work by Dr A. Charles of the Welsh Plant Breeding Station on upland pasture improvement, the decision-to try a rotary strip seeder was made, in comparison with whatever method was currently being used by contractors in S. Wales to reseed existing swards.

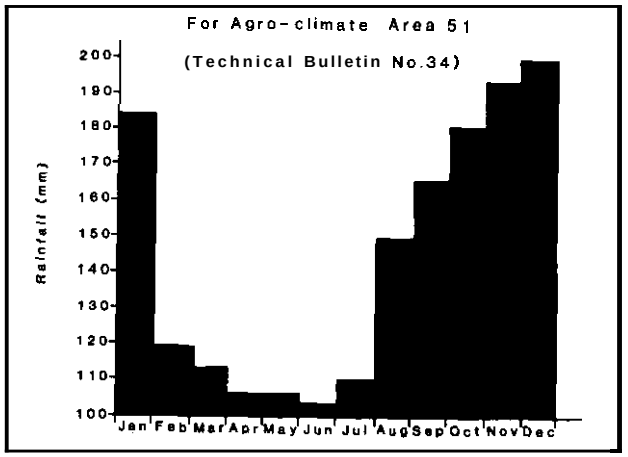
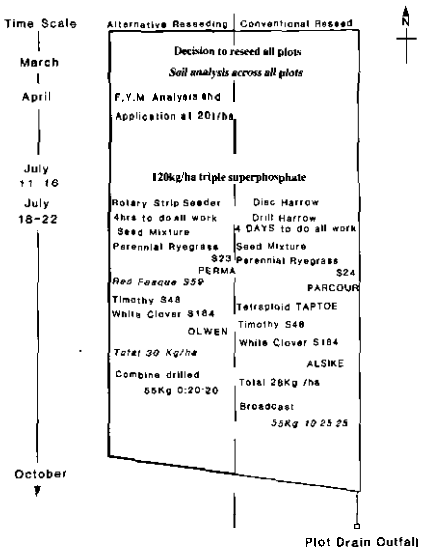


Fig 1. Average annual rainfall distribution for Agro-climate area 51 (Technical Bulletin No 34).



Sequence of operations at Hirwaun on *all* plots during ***1983.***

The work at Hirwaun site

Having reviewed the constraints and criteria to working an opencast coal site in S. Wales, the following is the case study of what has been done on the Hirwaun site. The techniques of shallow moling had already proved of benefit on an undisturbed experimental site monitored by the FDEU in S. Wales (Harris et al 1983). Therefore it was considered appropriate to try it on an opencast area.

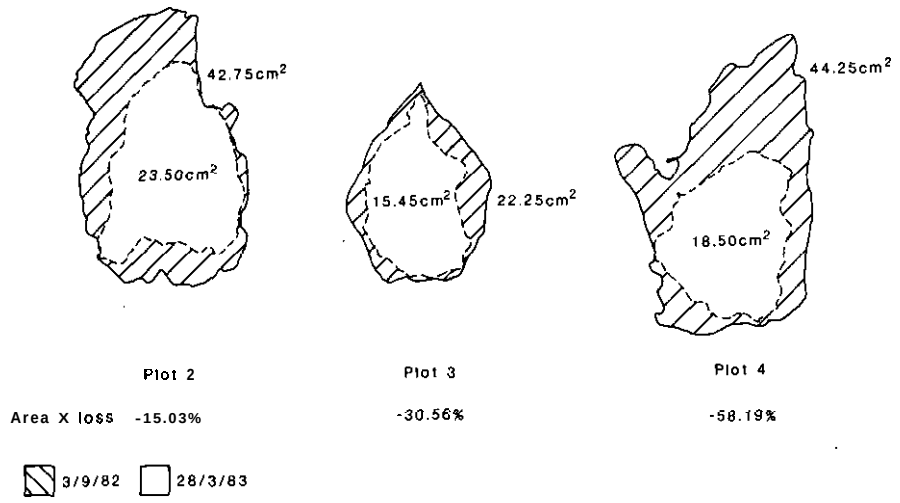


Fig 2. Polyurethane cast record of mole drains at the Hirwaun experimental site.

However, an additional modification was introduced to overcome the criticism by farmers that secondary drainage treatment on opencast land produced too much stone on the surface. The modification was to put a slight reverse rake on the leg of the mole stand. The concept was that, rather than lifting stones out of the ground, the reverse rake would cause them to be pushed down or aside. A full account of-the modified design is included in Bragg et al (1982).

