SOIL and water

Published by the Soil and Water Management Association Ltd. July 1985

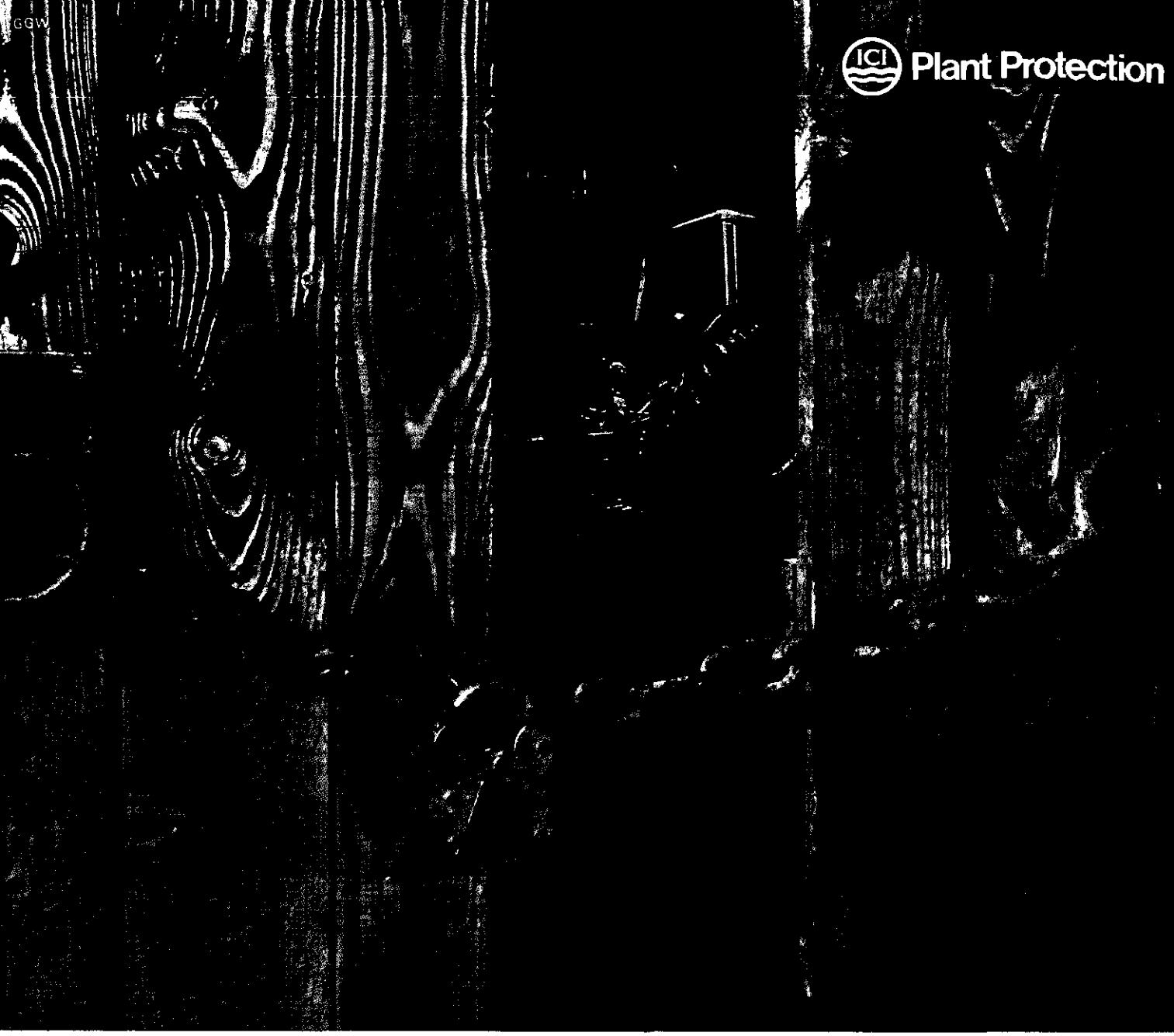
FEATURES

Land Restoration

Autumn Tillage

Drainage

Soil Management



After spending years opening doors, we're about to help you close some.

Opening doors to new ideas hasn't prevented us from recognising where we could be helping you by shutting a few old ones.

And it's with this in mind that we'd like to draw your attention to Soil Care Systems.

As the name implies, it's a flexible method of caring for your soil by reducing the number of passes you make across it.

Because with Soil Care Systems, you only take your tractor out when necessary. There's no wasted cultivations made to kill off weeds. Instead by using 'Gramoxone' 100, you can do the job quickly, and effectively, despite the weather.

And at the end of the day you still maintain, and frequently improve, the drainage and structure of your soil. So instead of making heavy weather of preparing your seed bed, remember Soil Care Systems.

Otherwise you could be quite needlessly working yourself into the ground.

SOIL CARE SYSTEMS

For our comprehensive handbook on Soil Care Systems, fill in the coupon and send it to ICI Plant Protection, Department CB, FREEPOST, Cirencester, Glos. GL7 IBR.

Name

Address

V13-1

SOIL and water
THE MAGAZINE ON SOIL CONDITION AND FERTILITY

Volume 13 No 1, July 1985

Editor: G G Baldwin MA MIMechE

Editorial Committee
Dr H P Allen (ICI)
Mr M S Darbishire (Farmer, Norfolk)
Mr M G Jarvis (Soil Survey of England and Wales)
Mr F P D Moore (Howard Rotavator Co Ltd)

Editorial and Advertisement Office:
SaWMA
22 Edgerton Grove Road
Huddersfield
West Yorkshire HD1 5QX
Telephone: Huddersfield (0484) 29417

Administration Office:
SaWMA
Cheltenham House
High Street
Banbury, Oxon OX16 8JJ
Telephone: Banbury (0295) 66297

SOIL AND WATER is the Journal of the Soil and Water Management Association. The views expressed in this publication are those of the contributors. The publishers disclaim any responsibility whatsoever arising from the use of the information contributed. The Association is a charity whose main objective is to promote the highest standards in the care of the sail: Britain's basic asset.

The editor welcomes offers of editorial material and advertising requests; details on application. Copy date for the July issue is mid-May. Except where used for promotional purposes. Soil and Water is available only to members of SaWMA. The annual membership subscription is £11.50 including VAT.

Fmnt cover—Sandy clay over Boulder clay—the soil at Mr John Rymer's JSR Farms Ltd, Southburn, Driffirld—and one of the sites in the ADAS cultivation trials investigating the long term effects of deep soil loosening. Mr Rymer, a founder member of SaWMA is this year chairingthe NAC Conference "Soil Management for cereals and rape':

A note about the ADAS trials is on page 6.

COMMENT

Our Continuing Role

Since our April issue, the main developments in SaWMA have been the detailed preparation of our 1985 programme and the straightening out of our membership records.

Details of the SaWMA events for 1985 are included in Diary on page 22. And don't forget the Conference "Pollution on the Farm" to be held on Tuesday, 12th November. Details of this are given on the back cover and we are pleased to proclaim the joint support of MAFF, ADAS and the East of England Agricultural Society in this important event. We are also very pleased with our 'line-up' of Chairman and speakers – men of quality, knowledgeable in their subjects and certain to generate and inspire valuable discussion and action.

Now is a very exciting time for SaWMA. Our farming industry, the country and indeed most of the Western world are becoming daily more concerned that proper attention is given to good management and preservation of our basic assets. SaWMA has been carrying this message for the last ten years. We plan to develop this still more in the future and show ourselves to be one of the leading organisations concerned with resource conservation, preservation and good management.

The Pollution Conference is a good example of these intentions. The Conference is planned to be of particular interest and value to farmers, conservationists and consultants but many others will find it worth while Too often these days, farming is being accused of misuse of thecountryside. A lot of the accusations are unsubstantiated and unjustified. The report we carry on page 5 (Pipeline) of theresolution passed at the York County Branch NFU shows that farmers do care and farmers are concerned – but first we do all need the facts to go on, and we do need to think and act on an international scale. Whatever the problems of pollution they are not just British problems and the least we can do is to tackle them as European (or EEC) problems if any sensible long term and economic solutions are to be found.

Also on this subject I think it is relevant to quote (with due acknowledgement to whoever conceived it) the slogan in the back window of the Land Rover preceding us out of the car park at the Farmers Weekly Drainage event – "Don't criticise farmers with your mouth full".

As I wrote in April – "Soil and Water, that is SaWMA, aims to provide the information to help the right decisions to be made."

But, and I must emphasise this, our programme demands full and adequate resources. We need the support of all current members and we want to attract many more new members. In return we hope that members will then find that they themselves attract a correspondingly greater benefit through their association with SaWMA principles and objectives.

We thank you for your support in the past and we hope we may count on your continued support in the future.

CONTENTS

PIPELINE...PIPELINE...PIPELINE... PIPELINE...

STRIPDRAIN – a new solution to drainage problems

Chelmsford Borough Council are experimenting with a sample of BTR Landscaper's revolutionary prefabricated drainage system HITEK STRIPDRAIN at their Melbourn Park Sports Stadium. It has been installed by Shelton Trenching Systems.

Stripdrain was developed in Australia and has since been widely used in New Zealand and Canada. BTR Landscaper have introduced it to the United Kingdom and Europe.

Rot-proof; **Crush resistant**

Supplied in a roll – in various dimensions depending upon application – Stripdrain consists of a rot-proof, cuspated plastic core with high crush resistance, wrapped in a geotextile fabric – 'Terram', made by ICI.

Stripdrain provides a water collection medium which is capable of filtering water through the whole area of its surface, whilst preventing ingress of soil and other particles.

Flexible; joins **by** scissors **and** tape

Stripdrain is flexible and will easily conform to the shape of uneven trenches. It requires no expensive bedding or backfilling.

150mm HITEK STRIPDRAIN being laid *at Melbourn Sports Stadium, Chelmsford*

Stripdrain is lightweight and joints and seals can be made with only scissors and adhesive tape. It does not need to be laid to a gradient and can be laid in narrow trenches from 250mm to 1500mm +, depending upon application.

Further information: BTR Landscaper, Freepost, Preston PRS 2BR. (0772) 421711.

ICI Plant Protection Ltd. wins Pollution Abatement award

Two divisions of ICI are among the four winners of this year's Pollution Abatement Technology awards.

At ICI Plant Protection Ltd., the award is gained for their new ELECTRODYN spraying system which incorporates a unique electrodynamic atomisation process producing uniformly-sized and electrically charged spray droplets. In the opinion of the assessors, the ELECTRODYN system dramatically reduces spray drift and considerably improves operator safety; furthermore, it dispenses with the need for large volumes of water and it provides excellent biological control at very low application volumes – 0.5 to 1.0 litres per hectare of the special product formulations.

Initially marketed as a hand-held tool primarily for the World's semi-arid agricultural zones, the ELECTRODYN system is now being developed as a vehicle mounted sprayer and also as a hand held tool for gardeners and growers. It is to be available in the UK this

The Awards for Pollution Abatement Technology are financed by the Environment Foundation and promoted by the Confederation of British Industries, the Department of the Environment, and the Royal Society of Arts. The idea of these Awards (first instituted in 1983) is to give publicity to the problem of pollution and to encourage the promotion of ideas which will not only combat man-made pollution but prevent new forms of environmental damage arising in the future.

Besides the financing of these Awards the Environment Foundation also seeks to encourage appropriate research. Already, they have committed resources to a project at Reading University for a study of the treatment of silage effluent.

Remote sensing for land and water management

The National Remote Sensing Centre (NRSC) at Farnborough, and the Department of Trade and Industry have set up a travelling exhibition to promote the use of Remote Sensing in the UK.

Remote sensing is the observation of the earth and the atmosphere from space. It is a valuable tool for surveying natural resources and monitoring the environment. It is a major contributor to weather forecasting, where rapid surveys and/or repetitive observations with wide overall views are required.