Three out of five plots on the Hirwaun site were moled with the modified mole at a depth of 30 to 35cm and 1 metre centres on September 3, 1982. The other two plots form the undrained control and a gravel-slitting system only. A plan of the layout of plots is given in Bragg (1982b). The mole channels formed were recorded using the polyurethane foam casting technique (Thorburn 1980). They were subsequently recast on March 28, 1983, and visually examined on October 12, 1983. Fig 2 shows the cross-sectional area of the mole channels when initially formed and after one winter. A figure for percentage loss in cross-sectional area after one winter is included.

Although the channels were not cylindrical, even at the time of moling, it should be noted that at 30-35cm on the reinstated area the material is compacted shales and mudstone (Bragg et al 1982). These materials would not, in their relatively unweathered state, be expected to form a good channel anyway. The moisture content at the time of moling was 17.42 per cent (a figure determined gravimetrically). This compares with a determined field capacity of 23.2 per cent and a permanent wilting point of 13.5 per cent. The figures presented might be interpreted as indicating that there was a SMD on the site in September 1982. However, this would be incorrect as in fact the high bulk density of the topsoil/subsoil interface on the restored material (1.6-1.8g/cc) at 25cm, prevents normal water movement or root penetration. This concept of marked density discontinuity affecting soil moisture is borne out by other work (Bragg 1983).

On examination of the channels on the various plots between September 1982 and April 1983, water was found to he moving in them. Admittedly, in parts the channels appeared to have collapsed or filled with a toothpaste-like deposit, but they were still acting as weep zones, for water movement. Also, as a field observation, it was found that grass roots had exploited the zone of weakness created by the moling operation. The root activity was such that they were binding together the roof material of the mole channels and stabilising them. On the surface, the mole channels were marked by a greener grass strip and a distinct slot.

In March 1983, one of two decisions had to be made. Either to re-mole the plots if necessary, or to reseed them. As the moles were thought not to be totally exhausted in use, but that the original grass sward had deteriorated severely, the decision to reseed was made. It should be made clear that some improvement of sward was possible with nitrogen application, but that the tussock nature which had arisen because of bad stock management was beyond ready repair.

A programme for 1983 was drawn up and included the following: all plots were divided longitudinally; one half of a plot was to be reseeded and fertilised conventionally, and the other half of the plot was to be treated with a mixture of organic fertiliser, high phosphatic fertiliser and reseeded with a rotary strip seeder. It was found after soil analysis, that as the phosphate index was so low throughout the area, a base dressing of triple-super-phosphate was necessary. The table sets out the sequence of operations up until October 1983.

In October 1983, the site was visited and the following observation and sampling undertaken:

- visual and photographic recording of sward establishment;
- note of ground conditions, between reseeded areas;
- sampling for hulk density cores and examination of holes.

Both reseeds had been successful, although a very dry spell followed the reseeding in July. The strip seeded area looked much better, and was firm but damp on walkover, while the conventionally reseeded area was sodden and squelchy.

Most important was the effect the reseeding had had on the mole drains. The mole drains under the strip seeded area were still actively transporting water. Those under the conventionally seeded area were present but virtually dry. The conventional reseed had sealed off the moles from the surface water, and they were therefore no longer of use.

If these observations are extrapolated into the farming sequence for the next season, the following may be postulated:

On the rotary strip seeded area the new grass and clover will develop and the drainage will continue to function. Stock will be able to graze the area and little damage to soil structure will take place. If it is deemed necessary, a new mole system can be installed.

Alternatively, on the conventionally reseeded area, the new sward next spring will be very susceptible to poaching and damage on the surface. particularly as it will have been very wet all winter. In fact the sward may be partially lost through severe waterlogging and/or frost damage to the roots. It will also be very short of nitrogen, due to loss of N from the waterlogged soil, and because of the soil's lower temperature, the grass will not start growing until later. This area will probably have been put backwards in time with regard to both drainage and soil development. It will certainly require remoling, but the surface may be further damaged.

The work of the FDEU will now be to continue to monitor the situation and quantify the effects where possible.

Abrasive wear of cultivation equipment by soil

An investigation into the use of wear-resistant material for soil engaging components, by Dr A. Foley, of the Machine Dynamics and Reliability Department at the National Institute of Agricultural Engineering, Silsoe, Bedfordshire.

THE NATIONAL Institute of Agricultural Engineering (NIAE) has been involved in the problems of soil abrasion for many years. Early research centred on the mechanisms of abrasive wear by the soil, and methods to improve the wear resistance of traditional materials (steels, cast irons).