Specific applications showing great promise include regional crop monitoring and yield prediction; detection of soil moisture conditions and the rapid survey of atmospheric conditions allowing, for example, considerably enhanced scope for monitoring of pollution.

The Exhibition 'Roadshow' comprises of a 40ft trailer housing three examples of British remote sensing equipment and also equipped with facilities to provide lectures, slide shows and videos to small groups of people. Subject to prior arrangements it will beavailable to attend at relevant conferences or meetings through the period up to the end of 1986.

Remote Sensing – MSc Course at Silsoe

Further opportunity to get really involved with remote sensing is also now offered by a new MSc course at Silsoe College in October.

The course – Applied Remote Sensing – aims to produce specialists trained in the interpretation and analysis of sensor information. It is designed for graduates (or the equivalent) working or intending to work in the UK or overseas in natural resource development, or in other fields where the application of remote sensing can effect improvement in resource management.

A leaflet on the course is available from the Student Recruitment Office at Silsoe College.

Course in Land Restoration

With our emphasis in this issue on land restoration it is also relevant to point out that courses are availablespecially to give training and instruction in this subject.

Land Capability Consultants Ltd, offer a course in two parts – two days of lectures and discussion on the principles and techniques of land restoration, followed by two days in the field at operational sites. Subjects covered include plant requirements, soil properties, soil handling, landfill, drainage and subsoiling, tree planting and after care.

This year's course runs 23rd to 27th September and will be the fifth in the series. The cost of the full residential course is £345 plus VAT, but it is possible to attend separately either the lecture course or the field course.

Further details from: Miss S P Corker, Land Capability Consultants Ltd, Times House, Willingham, Cambridge CB4 SLH.

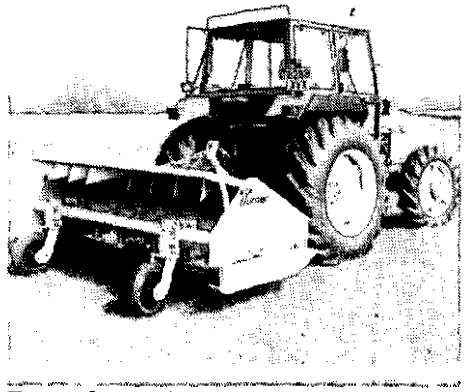
Correction

We much regret that the names of two of SaWMA's Corporate Members were inadvertently missed off the list published in our April issue. The members involved were:

Drinkwater Sabey Ltd.

Inter-Drain Ltd.

Corporate Members are valued supporters of SaWMA in its efforts to promote the highest standards of soil care and management.



Turner *International* announces two new *straw* choppersfor linkage *mounting* on *tractors* over 60 *hp. Respectively* 6 ' 6 and 7'6" *cut* model *TMSC200 is* priced *at* £1946 and *TMSC230* (above) at *£2165 (VAT excl).*

V13-1

PIPELINE...PIPELINE...PIPELINE... PIPELINE...

Newfrom A F *Trenchers* is *this attachment* for *Gehl Skid Steer Loaders enabling* them to trench for electric *cables,* water pipes and other small *underground* services. *Called* the A F T 30 the *trencher* mounts on the *lift* arms *of the* loader and a depth wheel enables the correct height for trenching *to* be *maintained.*

Trench width *is from 12.5cm* to *30cm* and *maximum* depth is *1.20m.*

Further Fund Reductions

After the announcing in our last issue of the slashing of funds to the Soil Survey we must this time publicise an equally distressing situation at the Scottish Institute of Agricultural Engineering.

A Consultation Paper just issued by the Department of Agriculture and Fisheries for Scotland (DAFS) proposes that the budget for agricultural engineering work should be reduced by £1.1m – a cut of 70 per cent.

The Scottish Institute is taking space in this journal (page 11) to publicise some of their activities. They invite support from all concerned with the welfare of agriculture in Scotland to convey their views to the Secretary of State.

Furthermore, the Institute draws attentions to the range of its current programmes, with their special relevance to the problems and interests of Scottish agriculture, and declares that the manner in which engineering has been selected to bear the brunt of R & D support cuts betrays a lack of appreciation of the long term serious consequences for Scotland.

See also page 6 for an announcement on behalf of the Soil Survey seeking contacts with users, and potential users of their services.

Small Scale Drainage

Anaplast Limited has introduced "TYPAR", Du Pont's permeable construction membrane in a handy-pack containing just 10 running metres. Called 'EARTH-PACK: it is an ideal size for many of the small jobs – on building sites; farm roads and gateways and in the garden – undertaken by both the amateur and professional.

"TYPAR" is a tough, non-woven polypropylene fabric which, although lightweight, has great strength and dimensional stability. Because this outstanding performance makes it suitable for reinforcement, drainage erosion control and many other large scale applications, it is used extensively in civil engineering projects rhoughout the UK, Europe and the USA.

The handy, economic-sized 'EARTH-PACK: supplied with a technical leaflet, enables the small user to capitalise on the same characteristics of increased life and reduced maintenance.

Without additional 'expert' help, access roads, drives and pathways, soakways, drains and many other jobs in the garden all become possible for the builder, farmer or handyman and he saves money.

"TYPAR" replaces expensive *well graded* aggregate filters in a *small* land *drain. It* allows *free* passage of water, *whilst* restraining *soil particles* from entering the *system.*

Call for Nitrates research at EEC level

Members of the York County branch of the National Farmers Union have passed a resolution calling for a serious scientific study of the effects, if any, of nitrates on underground water supplies. Proposing the resolution, Mr John Cook, Scarborough, maintained that most farmers believe that nitrates have no effect on underground water supplies. "Farmers are amongst the most responsible people in the community. If it is shown that nitrates are not a problem, then it is proper to have that proved – and if there is a problem, then again it will be to our benefit to know it".

Mr Cook further proposed the investigation should be undertaken at EEC level so that its findings would affect all countries and so that British farmers would not be at any competitive disadvantage if problems were encountered.

SAWMA **MAFF ADAS**
East of England Agricultural Society
One day Conference, 12th November 1985
Pollution on the Farm
See back cover for further derails

The Soil Management Course at Silsoe College

Co-sponsored by SaWMA, the course is now in its fifth year and is still much in demand from a wide range of interests.

Although primarily directed to farmers and farm managers the Silsoe Soil Management course is also attracting many others concerned with soils – representatives from the Service industries, from local authorites and from fertilizer equipment and other supply industries.

Led by Dick Godwin, the emphasis in the course is to make people think – to think about the soil – and to think of the soil as a feature of the farm which requires its individual management. With a medium as varied as British soil, and in the British climate, it is obviously not possible to lay down a specific treatment to achieve a specific effect under all conditions.

What the course aims to do is to provide an understanding of how soils behave when loaded, identifying the major factors influencing this behaviour, consider approaches to avoid or at least minimise soil damage during field operations and identify reclamation measures to alleviate problems. Delegates are shown how to examine soils; how to interpret what they see and then how to evaluate the best soil treatment to achieve the effect and condition required.

Re think priorities

The course seems to be eminently successful in achieving these aims. Speaking recently with Mr John Errington, who manages 1500 acres for Sir Neville Bowman-Shaw at Toddington, Beds, he tells me that attending the course has made him re-think his priorities. At this year's harvest he plans to make his main control point not by the drier but out in the fields examining the soil and determining when and with what to prepare for sowing next year's crops.

BOOK NOW

the next
Soil Management Course
6th-9th January 1986
Silsoe College, Beds MK45 4DT

Mr John Rymer, Managing Director of JSR Farms, Southburn, near Driffield helped instigate the first course in 1982 and has since arranged for his senior staff also to attend. He is in no doubt that this has benefited both them and the Farms. Managers and foremen at JSR Farms now have a much greater awareness of the soil and its needs. Mr Rymer believes that one cannot be static in farming – one must always be looking for better ways – and this means one must arm oneself with as much knowledge as is available. Experimenting with new techniques is to be encouraged – provided one understands what one is doing. A case in point – the power harrow – Mr Rymer views this machine with some concern – that, through lack of a proper understanding of the soil, there is here a new danger that a seed bed may be forced on the surface when below ground conditions really warn against it.

Generally, Mr Rymer's view is that soil working equipment and techniques are still changing so he feels he would like to attend an updating on the Soil Management course. Even though he is in regular contact with Gordon Spoor and Dick Godwin he would still like to hear their latest views in the context of the Soil Management course.

Reduce compaction

One element of the course which does find immediate practical application is the attention given to analysing the compaction effects of farm traffic. Great emphasis is laid on choosing the right tyres and wheel equipment and then on keeping wheelings to a minimum and controlled to defined traffic lanes.

But application of new ideas is not always easy! According to Mr Bill Pickup, Manager of Mr Ashley Cooper's 1400 acres at Hexton, Herts; after attending the Soil Management Course in 1982 it turned out to be the most expensive course he had ever been on – since it caused him to change much of his old machinery. But he has never regretted the change. The two 70hp crawlers that he used to use are now replaced by wheeled tractors and low pressure tyres and all operations are carried out using the controlled tramlines. Compaction is kept to a minimum.

Mr Errington too recalled the emphasis on limiting compaction – the principle expounded by Gordon Spoor that "there would be no need to cultivate at all if it wasn't for soil compaction". He too, since attending the course, is opting for wider tyres and low pressures.

A final point stressed by all I spoke to is that attending the Soil Management course had not been just a matter of listening to lectures or doing practical work. There had also been opportunity to meet the experts from Silsoe College, ADAS and various Research Institutes and to talk with them about individual problems. And, with this particularly, there had been the establishing of contacts and of helpful sources for further information in the future. With these benefits and the vital need amongst farmers and so many others to be well informed and "aware" about soils, it is hardly surprising that this course continues to be in such keen demand.

ADAS Trials at JSR Farms Ltd

The ADAS trials on Mr John Rymer's farms at Southburn, Driffield, Humberside are part of a series being conducted throughout England to investigate the long term effects of various deep soil loosening treatments.

The trials were set up in 1982 when, with the co-operation of the farmers concerned, sites were chosen on different soil types and four different loosening treatments (including control) were applied.

The treatments involved are:

- deep loosening, with Wye doubledigger, NCAE winged subsoiler, Howard Paraplow
- normal depth ploughing (control)

Subsequently, the trial plots have been subject to the normal farm programmes of cultivation and cropping; with ADAS having access for regular inspection and measurement.

The trials are 'sponsored' by ADAS Soil Scientist Mr Mike Marks and he will be presenting details of results to date at the NAC conference this November on "Soil Management for Cereals and Rape".

The Wick Series

Soil Assessment – I N L Kilgour, Soil Survey of England and Wales

These soils are brown deep well drained light loams that occur mainly on flat or gently sloping river terraces or over glaciofluvial sands. The soils are widely distributed in the Midlands, Northern and Eastern England and in Wales. They are the dominant soils over about 3,000 km' of land (1.95 per cent of England and Wales), and associated with other soils over a further 3,250km^2. Their distribution is shown on sheets 1, 2, 3, 4 and 5 of the National Soil Map.

Topsoils and subsoils are sandy loam or sandy silt loam with variable amounts of stones but they become sandy at depth and on terraces along river valleys they are often over gravel. A brief profile description is given below.

cm	
0-30 Ap	Dark brown slightly stony sandy loam or sandy silt loam.
30-60 Bw	Brown slightly stony sandy loam or sandy silt loam; moderate medium subangular blocky structure.
60-80 Bw	Yellowish brown slightly or moderately stony, loamy sand or sandy loam; weak medium blocky structure or structureless.
80-120 2BCu	Brownish yellow slightly or moderately stony sand or loamy sand; weak coarse blocky structure or structureless.