The use of hard facings and other surface treatments as a means of increasing component life has also been investigated during field and laboratory trials. However, the inconsistent performance of hard facings and uncertainties about the true cost of such processes caused the NIAE to turn its attention to engineering ceramics. These materials can possess excellent wear resistance by virtue of their extreme hardness, but problems due to their inherent brittleness have to be overcome if they are to play a useful role in agriculture.

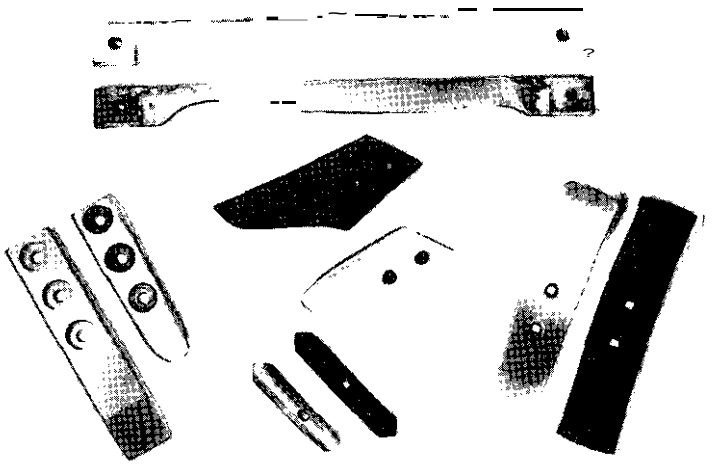


Fig 1. Effect of soil abrasion on cultivation equipment.

Wear in the soil

Wear of cultivation equipment (see Fig 1) occurs because the materials used in its construction are softer than the natural abrasives in the soil. In British soils, the main abrasives are forms of silica (flint, chert, quartz) with a hardness of around 1100kgf/mm^2. The steels commonly used have a hardness of 250-500kgf/mm^2, with cast irons being somewhat harder'at up to 800kgf/mm^2, although they are more brittle.

NIAE research has shown that for good wear resistance in British soils, the surface of a component should have a hardness of at least 900kgf/mm^2. Other factors which determine the extent and rate of wear include:

- the type, shape and size of abrasive particles, including stones;
- how the abrasives react on contact with cultivation implements ie whether they shatter and remain sharp, or are blunted;
- soil strength: ie resistance to penetration by stones.

Material requirements

The materials used in tillage equipment require strength and toughness to resist distortion and impacts, and hardness to resist wear. In general, steels have adequate strength and toughness, but relatively poor wear resistance, while the converse is true of cast irons.

Since extremes of hardness and toughness are incompatible in a single material, a combination of two materials, each having one of the required properties, could prove a suitable solution. Such a combination would have a hard surface layer for wear resistance and a softer but tougher core to help absorb impacts. The NIAE has looked at a number of ways of achieving this objective:

- Hard surface coatings applied by welding or spraying or created by diffusion treatments eg carburising, nitriding, boronising;
- The use of engineering ceramics adhesively bonded to the surface requiring protection.

Surface coatings and treatments

Hardfacings applied by welding often consist of hard particles, eg metal carbides, dispersed and bound in a softer matrix. The wear resistance of such materials is sensitive to:

- the relative hardnesses and sizes of the hard particles and the abrasive particles, and
- the applied load.

These factors affect the depth to which abrasive particles can indent the wearing surface and hence the extent of wear. They also explain why the performance of a particular hard facing material can change with the working conditions. Hard particles are more effective in reducing wear if the abrasive particle size is small and applied loads are low. As the applied loads increase and when the abrasive particles are larger than the hard particles, the properties of the matrix tend to determine wear resistance.

Application of hard facings by welding, also influences wear resistance by causing changes in the structure of the coating. The application'of heat and variations in time at high temperature can cause dilution of the hard facing by the parent material and dissolution of the constituents. The heat can also affect the temper and hence hardness of the base material if hard facings are applied to previously heat treated components.

Sprayed-on coatings, eg plasma-sprayed ceramics, contain large amounts of porosity and have low bond strengths to the underlying components. As a result they tend to be unsuitable in all but stone-free soils because impacts cause the coatings to crack and flake off.

Diffusion treatments, eg carburising, nitriding and boronising, while producing hardened surfaces with relatively good wear resistance, are unsuitable unless the tolerable wear is low. The hardened layers are typically up to lmm in thick-

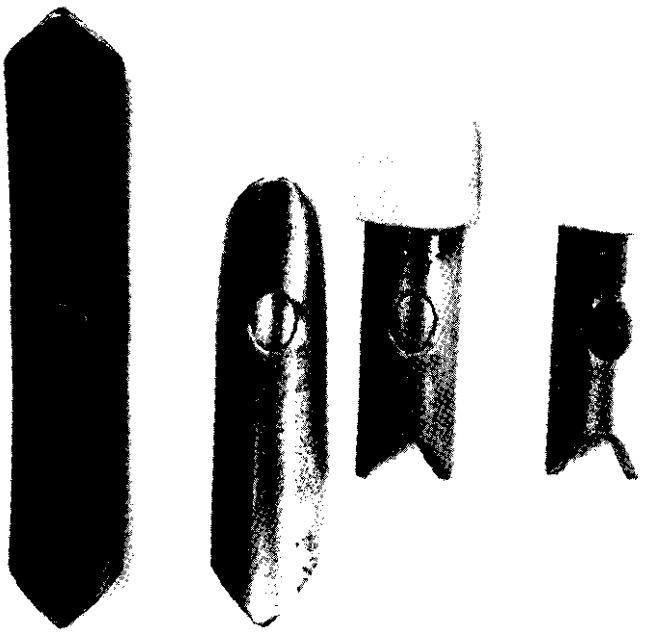


Fig 2. Comparison of new and worn steel and alumina spring tine points. Worn points have both travelled 190km through the soil.

ness, and so the overall increase in the life of many components is small.

A study of the costs involved in hard facing including consumables, labour, plant depreciation etc, showed that such processes were unlikely to be economic unless:

- the component is subjected only to sliding wear;
- significant savings in downtime can he made, or
- the labour involved can he written off as an overhead

Engineering ceramics

The group of materials known as engineering ceramics, which includes alumina, silicon carbide and silicon nitride, has been developed over the past 40 years to meet requirements, such as high temperature strength, which are unattainable with conventional materials. Engineering ceramics range in hardness from 600 to 3500kgf/mm^2, and as a result can have exceptional wear resistance. Their inherent brittleness must be considered during the design of components to permit transfer of applied loads to the underlying structure without significant distortion of the ceramic. During our research it was found that alumina (aluminium oxide) although not the hardest material tested, at 1400-1500kgf/mm^2, has the best ratio of wear resistance to cost. Alumina is widely used for its abrasion resistance in industries as diverse as coal mining and textiles. More importantly, it satisfies the criterion for reduced wear in the soil, viz the hardness of the wearing surface should be greater than 900kgf/mm^2.

Fig 3a. Ceramic subsoiler shins. The alumina pieces are honded on to a special steel carrier.

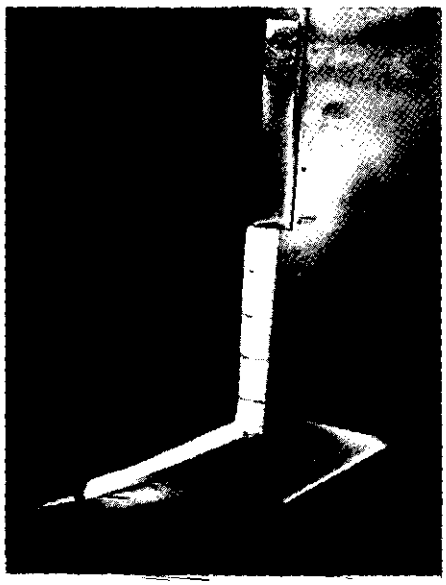


Fig 3b. Ceramic subsoiler shins. The alumina pieces are honded on to a conventional steel shin.

The use of alumina in the soil

Initial feasibility studies of the performance of alumina in the field, viz wear resistance and impact damage, were carried out at the NIAE. Following these successful trials, the development of ceramic-protected components was undertaken, the first being an alumina-tipped spring-tine point. A number of designs were evaluated for use in secondary cultivations, from which one was selected for commercial development (see Fig 2). The alumina tip is bonded to the steel carrier using a high performance epoxy resin adhesive. When testing of these points was carried out at eight sites, standard steel points wore between 4.5 and 8.9 times faster than the ceramic points. Impact damage was only a serious problems in particularly stony conditions.

Two designs of alumina protected subsoiler shin have also been field tested. One design (Fig 3a) has specially shaped pieces of alumina bonded on to a steel carrier which is then attached to the subsoiler leg. The other design (Fig 3h) has shaped pieces of alumina bonded directly on to the leading edge of a standard shin, which is held in place by normal methods. In both cases, the ceramic is bonded to the steel using the same high performance epoxy resin adhesive as for the tine points. Reductions in wear rate by factors in the range 5 to 8 compared to conventional steel shins have been measured during cultivations of up to 250ha.