Opportunities for land work

Because the soils are permeable, rain percolates quickly into the ground and surface run off is usually negligible. Artificial drainage measures are not required. The topsoils retain little water and the land is particularly well suited for cultivation, including direct drilling. There is considerable flexibility in most areas for landwork in autumn and spring, and even in wet western districts some spring work is usually possible without causing undue damage to soil structure. This is illustrated in Figure 1 which is taken from the Soil Survey publication *Soils and their Use in Northern England* (Jarvis *et al* 1984).

In Eastern England and in the Midlands cultivations can be carried out with care in rainfree periods throughout the winter, but cultivation pans can develop if heavy machinery is used. Soils containing a large amount of sand and silt are particularly susceptible to structural breakdown and surface caps may form if bare soil is exposed to heavy rain leading to patchy emergence of seedlings. There is also a risk of water erosion on sloping ground and gullies may form with loss of soil material downslope. Wind erosion may occur when the surface is dry. Erosion risk is increased where the amounts of organic matter in the topsoil have been reduced by continuous arable cropping.

Cropping

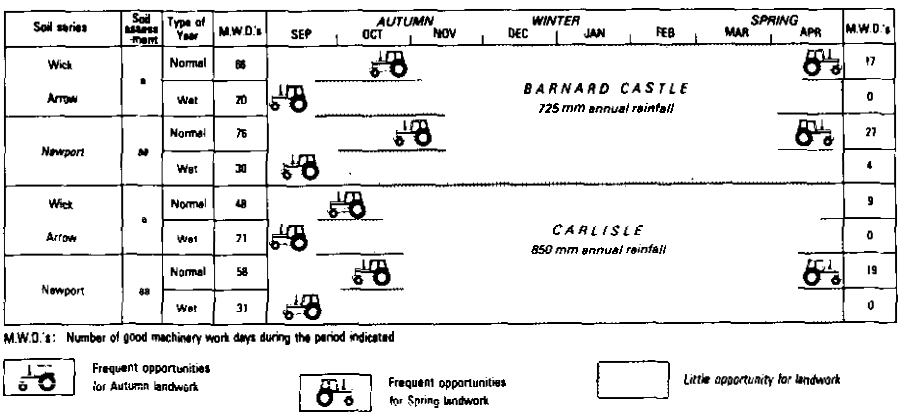
Land with Wick soils is very flexible and is valued for agriculture especially in the wetter west.

A wide range of both autumn and spring sown crops is grown in Eastern and Midland England including cereals. sugar beet, potatoes, oilseed rape, and field vegetables with soft fruit production in districts with a mild climate. There are few limitations to crop production but the soils have only a moderate capacity for storing water for plant growth in summer.

Irrigation for potatoes

There is sufficient water for rooting cmps such as sugar beet but many other crops are slightly affected by drought, and potatoes and grass especially so. Potatoes, in particular, benefit from irrigation. On the moister climate of North West England and Wales, dairying and livestock rearing are predominant based on intensive grassland with cereals, chiefly winter sown, and root crops. Good yields of grass are usually obtained, although in dry years growth is checked by shortage of water. The soils areas are also well suited to winter cereals but less suited for spring sown crops because the growing season is short. The land is very suitable for forestry and oak, beech, sycamore, Japanese and hybrid larch, Sitka spruce, Scots pine and Douglas fir all grow well.

Fig.1. The *effects of soil* and climate on *landwork*



Reference
Jarvis, R A; Bendelow, V C; Bradley, R I; Carroll, D M; Furness, R R; Kilgour, I N L and King S J (1984)
Soils and their use in Northern England
Bull. Soil Survey of Great Britain

This publication and the National Soil Map are available from the Soil Survey of England & Wales, Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ

RESEARCH

Norfolk Agricultural Station

Cultivation techniques still the key factor in improving and maintaining soil structure

Interim results from some of their long term experiments are given in the 1985 Annual Report of the Norfolk Agricultural Station.

One experiment, now in its eleventh year, explores the effects of rotational cultivations on the structure of the fine sandy soil found towards the Northern boundary of the farm. This soil is low in organic matter (around 1.6-1.8%) and the poor structure is very liable to compaction when cultivations are carried out at moisture contents even as low as 13 per cent.

In the past, it had been shown that this difficulty could be contained by the adoption of "minimum" cultivation techniques – eg. no more than two straight tine shallow cultivations for sugar beet seedbed preparation.

The long term trial into the effect of rotation and other treatments has shown that benefits to soil structure following leys have been very short lived. The emphasis remains, therfore, on cultivation techniques to improve and maintain soil structure.

Straw incorporation

Elsewhere on the farm – on sandy loams (Ashley series overlying Chalky Boulder Clay) similar to much of the medium to heavier soils found in Norfolk and much of Suffolk – another experiment has been set up to investigate both short and long term effects of straw incorporation.

The straw is chopped at harvest and a comparison is then being made between immediate ploughing in and ploughing in after weathering some 21 days later. Also under examination is the need or otherwise to carry out a pre-ploughing cultivation to mix soil and straw and the need for additional autumn or spring nitrogen.

This experiment is part of a co-ordinated series with other trials being sited on four ADAS Experimental Husbandry Farms.

Ransomed, Healed, Restored, Forgiven
The Restoration of Opencast Sites

by Ian Carolan, NCB Restoration and Research branch

Few people outside the Opencast coal industry are aware of the detailed forward planning, consultation, co-operation and compromise that occurs between the interested parties to produce a successful land restoration.

The high standards demanded in current restoration and rehabilitation practice are best understood by briefly tracing the history of the industry in Great Britain.

The mining of coal in Great Britain by Opencast methods was started in 1941 as a wartime emergency measure. At this time sites were small in area and of short working life, with working depths rarely exceeding 15 metres, being limited by the available mining machinery which was small and light when compared with present-day machines. Even in these early days Government policy required that land taken for opencast mining purposes would be restored to agricultural use.

Wartime expediency and shortage of suitable earthmoving machines meant that standards in soil stripping, storage and respreading were much lower than those acceptable today. In 1948 a Technical Advisory Comittee was appointed with representatives from the Ministry of Agriculture and Ministry of Power to review restoration practices. The report of the committee led to an improved code (1951) of restoration.

The Opencast Executive

During the period up to 1952 various Government ministries supervised opencast mining activities, but in that year responsibility was transferred to the National Coal Board (NCB) and the Opencast Executive (OE) came into being.

In 1974 'Plan for Coal' was agreed between Government, the NCB and the Mining Unions, this agreement gave the OE an annual target of about 15 million tonnes output. To maintain such a programme requires 50 to 60 operational sites, this represents a land requirement of approximately 2,000 ha per year being brought into coal production. At any one time there will be approximately 8,000 ha being worked for coal and with a further 10,000 ha in the restoration phase of operations. Sites range greatly in size, from about 35 ha to 862 ha, with a life of 2 years to 12 years excluding the period for restoration and rehabilition. On average most sites are around 150 ha and have a productive coaling life for 4 years. This relatively short working life contrasts sharply with many other surface extractive industries where operations can run into decades.

In any locality the working of an area of 1 for coal has its effect on the environment; noise, dust, vibration from blasting, visual intrusion and increased road traffic are amongst the most obvious. However, within the space of a very few years all the mining activity will have ceased and the area will have an established grass sward and the more permanent features of the re-formed landscape will be established.

Coalfield Farm Restored Site, near Ibstock, Leicestershire. Protected wafer course, new hedge, hedgerow frees, new fences.

With large volume extractive sites such as sand, gravel and hard rock quarries, restoration is frequently at a lower level, unless, it has been filled with domestic or industrial waste to raise the surface to fit the surrounding landscape. The filling of a large void with waste material is often slow, unsightly and frequently produces secondary problems, such as wind dispersed litter, heating, methane generation, and uneven settlement. In the case of opencast coal, even after the removalof the coal where ratios of 4:1 to 40:1 may be worked the land is returned to approximately the original levels.

The OE takes considerable care over restoration; standards have improved considerably during the last decade. These improvements have come about at the instigation and expense of the OE and will be discussed briefly under the headings: Organisation and Methods; Soil Survey; Underdrainage; Improved Techniques and Tackle: After Use (Agriculture, Forestry, Recreation, Industry). These efforts are aided by innovation and backed by a Research and Development Programme.

Organisation and Methods

After the last coal has been removed and the void filled, the final grading and levelling is carefully supervised to ensure that when the sub-soil and top soil are replaced, the new contours will blend into the surrounding landscape.

On most sites the new contours will differ very little from the original owing to the bulking of the disturbed and replaced overburden. Before the subsoil is replaced the surface of the overburden is ripped to a minimum of 300mm using a winged ripper to break up surface compaction caused during spreading and grading to the required contours. Any large stones are removed before the first layer of sub-soil is laid. The previously stored subsoil is now spread using motor scrapers, in two separate layers of about 300mm in thickness. Each layer is rooted to loosen compacted horizons, enabling stones above a specified limit to be removed mechanically or by hand. Following the satisfactory laying of the sub-soil, the top soil is then spread by motor scraper, this too is cultivated to remove the compacted interface between the top and sub-soil layers, and any stones above the specified limit are removed.

To ensure that a high standard is maintained the work is carried out in stages, each stage is inspected and approved by officers of the Ministry of Agriculture Fisheries and Food (MAFF), before work is allowed to continue. When the final area of top soil has been spread and accepted the contractual work by the mining contractor is complete. The site is now ready to start the five year restoration programme.

During the restoration period many of the features associated with an undisturbed landscape are replaced, these include, the reinstatement of rivers or streams with appropriate erosion control measures along their original or re-aligned course, hedges particularly along ownership or major internal boundaries, fences as divisions of individual ownerships, farm access roads, trees and woodland. On occasion a new farm may be designed and built to replace one removed during the mining process.

Land rehabilitation includes the sowing of appropriate seed mixtures and the application of manurial treatments, the installation

of comprehensive underdrainage, water supply to the fields and the control of grazing by a licencing system. Officers of MAFF or their Welsh or Scottish counterparts, acting as agents to the OE undertake the supervision with specialist contractors carrying out the work.

Soil Surveys

Full Soil Surveys of proposed sites were initiated in 1979. The information gained from the survey includes physical, chemical and biological properties which may influence methods of handling. Additional information includes in-situ volumes of soil horizons, of the various mapped soil types. The indication of any volume shortfall and the identification of material below the recognised soil profile which can be used to supplement the sub-soil at the time of re-spreading. The chemical and biological information will indicate the levels of any ameliorative treatments that may need to be applied prior to stripping and storage, or at the time of re-laying.

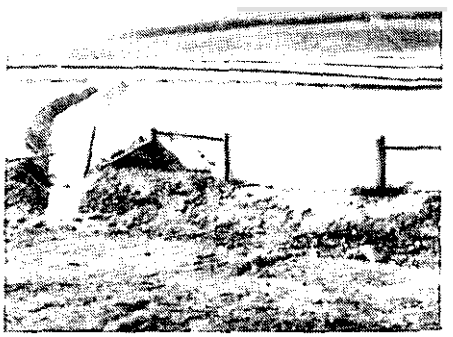
Accepting the constraints of ownership, with some occupiers occasionally wanting the top soil stripped from their land stored separately, and replaced after mining, the better soils particularly the subsoils may be amalgamated and re-spread on the more advantageous aspects, leaving the poorer soils for permanent pasture or woodland areas.

On most sites approximately 250mm of top soil is stripped and stored in mounds on the perimeter of the site. Where available at least 600mm of subsoil is saved, this is frequently supplemented by material from lower in the soil profile, or from greater depth in the geological column. The objective being wherever possible that a minimum 900mm thick soil profile can be formed at the time of re-spreading.

Drainage

The exposed coalfields of Great Britain receive between 600 and 900mm rainfall per annum, with parts of South Wales and Ayrshire receiving between 1200 and 1800mm.