Abrasive wear of drainage equipment has also been investigated. Trials with solid alumina mole plough expanders (Fig **4)** were particularly encouraging. Estimates for the increase in life range from 5 to 10 times compared with conventional expanders.

Our latest development has involved

continued

Abrasive wear

Continued

the use of alumina to form the cutting edge on precision seed drill coulters. Accurate depth control and a consistent drill profile are both required when drilling sugar beet, for example, in order to maximise plant emergence. The rate of wear of conventional coulters tends to be high and very variable due to the properties of the chilled cast iron cutting edge. In contrast, during extensive field trials, ceramics coulters wore 3 to 4 times slower, on average, and more consistently than conventional coulters (Fig 5). Furthermore, impact damage on the ceramic due to stone contact was minimal and confined to non-critical areas. The use of ceramic coulters will reduce downtime needed to check and adjust the depth setting to compensate for coulter wear and result in less frequent replacement, saving both time and money.

Other experimental components incorporating ceramic protection have been tested in the field, including plough landsides, suhsoiler feet and hearings for root crop harvesters.

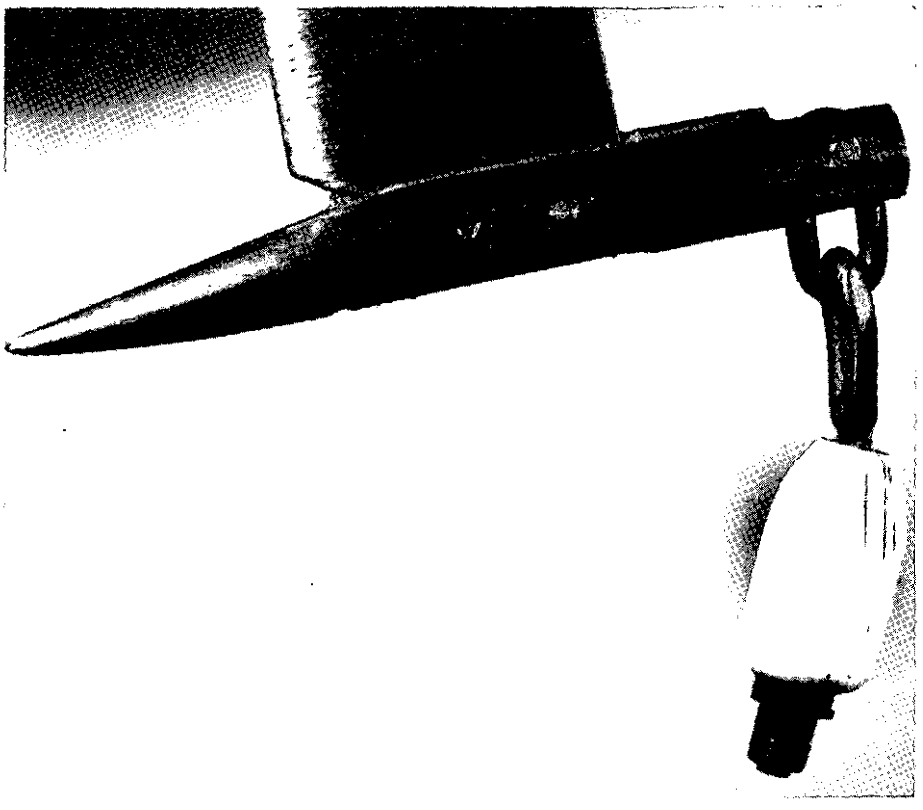


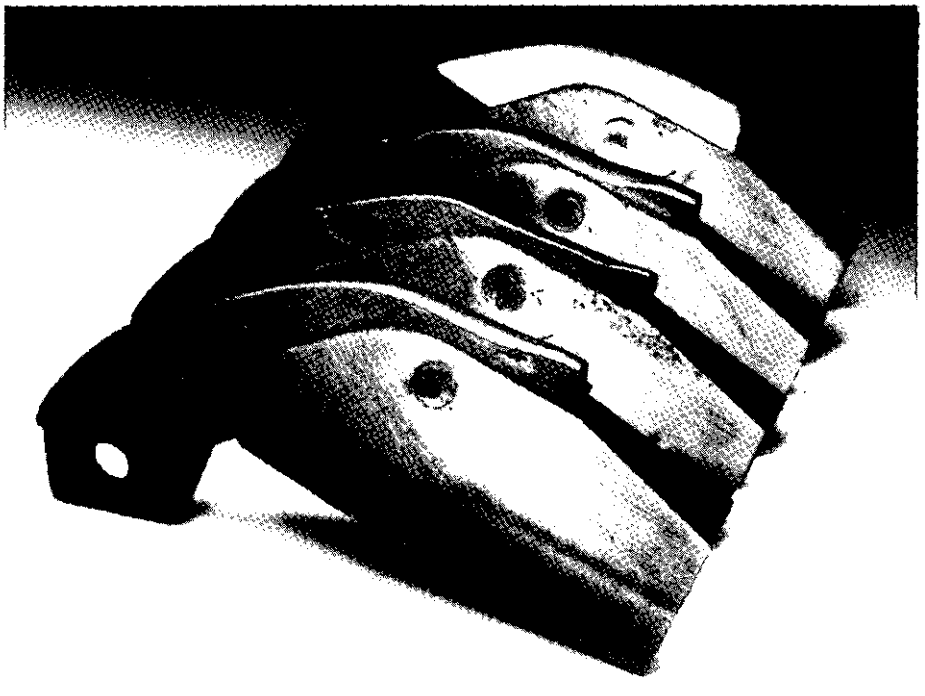
Fig 4. Solid alumina mole plough expander after 400ha.

Commercial developments

The alumina-tipped spring tine point was launched nationally by Smiths Industries, Ceramics and Ignition Co in 1982, and is now widely available. The solid alumina mole expander was introduced commercially by Anderman and Ryder (manufacturers of alumina ceramics) during spring 1983. More recently, Smiths Industries have introduced an alumina-protected subsoiler shin similar to that shown in Fig 3b.

Hestair Farm Equipment Ltd have announced that they are to introduce ceramic coulters as standard on new Webb and Stanhay drills. This move follows further extensive trials set up by Hestair in conjunction with British Sugar PLC and the NIAE. It is seen to be of great significance, as the first example of an equipment manufacturer making ceramic wearing parts standard equipment.

Fig 5. A ceramic tipped Wehb coulter which has done the same amount of work as the three conventional coulters together.



Future trends