The underdrainage of restored sites has been part of the restoration programme since the early days. The specification then, as now following regional preferences. In general, lateral drains are laid at 600mm depth at a spacing of 12 to 20 metres, today, all with permeable fill to within 200mm of the surface. In the past the underdrainage systems were installed in the 4th or 5th year of the restoration period or occasionally even later. This clearly had an adverse effect on the promotion of soil development and root penetration. In the early 1980's moves were made with the co-operation of MAFF to bring forward the installation of the underdrainage and water supply into the first or more usually the second year of restoration. Also at this time the first contracts were let for comprehensive underdrainage in the South Wales Coalfield. With drainage schemes going in at an earlier date there is every prospect that the artificially re-formed soil profiles will benefit from improved water movement allowing deeper rooting of the grass leys established at the start of the restoration process. To facilitate the movement of water to the lateral drains. whatever the intensity. a moling or sub-soiling treatment is carried out across the lateral drains.



Ffyndaff Site, South Wales. Progressive restoration, new field *boundaries,* hedger *to be planted* on banks. The steeper slopes *are to be planted with* trees up to the forest boundary.

Improved Techniques and Implements

With the expanding mining programme and the consequent increase in the area under restoration it was apparent by the late 1970's that some of the techniques and implements used in both contractual and agricultural restoration were inadequate. Much of the tackle employed at this time was designed for civil engineering, not for "agricultural" type tasks with a corresponding lack of effectiveness in meeting the specification. ▶

In association with a number of manufacturers the OE has set out to develop and build a set of implements capable of performing the restoration tasks to meet current and then future specifications.

The implements developed to date includesets of:

- tool carrier/heavy duty ripper fitted with winged tines;
- tool carrier/multi tine cultivator/rib roller;
- disc cultivator;
- levelling sledge.

More recent one-off implements include: Secondary Tool Beam to fit to the Aveling Barford Motor Grader for lighter cultivation work; Stone windrower designed to move and windrow stone between 150mm and 750mm diameter from within the upper 300mm of overburden or subsoil; Mole Drainer, a larger version of the standard agricultural model, capable of working in difficult ground conditions; Seven tine ripper/subsoiler with an adaption for injecting sewage slurry below the soil surfacc

After Use

Since the mining technique only involves a temporary occupation of the land there is not a sustained loss of agricultural land to the nation. The techniques and safeguards covering restoration to agricultural use have been briefly described. Other after uses include forestry and woodlands. In Wales and Scotland much of the land taken for mining is in poor quality agricultural occupation. Following restoration many of the steeper slopes and poorer quality soils are returned to forestry use. Here the Forestry Commission acting as agents to the OE undertake the ground preparation, planting and initial maintenance. The lower slopes with gentler gradients are returned to grazing use.

Where sites are to be worked close to highly populated areas particularly in the East Midlands and Yorkshire the County and Local Authorities have taken the opportunity, in association with the OE and Water Authorities, to creaste recreational areas. Relatively small areas are scheduled for industrial purposes.

Current research work funded by the OE confirms that restoration standards have advanced and that the farming community can enter into rotation cereal production within a few years following the cessation of mining.

Reclaiming mined land for Forestry

by David Fourt, now operating as a consultant after 35 years with the Research Division of the Forestry Commission

The natural vegetation cover of Britain is forest, and most mine spoils become colonised by scrub. and develop into woodland. Reclamation accelerates the process, removing site and root-zone constraints, using mechanical and sylvicultural techniques based on the needs of growing plants.

Land use

The deeper soil structures under woodlands or agriculture are lost when disturbed by mining, and although loosening by heavy machinery is a basic reclamation operation their replacement requires the drying effect of vegetation – especially of trees.

Low-grade farm land may fail to respond to reclamation, or other inputs and then revert to forestry. Woodland often survives because of constraints like poor drainage, stone or texture, but mining can modify or remove these, improving conditions for subsequent tree growth. Minerals are also worked from beneath heathland, or moorland, and new soils can be formed from richer mineral substrates in the overburden while discarding gleyed subsoils, and retaining organic layers for their nitrogen store. Other land uses after mining include waterparks, and golf courses, each with tree planting as part of a leisure complex. Many mine voids, instead of low level reinstatement, accommodate vast amounts of domestic and industrial waste. Some then return to agriculture or amenity tree-planting but inadequate cover, gas or liquid effluent and heating problems interfere, and a more basic approach is needed before such sites can be considered suitable for woodlands.

Political

The Town and Country Planning (Minerals) Act 1981 defines the restoration conditions for mining permissions, including those to forestry. The Forestry Commission advises on the suitability of mined land for tree planting and the specification required for success, with the Grant Aid available.

Broadleaf trees. including alders, attract more aid than commercial conifers. Forestry plantings are considered a "beneficial land use" and, subject to some constraint as to species, planning authorities support technical improvements and innovation in reclamation.

A five-year after-care period is specified, during which the mineral operator is responsible for site conditions.

Mechanical operations

It has been observed that trees often grow well on ungraded spoils, such as dragline "hill and dale": because they are loose and not compacted by machine passes.

But the aesthetic attraction of dozer-grading of unsightly spoil heaps for visual amenity has resulted in serious root zone problems. Repeated vehicle passes during grading or subsoil replacement result in laminated and compacted material low in the coarse pores needed for roots, drainage, and gas exchange. Such surfaces are difficult to plant successfully, especially where heavy textured and with inadequate slopes.

To improve water movement we recommend the formation of 30m x 1.5m high ridges, to give 5° slopes, and these are then loosened using winged ripper tines mounted on a heavy tractor. These are drawn across the ridge, to 75cm depth, mechanically forming coarse pores.

Over porous strata, vertical percolation can be improved by furrow ripping, but where impervious, ditches are formed with a side-acting bucket on a tracked excavator. Elevation of the planting position is achieved with RCM discs, an operation which assists early growth on heavy spoils.

To avoid compaction due to grading machinery, subsoil-topsoil mixtures can be loose-tipped over draining or sloping surfaces using dump trucks. The overlapping heaps, in 30-40m units, spaced 2m apart, are aligned downslope. Trials on coal spoils, brick-clay, wastes and stoney overburden give cause for optimism, weathering soon reducing hummock size.

Run-off from unvegetated surfaces can be damaging unless drains and culverts are adequate. Contour ditches, or berms in the uplands, spaced at 30-40m, can restrict the velocity and erosive power of water, conveying it to suitably armoured watercourses. Large flows have been contained in coarse-rock filled gulleys up to 20m across in the Canadian Rockies. This method could be

V13 -1

used in our wet uplands to convey run-off downslope with a reduced risk of erosion.

Tree species

Effective colonisation of mine spoils requires pioneer species, and the most successful are the Alders, which can fix atmospheric nitrogen, a valuable asset. There are four tree species, and two shrubs hardy in our climate and suitable for a range of habitats. All have nodules containing the Ascomycete *Frankia.* One tree legume, *Robinia,* uses *Rhizobium* for fixation and can be useful, but is not without problems. Other pioneers include ash, sycamore, maples, birch, cherry, white and grey poplars, with the coniferous pines, especially Corsican, and larches. Species such as beech. oak, hornbeam or chestnut are less suitable for pioneer plantings, and should await the development of woodland conditions. All except Corsican pine are vulnerable to wildlife and need protection by fencing. For sandy sites, Corsican pine with common or red alder are suggested, with larch and other broadleaves on more retentive loams.

A high plant stocking ($2500 +/ha = 2m^2$) ensures early canopy closure, reducing nutrient losses, and increasing root action leading to improved structure.

Nutrition

Over a relatively wide range, nutrient supply has little effect on the newly planted tree, as first year survival depends more on moisture supply. Soluble fertilisers can accentuate drought effects by raising osmotic potentials.

Compared to grasses, spaced tree-plantings have modest nutrient requirements provided the mineral spoil stores adequate moisture within root range, with the mineral nutrients P, K, Ca and Mg.

Only heath or moorland topsoils need mineral amendment, usually of phosphorus. Until the second year, nitrogen in conserved topsoil will he sufficient, provided a 1m diameter weed-free zone is maintained round each tree.

Mineral nutrient assessment by soil analysis can be helpful, but analysis of foliage taken from the 3rd season is preferable for identification of nutrient elements in deficiency.

Incorporation of N-fixing Alders in the planting mixture may show benefits from the 5th year, nitrogen being transferred through decay and release from leaf litter. Alder systems are easier to manage than legume covers, though some competition control may be needed.

Forest trials have shown that inter-row line sowings of unpalatable legumes, such as *Lupinus, Lathyrus, Astragalus* and *Galega* are useful and effective, and less subject to wildlife defoliation than forage species. They can pose problems of spread by seeding, or conversely a good cover may be elusive. *Trifolium* species should be avoided, being competitive, and palatable. On replaced upland peats, deficiencies of potassium and phosphorus are to be expected, though

Loose-tipped glacial drift **and overburden mixtures were left** *ungraded at this* **South Wales** *coal opencast.* **The low hummocks** *are* **less obtrusive** *than hill-and-dale, and* **can rrap and** *retain leaf litter, reduce* **erosion, and nor constrain forest** *operations.* **The** *20* **year old Larch crop is well-grown** *and ready for first* **thinning.**

release of nitrogen often follows disturbance and mixing of peat with spoil.

Because many mine spoils are calcereous, lime-induced chlorosis may develop after canopy closure with some tree species. Ash, sycamore, maples, birch and cypresses are little affected, Corsican pine, larch and beech are intermediate, with oak, chestnut, Scots and Lodgepole pines often severely damaged.

Organic wastes can be effective and cheap sources of nitrogen and phosphorus on poor sites, but their application should await the

Left: During the *summer reclamation* "window': the sire has been *ridge-landformed* to *improve* drainage, and allow deep *cultivation* by multi-shank winged tine cross-ripping to *75cm,* and then *disced* to elevate the *planting* position. Following excavation of a shallow *furrow* drain, a low-maintenance *grass mixture* will *be sown to control erosion.* The tree crop of *Larch will* be *planted* in *the* following Spring.

Right: *Well-grown 11* year-old Italian *alder,* with Corsican pine *surrounds,* planted on spaced *deep-tine ploughed* restored gravel *workings* in NE Hampshire This method of ground *preparation, though* effective, *has* now been superceded by ridge *landforming* and *loose-tipping.*

development of root-spread by the young trees, to allow uptake, usually in the 4th or later years. Their use on younger trees is wasteful, and may sharpen weed competition For moisture at a vulnerable growth stage.

Problems remaining

- Improved topsoil storage should conserve nutrients, hut not weed-seeds. A biological method is required for replacement of organic N after the replacement "flush': Organic matter incorporation by faunal action, with wetting and drying by special N fixing plant covers, needs package development. At present, structural re-development is slow, and repacking with deterioration in porosity is common on silt-rich media.
- Refinement and practice are needed in biological nitrogen fixation systems. Alders are much more manageable than legume-based covers, which need care with seeding and competition control.
- Removal of organic matter and fine particles by sheet erosion can he severe. Gully erosion is common where stream-bed gradients increase. Losses are continuous, insidious and usually preventable and need s range of techniques including seeding, mineral berms and rock-drains.
- Raw spoils such as coarse sands, chalk and limestone waste, and raw clays, need studies in vegetational establishment.
- Landfill re-vegetation problems include root-zone limitations in the cover as well as gases, subsidence, heating and leachates from biological decomposition. The effects of cover types, slopes, venting and waste pre-treatments all need evaluation and experiment.

Summary

- Disturbed soils can regain structure and productive land use under woodland, but more than 5 years may he needed to resolve growthproblems.
- Good tree establishment requires that physical conditions. such as the orovision of a deep well-drained, weed-free rioting zone, is given a higher priority than nutrient amendment.
- For satisfactory growth on poor spoils, biological fixation of nitrogen by Alders or Legumes can give improvements. From year 2 fertiliser nitrogen can be placed close to the tree, and front year 4 organic wastes can be spread widely, but weed control is essential. Mineral elements are in adequate supply on most spoils except former heath or moor. Foliage assay from year 3 is to be preferred to soil analysis to identify nutrient limitations.
- Pioneer species can be succeeded by oak and others when woodland conditions are re-established. Alders arevaluable components in mixtures for poor soils.
- Differences in spoil, climate, hydrology, land use, erosion, and drainage imply site-specific requirements, though machine options, phasing, with check lists, and "decision trees" can be helpful in deciding priorities.

Further reading

A Guide *to Reclamation* of Mineral *Workings for* Forestry by K Wilson, Forestry Commission 1985, R & D Paper 141.

V13 -1

Farmland Restoration
The Greenham Solution

After the well attended field meeting in May last year, we have been promising readers a fuller report on the techniques developed at Greenham Sand and Ballast Co. Barry Bransden, Manager of Greenham's Restoration Department, who hosted the SaWMA meeting, has since also given a talk on the subject at the Stratford Drainage Workshop. So now we have two events to write up.

Geoff Baldwin has made a special visit to Greenham's pit at Shepperton and heard and seen for himself the details of what is being done there and elsewhere in the Company's land.

Putting it very simply, Barry explained that the aim of the Greenham company is to recreate prime farmland within a minimum period of as little as three months. Speed of restoration is important to mineral extraction companies such as Greenham, not least so that they give minimum disturbance and offence in what are often residential or recreational areas.

Special Restoration Department

To achieve this objective of minimum disturbance, the Company decided firstly to set up a special Restoration Department and then to make the Manager of that department responsible for planning and controlling the whole cycle of events from opening up the site to its satisfactory restoration.

Barry Bransden was appointed Restoration Manager, and using his own experience as farmer and contractor, and working with the experience and records built up in the Company, he realised that the earlier traditional techniques of restoration had not only been very time consuming but had also left problems of soil compaction and poor drainage – with the result that restored land finished far short of the capabilities for production that it had before the gravel was extracted.

After close study by the Company a detailed new technique was planned and a trial site was established. The principles worked and there is no doubt that their ability to demonstrate the speed and effectiveness of their techniques helped the Company to gain planning consent in 1978 on a further 90 acres at the Littleton Lane pit at Shepperton.

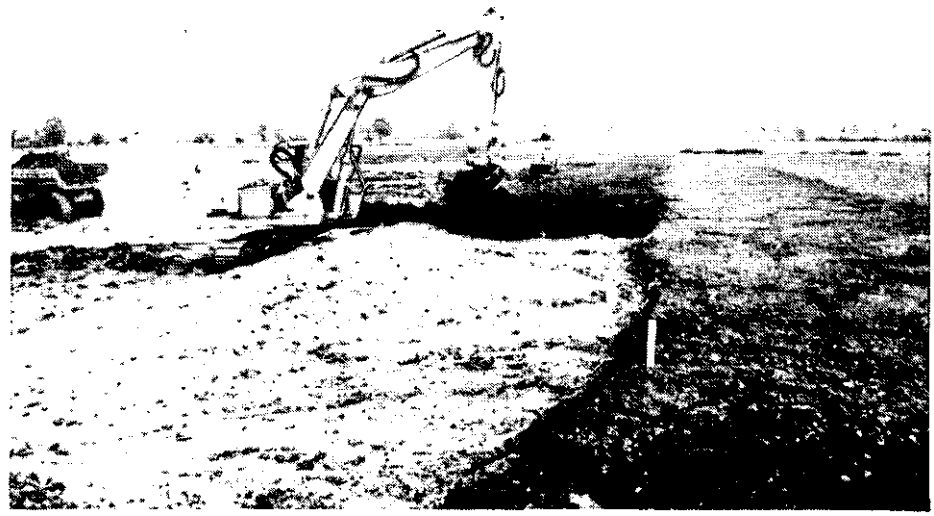
Planning for restoration

The process of planning for restoration in the "Greenham solution" as they call it, begins before any material, even top soil, is moved. The acreage chosen for clearance each year must be sufficient to yield an underlay of gravel equal to the planned working capacity of the plant.

In the first year of working, top soil and subsoil had to be moved to a storage area hut in each subsequent year the system is that top soil and subsoil are only moved once – removed from the newly worked area and transferred to the previous year's working over the fill.

The planning for restoration starts with the concept that there will be a need to drain the restored land. All design has to start from the outfall level available to the site – whether this be ditch, soakaway or river. Recognising that the replacement material (the fill) will undoubtedly be less permeable than the gravel it replaces, means that drainage must certainly be necessary.

Another important point is that the fill must be graded as carefully as the eventual top soil. Failure to prepare properly in this way would result in an uneven depth of workable soil and quite probably a loss of potential fertility.



Picking up top soil and placing on top of previously placed subsoil

No machines on the restored land

But obviously of critical importance in the restoration scheme is the decision on how, and with what techniques, the actual soil itself will be moved. Barry takes reasonable pride in explaining the Greenham solution.

On the premise that soil, once damaged, is difficult, if not impossible to remedy, the technique to be adopted had to be one that would at no stage cause irreversible damage to the soil. This is achieved by using a combination of hydraulic excavators and dump trucks to handle the soil. Soil movements are managed so that all vehicles keep to the exposed gravel surface, or to the infilled surface awaiting restoration.

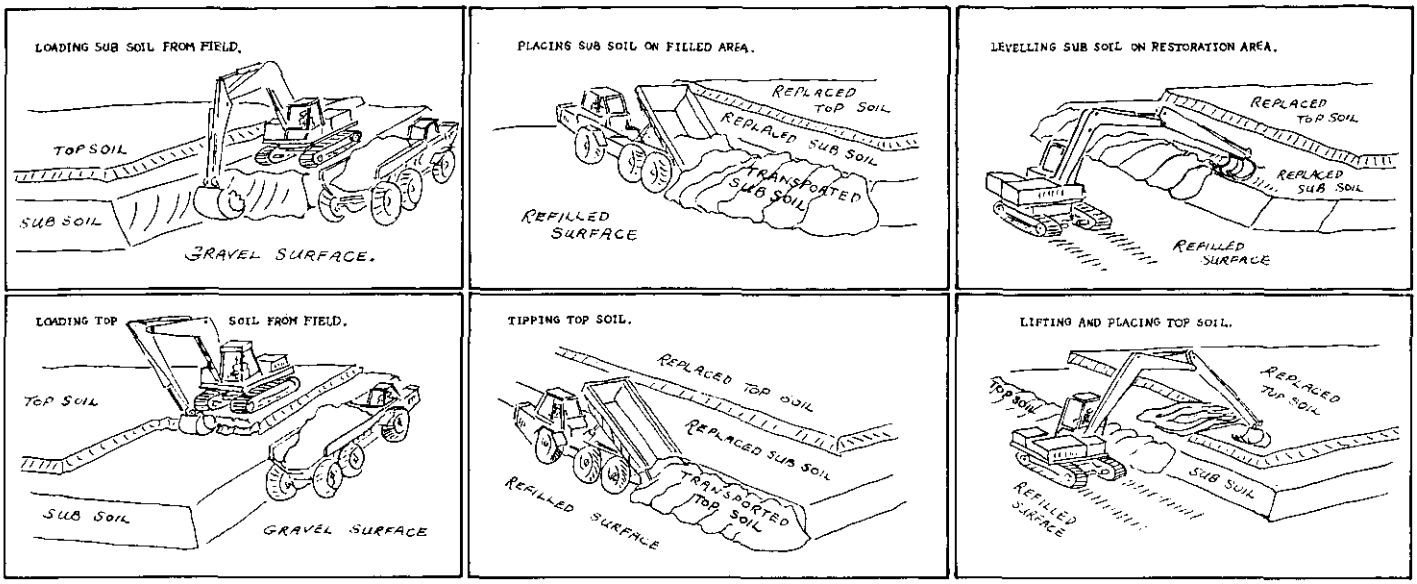
To recreate thecorrect subsoil and top soil layers a hydraulic excavator lifts the top soil on to the subsoil layer that it has previously levelled.

Great care was exercised to monitor the soil condition and checks have been made daily on soil moisture content and plastic limit to establish that wen moving soils with high moisture content will not cause harm by this method. Again, Barry stressed the principle that no machine goes on to the newly restored land. Soils are left in a loose condition with the top soil accurately placed to the correct depth over the subsoil.

As a help in explaining the Greenham technique, Mr Keith Johnson, Director in charge of restoration, has prepared a series of sketches outlining the broad sequence of events. We have only spacee to show a selection of these – concentrating on the earth moving work after the important planning of levels and marking out of the site has already been carried out. (See next page)

Drainage installed before soil replaced

A further feature of the Greenham solution is that the drainage system is installed on top of the fill – before any subsoil or top soil is replaced. Experience has shown that if drainage is not provided at this stage, then during the next Winter the soils will completely fill with water and prove very unstable for any cropping. As the soils are placed on a re-designed slope and because they are plac-



The Greenham Solution – sketches by Keith Johnson

ed strip by strip it is very easy to put in drainage as the soil movement progresses. To allow for slight imperfection of grade, a bigger diameter of pipe is used than is technically needed and a relatively close spacing (12 metres) is also chosen.

The finished result is a soil on the correct slope of grade, with the designed depth of subsoil precisely covered by the available topsoil and the drainage system installed right from the day of placing.

There are no further major works to be carried out once any complete strip is finished.

Quality checks and surveys

However, the responsibilities of the Restoration Department do not stop there. Checks continue to be made on the quality of the restored land and the validity of the techniques used.

For example, there is regular recording of perched water tables in the soils by the use of dip wells and the monitoring of hydraulic conductivity. Such measurements have helped to show that the 12 metre drain spacing is correct for this site. Results from a continuing control plot show that the perched water table was maintained at more than 0.8m below soil surface during any experienced amounts of rain or snowfall.

Soil density measurements show that the restored land has no greater density than had the undisturbed soil – and, indeed, initially the density was much lower that with the undisturbed ground.

As to the quality of the restored land and its suitability for agriculture, Barry Bransden has reservations as to how far the yield of a particular crop can he an indication. He cites the ability to grow pot plants in an inert material – that does not represent land restoration. In his view crop yields are very much a function of management combined with weather conditions – and they can only be used as an indication. He is probably being over cautious because by all accounts crops grown on this Greenham restored land have heen the equal or better of those on neighbouring undisturbed land.

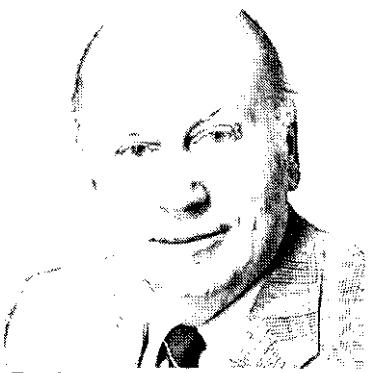
For a more convincing assessment of quality, Barry quotes the results of a survey carried out jointly in 1983 between the Ministry of Agriculture (MAFF) and Greenham's own consultants (Land Capability Consultants). This survey showed that the land replaced between 1979 and 1982 had achieved an interim grade '2'. The general grading on the land prior to digging is grade '2' with some areas grade '3A' due to either wetness or shallow soils. This general assessment has been confirmed by a further survey carried out this year by Reading Agricultural Consultants.

Minimising pollution and nuisance

One other aspect of the Greenham work also deserves a mention in these days of trying to control and eliminate pollution. Great care has heen taken to minimise the effects of the gravel working on nearby residential areas. The site has been screened by earth banks and by tree planting and noise levels have been reduced by the use of acoustic screening and rubber lining of chutes. Mechanical wheel cleaners have heen installed to prevent mud being carried on to the public highway and, in dry weather, a sprinkler vehicle operates over the internal roads to prevent dust.

Summer cabbage in August 1984 on land restored 1983 (foreground); 1982 (middle distance) and 1981 (farground). Variety: Princess (TOZER) yielded 2750 x 12 ha

SaWMA Council Member elected President of AEA



Frank Moore

President of the Agricultural Engineers Association for 1985/86 is Mr F P D Moore. Agricultural Advisor to Howard Rotavator Co Ltd.