It is anticipated that further components incorporating ceramic orotection will become commercially available in the next few years. Unfortunately, currently available alumina ceramics are not suitable for use in some soil types, especially those containing large quantities of stones. However, more impact resistant grades are under development and may have a positive effect on the use of ceramics in agriculture.

Sintered tungsten carbide/metal composites may also become an increasingly popular means of improving wear resistance, despite their cost, which is much higher than for aluminas. Such materials can have better impact and wear resistance properties than aluminas, and are widely used in coal mining for coal-cutting picks. A sintered tungsten carbide tip is now fitted as standard on one make of seed drill coulter.

Continued development and introduction of new weld-applied hard facing materials is expected, since many farm workshops are well equipped to use such techniques. However, as made clear earlier, the wear resistance of a given hard facing material is likely to show large variations depending on the working environment.

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DIARY

DECEMBER **1984**

3-6	Royal Smithfield Show (Earls Court)
5	British Hydrological Society (Birmingham University) — Operating surface water under drought conditions
7	British Hydrological Society (Royal Society Rooms) — Floods in Scotland
10-12	RASE conference (Warwick University) — Cereals **course**
12	SEESOIL Winter meeting (Silsoe College) — Soil erosion
17-19	Short course (Silsoe College) — Irrigation: Principles and Practices

JANUARY **1985**

7-10	Short course (Silsoe College) — Soil Management
7-10	Short course (Silsoe College) — Field Drainage: Principles and Practices
16	British Hydrological Society (NWW Dawson House, Cheshire) — The use of the **WASSP-SIM** Model in hydraulic analysis for sewage rehabilitation
17-20	Short course (Silsoe College) — Agricultural Drainage Design and evaluation
18	British Hydrological Society (Strathclyde **University**) — Acid rain
22-24	**SAWMA/NAAC** Drainage Workshop (Stratford-upon-Avon, Warwickshire)

FEBRUARY **1985**

5	RASE conference (NAC, Stoneleigh) — Irrigation: **getting it** right
7	**Barley '84 follow** [illegible] (Royal Hall, Harrogate)
26-27	RASE/ADAS conference — **Soils Workshop**

MARCH **1985**

8	British Hydrological Society (Royal Society Rooms, Edinburgh) — The effects of upland management practices on water resources