This will mean another busy year for Frank who, besides his business career, also manages to make time for active participation in SaWMA and indeed also in several other prominent associations.

Frank joined SaWMA in 1979 and his wide experience, particularly of the manufacturing and commercial side of our members' interests, soon brought him election to the SaWMA Council, the Technical Committee and the Management Committee. He can justly be described as an all-round working memher of our Association.

In his business career, as a Director of Howard Rotavator Co, Frank has been specially involved ii developing e rt business. In 1977 he was awarded the Queen's Jubilee Medal for Service to the Industry and in that year led the first AEA Mission to China.

Additionally, Frank is a memher of the FAO Panel of Experts on Agricultural Mechanisation, a Governor of Writtle Agricultural College and a memher of Court for Cranfield Institute of Technology.

Frank lives at Thornton Magna, near Eye, Suffolk.

V13 -1

International Drainage in the South East

Mike **Darbishire** reviews the Farmers Weekly International Drainage Event – 1985

FOR the first time in recent years, the event was staged in the heartlands of East Sussex. The location at Veals Farm, **Laughton** comprised of 40 ha of grassland – long term leys and permanent pasture – on mainly day soils. Peter **Herbert,** the owner, recently purchased the properly, and is seeking to improve output and the versatility of the enterprise by implementing a comprehensive drainage scheme

The Site

The site provided for ingenuity to resolve the problems in design for men and machines due to the undulating nature of the terrain., The low permeability through the five series of weald clay soils, identified by members of the Soil Survey, demanded different treatments. Monoliths of the soil types were displayed by ADAS/LAWS. They included:

- Denchworth – stoneless clay
- Dale – similar with more silt
- Lawford – slightly stony
- Wickham – silty clay loam over clay
- Curtisden – silt through-out

The specification for the scheme called for 20m spacing of drains with permeable fill to within 380mm of the surface. Moling was conducted at 2.0m spacing to a depth of 500mm. Care was necessary in the moling and sub-soiling area, which was for the first time over existing drains. Today there is greater emphasis on secondary treatments, and the use of stone back-fill in this area has meant a change from the traditional. Until five years ago, straw was the only material used over drains in the South East.

Conservation

Conservation was not overlooked in the scheme design. Plans for an additional pond to augment the two existing ponds will form a conservation area. Steps were taken to reduce the risk of pollution from leached fertiliser and the preservation of a 500 year old hedge is assured by routing a 'main' to a single outfall.

By Hand

In sharp contrast to the extensive range of machinery – provided by some 80 exhibitors – was the valiant and crowd drawing "lone Yorkshire Ministry officer" who was digging his own trench and laying a perfect drain by hand. He used the traditional tools of the past with great expertise. Several onlookers benefited by even learning the art of using a spade!! The lesson was the economy of draining a 'wet-spot'. "It is the most cost effective over, say, a distance of a couple of chain or so" was our intrepid officer's comment.

Machinery

The manufacturers put on a creditable display of static and working machinery, materials and ancillary equipment. Both Mastenbroek and Inter-drain were working with their large 'V' plough equipment for which we understand there is an increasing demand both at home and overseas. They are particularly suited to grassland drainage, leaving little surface disturbance. Clay and plastic tiles were being laid using both trenchless and trenching machines. Bruff and Dynapac Hoes demonstrated a range of machines at their allocated sites. As usual they drew a reasonable crowd of spectators throughout the day. All the main units were supported by a wide range of self-propelled and tractor pulled gravel trailers, pipe-handling equipment, back-fillers, and most were Laserplane controlled for depth.

Multi-purpose Minis

In response to criticism last year, there was an increased range of small trenchers designed for small drainage works, sports fields, and with the versatility of laying 35mm pipe, cables, water supply, and irrigation mains. The comprehensive range included the AF Trenchers, Bourgein Oxford 'Task Force 700', Shelton rotating wheel trencher (now with acapacity for 2"–6" width trenches), a Bruff mini drainer and the new Mastenbroek 7/12 for orchards, vineyards and sports fields.

Ditchers

Pride of the event was the new JCB 13.7 tonne 360 degree excavator and their new 3CX site master which each gave very effective performances to show their outstanding capabilities. In additon, there were a variety of ditchers, from the West Mac rotary to thk eye-catching new McConnell Ditch Boss back-hoe powered by a new small Kubota tractor (L 4150) of 45 hp and hydraulic shuttle transmission. The self contained unit is trailer mounted and can be moved to site by the same tractor.

Static Displays – Services

On the static site were to be found the various ancilliary manufacturers and representatives of associated organisations. Tented displays included those of SaWMA, NAAC, LDCA, CLA, NFU and MAFF/ADAS. The latter, complete with computer link and background information on Veals Farm, concentrated on Drainage After Care and Conservation on their well presented display.

Ancilliary Equipment and Materials

Computers were much in evidence and for rapid drainage design the Pipe Plan System presented keen interest. Using a Sharp PC 1251 pocket computer planning time is reduced (cost £295.00). Various underground detecting devices merit mention, with emphasis on the British 'Tracka Systems' from Woodbridge, who have now initiated a new marketing arm.

'Practising what *he* preaches' – Cordon Spoor in *the pit* ar the *F.W. Drainage* Evenr

Amongst their range of GRC (glass reinforced cement) drainage units, BCM were featuring the new 1m diameter inspection chamber designed to suit MAFF safety standards requiring adequate space in emergency for another man alongside.

Filters included the coco-wrap and increasing evidence that Big 'O' filter wrap for both clay and plastic tile is gaining acceptance. New to the scene was BTR Hitek, who use a dimpled, rot-proof synthetic polymer with a high crush strength and light weight factor. This application was demonstrated with the Shelton slit trencher.

Stressing the importance of 'After-Care' was the range of jetting equipment now available These were to be seen mainly on the static site.

One of the most innovative of techniques shown was the development by Aqua Pipes to use the close-space drainage system for reverse flow irrigation, which attracted much interest.

Attendance

The weather, fine and dry, enabled the 3,000 visitors to discuss and assess equipment and techniques. Though the gate was down on previous years, it was reported that some 25 countries were represented, the largest contingents coming from France, Germany, Holland and Canada. Some 40-60 arrived from each of these countries.

e t trends in tillage equipment

The Agricultural Engineer's view – by David Patterson, Field Machinery Divison, N.I.A.E.

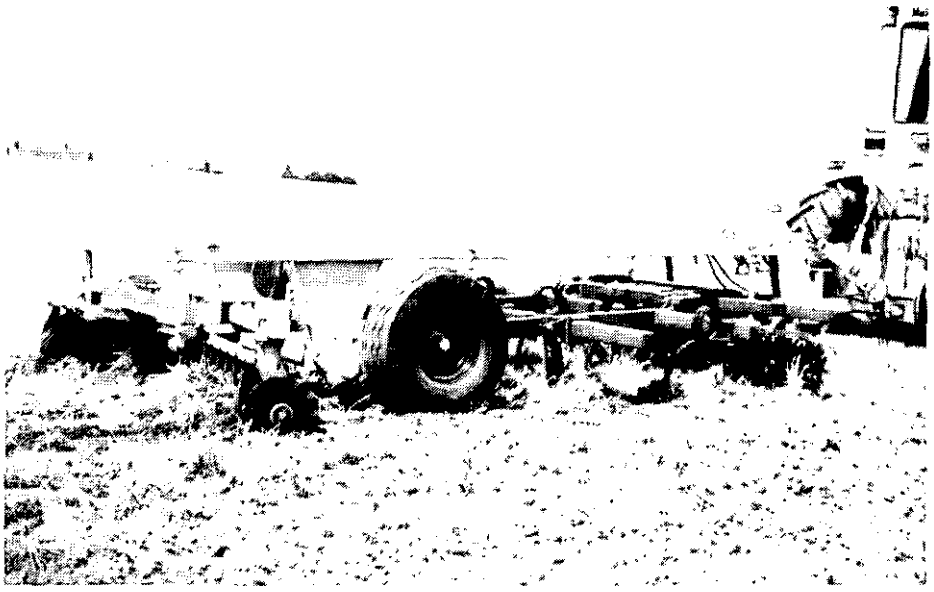
ACCORDING to a recent survey comparing last year with 1983, the proportion of the total cereal area burned declined only marginally from 37.7% to 37%. There was however an increase in the amount of straw incorporated from 58,600 ha to 243,000 ha (represents 7.1% of the total cereal area) and this was largely as a result of a decrease of 4.6% in the proportion of straw baled and removed.

These statistics indicate the importance that farmers attach to the option of straw burning in order to adopt high speed shallow cultivations for maintaining the present large areas of land in the high yielding winter cereal crop. However, because of possible increasing restrictions on straw burning, farmers are experimenting with straw incorporation techniques, which brings a requirement for deeper cultivation. Hence, there is a wide array of different types of tillage equipment being used on farms today and the types used depend not only on whether burning or incorporating straw, but also on cropping, soil type and climate.

Straw spreading and chopping

The combine-mounted straw spreader is the common method of providing a suitable and efficient way of obtaining an effective burn. But use of thecombine-mounted straw chopper is increasing because it is essential for straw incorooration and when burning, the shorter length of straw tends to reduce the intensity of the burn and hence the degree of pollution. The length of straw and stubble required for successful incorporation depends on the following cultivation. When ploughing, experience is indicating that a coarse chop length and high cutter bar height on the combine are adequate, but when adopting non-inversion techniques the converse is true. Some manufacturers havegiven consideration to fitting a second cutterbar behind the header to cut the stubble and so ease mixing of straw into the soil when using non-plough techniques; it seems that the success of this technisue will depend on the reliability of the equipment.

The tractor-mounted straw chopper has become popular as designs are being modified to chop the stubble as well as the straw and so assist in successful straw incorporation. New types of mechanism, such as the use of turbines and blades, to achieve very fine chop lengths, are becoming available. Some farmers are adapting existing forage harvesters for operation in straw and results are indicating that the very fine chop length obtained is easing their straw incorporation problems.



Econ/Tasker Mulch Train incorpomfingsfubble and chopped *straw*

Tillage after burning

Following burning, the use of high speed equipment at shallow depths is popular, the main types being heavy duty flexible tine cultivators, disc harrows, soil-driven rotors of various types and combination equipment consisting of various types of tine and disc. The heavy duty flexible tine, with its ability to provide fairly effective soil shatter, is slowly replacing the fixed tine chisel plough, and the heavy disc harrow is widely used on burnt stubbles. The techniques of shallow surface cultivation followed by drilling have proved more effective than using a special direct drill, which has decreased in importance.

However, over the years, consistent use of shallow cultivations and direct drilling have led to an inability to control grass weeds and to a build-up of shallow levels of compaction at depths between 100 and 250mm. This situation has largely contributed to the recent revival of the plough to control weeds and to prevent build-up of surface ash and trash which absorbs soil acting herbicides, and also to thedevelopment of a whole range of top-soiling (shallow sub-soiling) equipment that will loosen the soil without bringing clods to the soil surface. Coupled with the wider use of the plough has been the reintroduction of furrow presses of various forms to improve the tilth and consolidate the furrow slice. Another innovation on ploughs is the provision of means of varying furrow width. which enables optimum operation under a range of different soil conditions. A number of manufacturers have followed the continental trend of introducing the slatted-mouldboard which is most effective on the poorly scouring soils.

Straw incorporation

With the need for incorporating straw into the soil, a number of novel designs of equipment are now being sold. It is most convenient to review these by considering the main methods for incorporating straw, by inversion, mixing, placement of straw and one pass systems.

Various modifications have been made to the plough to improve its performance in straw residue, the main ones being the use of a concave disc (in place of the straight vertical disc) or adjustable trash boards to distribute straw more evenly down the furrow slice However, experience is indicating that one of the most effective ways of burying the straw completely is to use the traditional skim. Many of these attachments, including the furrow press, do reduce total output.

The high energy requirements of the traditional plough causes farmers to constantly seek for ways of overcoming this and there is a trend towards shallower depth ploughing. Another alternative is the continental shallow plough which is suitable in many conditions, particularly as they can now be fitted with trash boards as a standard option. For operation under hard conditions.

Combined cultivation and drilling using a Bridge Link

which is frequently a limitation of these implements, some designs can be fitted with an underbnster tine. which not only assists penetration but also breaks up the furrow bottom.

A vast range of equipment is now available to provide varying degrees of mix of straw with soil. **A** number of imported cultivators, having tines fitted with curved and twisted wide shares have become popular as they move large quantities of soil sideways to increase the amount of straw burial. During subsequent passes, further mixing occurs from a re-ridging action, but under heavy land conditions clods can be a problem.

The recent development of the serrated disc (chisel disc) is effective for achieving penetration and has less smear than plain discs, but it does not incorporate straw as well as plain ones. Disc harrows for operation on cereal stubbles are becoming larger and heavier with weight per disc being in the region of 150 kg/disc for effective penetration.

A number of manufacturers have introduced combination implements where a whole series of different types of soil working mechanism are used. These trains of implement include the use of discs and heavy duty tines, twisted shares, mixing blades and a crumbler bar, or heavy duty tines in conjunction with a powered rotor. Where high power tractors are not available, there is a new development, described as a "Power Frame'; which enables tines and a rotary cultivator to be operated in tandem behind a medium size tractor; an engine above the tines powers the rotary cultivator.

Recently there has been renewed interest in the slow running spading machine as an effective way of incorporating straw. **A** number of imported machines are being sold in the UK but the major disadvantage is their very slow forward speed.

Another method of disposing of straw is placing it in a strip beneath the soil surface. A recent development consists of a straw chopper and sub-soiling tines to collect, chop and bury stubble and straw to a depth up to 300mm. Although the straw tends to be placed in one region at depth, preliminary results from experiments show that straw degradation is satisfactory. The poor leg design, which results in an uneven soil surface, has been replaced by narrower legs which cause minimal surface disturbance.

In certain situations the true one pass system may have relevance on the lighter and medium soil types and following a late-harvested crop. A continental machine consisting of a rotary cultivator and air drill with a unique placement of seed beneath the straw residue layer has undergone trials in the UK. This system may not be suitable for continuous cereal growing on heavy land, where it is not possible to take advantage of natural weathering.

Secondary cultivation

There has been a trend by British manufacturers to adopt the Continental practice of designing seed bed cnltivators'that combine more than one type of cultivator element. The combination of tines (either sprung, spring-type or rigid) with discs, a crumbler roller and perhaps a scrubber or levelling bar is aimed at producing a better seed bed with fewer passes than if several different implements were used. Another version is the use of ground-driven crumbler rollers interspersed between two rows of chisel type tines, which are very effective on the lighter and medium soil types.

Improvements in powered rotary cultivators both vertical and horizontal axis machines, have been in stronger construction, new tine designs and additional means of providing a finer tilth by using combs or clod crushing boards behind the rotor. Compared with draught implements, outputs are low and energy requirements high but under difficult cloddy conditions they produce a fine, level tilth in one operation.

Combining powered cultivation equipment with drills has become popular whilst bridge links, which allow different secondary cultivation implements to be attached to a drill, provide steady sales.

Implement rotation

With the more extensive use of wider ploughs and larger horse power tractors there will begreater compaction and damage to the soil profile. Thus the recent benefits of improved soil structure through shallow cultivations and direct drilling will be lost. Therefore it would seem expedient, with the greater knowledge of the action of different implements, to aim to use the plough as part of the overall cultivation strategy, with the other lower energy and higher output cultivation techniques being used as often as possible. The incentive to minimise soil disturbance and numbers of operations will accelerate with continued rising costs and prospects of reduced profit margins. The optimum system for a particular set of conditions will generally be the one that gives maximum crop yield with the least input.

Future developments

Where straw is mixed in with soil, there will be a need for improvements in design of both combine-mounted and tractor-mounted straw choppers, particularly in respect to producing a finer chop length at reduced power levels. At some minimum chop length (50mm) it will be more efficient in power to split straw lengthways to increase degradation and this will be an area for new machine development. New designs of mechanism will be important to provide more even distribution of both chopped straw and chaff from combines.

There will be further developments of cultivation equipment that can provide better mixing of straw and soil and for machinery that can invert with an improved mix of straw and soil. The latter may be achieved by improvements to the plough or new machine designs. With the requirement for deeper primary cultivation and the present trend towards ploughing, new designs of secondary cultivation machinery, that can achieve a higher output and provide more effective soil disintegration, will be in demand.

With the continued trend to heavier machinery it may be possible, in the future, to devise wavs of minimising the problems of soil compaction by new designs of wheel systems or through controlling traffic to specific areas.

V13-1.

Drainage of Sloping Clay Soils

In this article, Dr Robert Parkinson (Seale-Hayne College) and Dr Ian Reid (Birkbeck College) describe some results of a long-term investigation carried out by the Department of Geography, Birkbeck College, University of London into the mechanisms of water disposal by underdrained clay soils.

In December 1984, grants for agricultural drainage schemes were slashed from 30% to 15%. This was only the last in a series of reductions that have occurred over the last 5 years. With the cost of field drainage being borne increasingly by the farmer, it is essential that he fully understands the design principles which underlie the installation of a scheme. He needs this information not only to spend money wisely at the time the job is carried out, but also to see that the system has an economically useful life-expectancy and that it is going to he as convenient as possible to maintain. This applies to clay soils particularly. They can be successfully treated using widely spaced tile-laterals so long as mole channels are drawn at 2 to 3m spacing and intersect the gravel fill that covers the tiles (Leeds-Harrison, 1982). But such systems are not efficient if moling is carried out when conditions are likely to lead to channel instability, or where soil variability (eg patches of silt or gravel) causes premature collapse of the mole channels.

Recent developments in drainage design even include a return to closely-spaced permanent laterals. For example, there is some indication that 35mm plastic drains laid at 3m spacing will solve the drainage problems of soils with low hydraulic conductivity, and that the cost of such schemes is only marginally greater than conventional tile-cum-mole systems.

With such a range of drainage options available, it is important that the hydrological efficiencies of systems of all types are assessed. It is only by doing this that the individual farmer can get the hest value for money.

A Long term Drainage Experiment

The MAFF Field Drainage Experimental Unit have been assessing the merits of different drainage systems in various parts of the country for many years (for a recent example, see Harris et *al,* 1984). However, their experiments have generally favoured sites where the ground is flat or where there is a uniform gradient. There are very good reasons for this, but it does. mean that little attention has been paid to uneven ground, and let's face it,

Fig.1 General view of the *Enfield* Chase topography. *Ground* slope *increases* away *from* the *camera.*

it's in the hollows or at those places where the form of the land changes that persistent problems occur.

We at Birkbeck set out to investigate the effect that topography has on drainage efficiency in the gently undulating claylands that surround London and extend into a good deal of Essex and parts of East Anglia. Our experimental site is on the heavy soils derived from the London Clay that underlies Enfield Chase, Middlesex. A general view of the area is given in Fig.1. The soil is naturally fertile, but represents a management nightmare. This is because its structure is so easily damaged by untimely or continuous cultivation. (See Reid & Parkinson, 1981, for an appraisal of its water-handling properties). It is a surface water gley of the Windsor Series (see Fig.2). Subsoil clay content is around 60% and the soil cracks to about 70-80cm in summer months (Reid & Parkinson. 1984).

We have assessed the efficiency of tile-cum-mole systems in which the gravel covered tiles had been installed at 40m spacing and moles drawn at 2m spacing approximately orthononal to the tile lines. Several topographical configurations typical of the area and much of the British claylands have been investigated.

Drainflows from six individual tile laterals and several more complex tile networks have been recorded continuously over a period of more than 4 years. Small weir boxes (Fig.3a) and tipping bucket devices (Fig.3b) have been successfulv used in gauging the outfall of tile-lateral;; the networks have been monitored with standard thin-plate weirs sited in ditches just downstream from the system outfall.

ıen Do the Drains Run?

Once a system has been in,t so much is take" on trust. A walk round the farm, especially after a heavy storm in winter, confirms that the drains are doing something, and there is an inevitable willingness to believe that the soil feels firmer if only to justify the expense. But questions naturally arise: when and for how long do the drains

Fig.2 Windsor Series soil profile developed on London Clay and underpermanent pasture, Note *the well structured A* horizon hut more massive *subsoil.*

Fig.3a Small weir-box used for measuring tile-*drain outfall.*

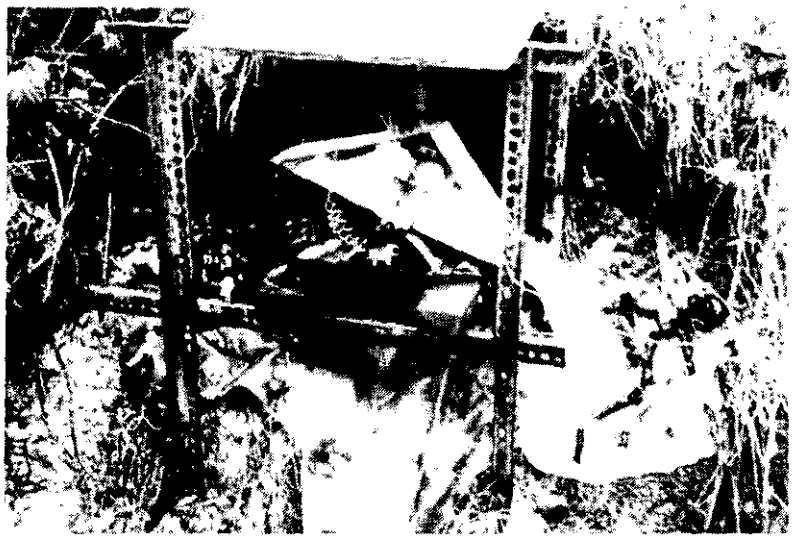


Fig.3b Tilting *bucket* device registering *tile-drain outfall.*

run? And just how efficient are they at removing storm-water?

In the 4 years of our experiment, during which time we were also monitoring soil water contents. drain discharge would begin on average 2 months before the soil reached field capacity. This is important. The soil – and especially cracking clay soils – cannot be conceptualized as a simple reservoir that gets progressively emptied in summer, and then fills to the brim (ie field capacity) before yielding excess water (ie drainage) in winter. Some rainwater escapes down the cracks caused bv summer desiccation. This process is referred to as 'by-passing' because the water is routed oast the topsoil and goes directly into the subsoil. (For a detailed description, see Bouma, 1981. and Reid & Parkinson. 1984). This is also where the tine cracks of the moie plough have an important role to play. They are artificial fissures that are maintained by natural forces of desiccation. As such, they are just as significant in directing water into the subsoil, this time directly into a mole channel (Leeds-Harrison *et al,* 1982).

Because of by-pass flow, a significant amount of drain flow occurs in autumn and early winter before field capacity is reached, and in these soils this is not until January. In fact, on average, 30% of the year's drain flow events take place during this period. The evacuation of water that gets into the cracks and away in the drainage system has obvious benefits for all thosewinter sown cereals. They enjoy favourable soil conditions for longer, and at an important time for root development. But while the drainage system carries water *before* the soil has reached field capacity in autumn, there is an abrupt *finish* to the drainage season at the onset of the first soil moisture deficits of late spring. Only rearely do the drains run once soil water content drops below the mean level it holds in winter. This has great benefits. It means that water is retained to sustain summer growth. This is especially important in clay soils because much of the moisture is held at forces that make it difficult, if not impossible, for most crop plants to extract. The disadvantage of such an abrupt finish to the drainage process is that the soil may remain plastic for longer, so that secondary cultivations, top-dressings, etc run the real risk of damaging soil structure.

The sealing of cracks by winter swelling means that summer storms do not result in drainage. This is interesting, because the drains *do* run in autumn even though soil moisture contents are not measurably different. The reason for the lack of summer response is because progressive drying has yet to open the cracks to mole channel depth. Clearly, the drying and wetting history of clay soils is just as important as actual soil water content in dictating when the drainage system will function. The problem this creates for the drainage engineer is that it complicates any attempt to derive a general model that would predict drainage, and makes it even more important that empirical studies are made.

Topographical Control of Drain Discharge

The catchment of an individual tile drain on sloping land differs from that on level ground. In the same way, the flow processes that cause drainage from a network of drains laid in a topographical hollow will differ from those that cause a single lateral on uniformly sloping ground to discharge.

Standard design-equations for drain spacing (eg MAFF, 1982) include ground-slope as one factor determining pipe size, etc but they take no account of theform of the slope – its geomorphology.

Our experimental results at Enfield Chase indicate clearly that both slopegradient and slope form are important factors. In other words, there must be some consideration of whether the land has a concave bowl-shape or whether it is convex. Fig.4a illustrates a

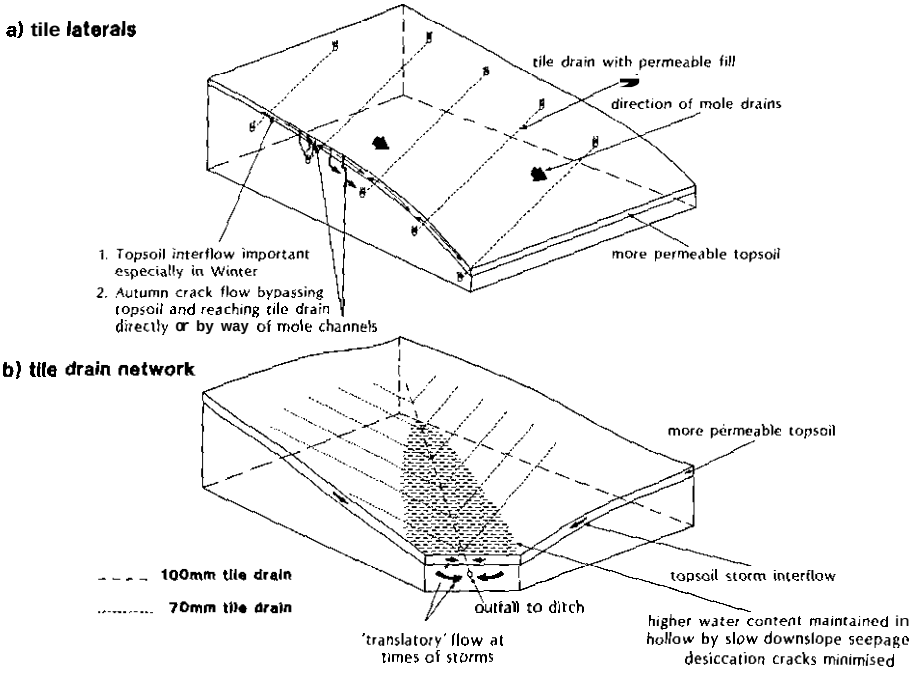


Fig.4 Cut-away block *diagrams* showing *water transmission* mules *for* a – *tile laterals* draining a convex slopeform, and b – a *tile-drain network* draining a concave, bowl-shaped hollow.

situation typical of many claylands. A series of laterals are laid equally-spaced and approximately along the contours. The difference in hydraulic conductivity between top-soil and sub-soil especially in winter when swelling has forced the closure of the large desiccation cracks, means that a high proportion of water moves towards the drains in the more permeable topsoil. (It is worth noting, incidentally, that mole channels drawn across the tile drains and therefore running with the slope in these situations are disposed in the least effective fashion). As slope increases on this shallowly convex slope (Fig.4a), the catchment of individual drains changes. Drains on gentler slopes produce significantly larger storm outfall than those placed on steeper parts of the convexity. This carries an interesting and unexpected paradox: where slopes are steeper, short-term drain efficiency is lower and the soil remains wetter with all that this implies for poorer rooting conditions at positions in the landform which are traditionally thought to present no problems.

But these convex slope forms *do* dry out in summer because long-term slow seepage combines with evaporation to evacuate the water. As a result, the soil develops wide and deep polygonal cracks, and these become the important escape route for rainwater in autumn.

In contrast, the drainage of a basin-like landform is very different. Discharge from the system is not significantly different between winter and autumn. This is because the concentration of water by both downslope stormflow and slower seepage ensures a wetter soil in the hollow throughout the year (Fig.4b). This, in turn, inhibits the development of those desiccation cracks that are so important on convex slope forms. As a result, the difference between drainflow hydrographs for winter and autumn are much smaller in the hollow than they are on a convex slope. This is illustrated in Fig.5. Two storms of roughly the same size and same intensity have been chosen from the hundreds we have monitored. The winter storm (8.1mm) falls on a fully wetted soil in March; the autumn storm (8.6mm) falls in December on a soil that has yet to reach field capacity. An inspection of the drainflow hydrographs shows that the autumn storm's discharge peak reaches 71% that of the winter counterpart in the topographical hollow that is drained by the tile network. But the autumn peak of the individual tile lateral on its convex topography reaches only 35% of the outfall produced by an almost identical winter storm.

One other pattern can be seen in the hydrographs. The hollow responds to *winter* rain much quicker than does the convex slope represented by the individual lateral. This is because the bowl-shape of the hollow attracts seepage, and it is, therefore, invariably wetter at the start of a storm. Resident soil water is 'pushed' out by the succeeding rain. The process is called 'translatory flow' by the hydrologist, and explains why streams rise quickly after a storm. This is to be expected

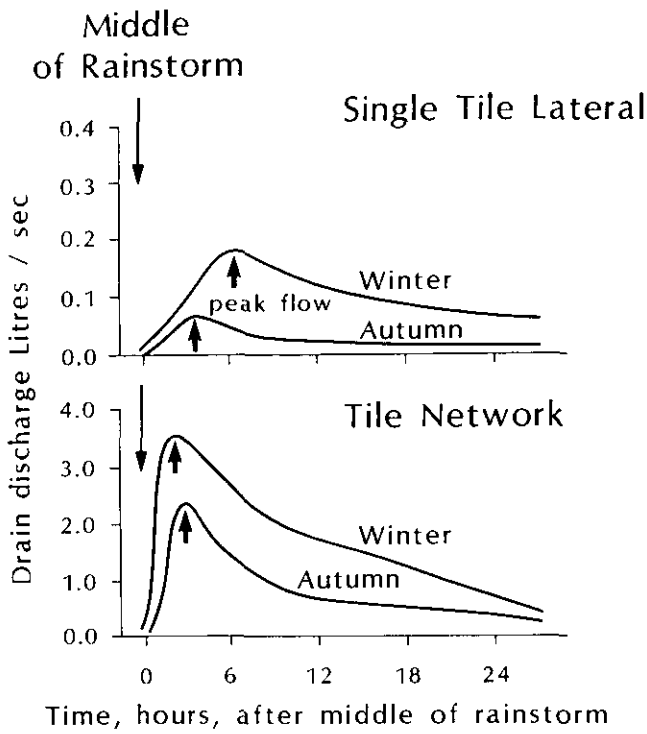


Fig.5 Examples of drainflow hydrographs showing seasonal differences in the response of a network draining a topographic hollow and that of a single lateral draining part of a convex landform.

– hollows are easy-to-recognise wet spots on any farm. What we cannot show with the 2 hydrographs chosen, but which comes out as a *general* pattern from our 4 years work is that, in *autumn*, the convex proud parts of the topography actually respond more quickly than the hollows. This says something about differences in the route taken by drainage water in the 2 situations at this time of year. Where the desiccation cracks have developed fully after summer drying – ie on the convex slopes – the water is transmitted down these and teaches the moles and then the tiles in a short space of time. Where the cracks are not allowed to develop, as in hollows, this short-cut by-pass route is not available. In fact, Fig.5 allows a glimpse of this. The hydrograph peaks for the tile network occur at roughly the same time after the middle of the rainstorm indicating no difference in route between season; but the autumn drainflow peak for the lateral occurs some 3 hours before its winter equivalent, indicating a significant seasonal change in the transmission route from the soil surface to the drain. As a corollary, these differences between sites mean that the maintenance of good topsoil structure that will facilitate plough-layer interflow will be more important in landscape hollows than where desiccation is more intense.

Concluding Remarks

When designing field drainage, the *form* of the land – its shape – must be taken into account as much as slope gradient. Hollows in the landscape are notorious, but we show that the crack flow that is known to be vital to the successful operation of a mole-cum-tile system may be reduced as a result of the maintenance of high moisture levels by the very seepage water that the drainage system is intended to evacuate. Perhaps more surprising is the fact that in heavy clay soils, convex landforms are not as efficient in disposing of water as might be expected. Because of this, drain spacing might usefully be reduced at the very points in the field *traditionally thought to present* less problems.

One other point might be made. The success of moling depends on creation of stable mole channels. It is well known that soil conditions are right for a very restricted part of the year. But this presumes uniformity. Soil water content, and therefore soil plasticity, varies widely, and the *shape* of the land is *the* major controlling factor. One should never draw a mole plough through an undulating field and expect 100% success.

References

Bouma J. 1981. Soil morphology and preferential flow along macropores. *Agricultural Water Management* 3, 235-250.

Harris G L, Goss M J, Dowdell R J, Howse K R & Morgan P. 1984. A study of mole drainage with simplified cultivation for autumn-sown crops on a clay soil. 2. Soil water regimes, water balances, and nutrient loss in drainwater 1978-80. *J. agr. Sci., Camb.* 102, 561-581.

Leeds-Harrison P. 1982. Water flow into mole drained soil. *Soil and Water* 10, 9-11.

Leeds-Harrison P, Spoor G & Godwin R J. 1982. Water flow to mole drains. *J. agr. Eng. Res.* 27, 81-91.

MAFF 1982. *The Design of Field Drainage Pipe Systems.* Ref. Booklet 345. HMSO.

Reid I & Parkinson R J. 1981. Too wet, too dry: clay soil problems. *Soil and Water* 9, 7-9.

Reid I & Parkinson R J. 1984. The nature of the tile-drain outfall hydrograph in heavy clay soils. *J Hydrology* 72, 289-305.

Reid I & Parkinson R J. 1984. The wetting and drying of a grazed and ungrazed clay soil. *J Soil Sci.* 35, 607-614.

DIARY

JULY **1985**

1-4 Royal Show—NAC Stoneleigh, Warwicks—Arable Marquee includes —soil acidity demonstration
—straw incorporation machinery
—land drainage feature

9-11 Great Yorkshire Show—Showground, Hookstone Oval, Harrogate

10-11* **Association of Drainage Authorities** Open Days—Cross Guns Meadows, Thorney, Nr Peterborough

31* **SaWMA Field Meeting—2.00pm**—Irrigation Scheduling and Management—Brandon Field Estates, Brandon, Suffolk
(by kind permission of Frederick Hiam Ltd)
Contact Geoff Baldwin (0484) 29417 for further details.

SEPTEMBER **1985**

4* Tractors at Work—Proctor Bros (Wingland) Ltd, Suttou Bridge, Lincs

5* **SaWMA e Me** 2.00pm—Straw incorporation with primary cultivation machine as an element of soil management.
Staverton Court Farm, Staverton, Nr Cheltenh , Glos. (b l i d permission of Messrs Newtons Ltd)
Contact Geoff Baldwin (0484) 29417 for further details

9-12 **Soils and Environmental problems**—British Society of Soil Science—Cambridge

11-12* **Cultivations, Straw Disposal** '85—on heavy land belonging to H Raby & Sons, Great Stukely, Nr Huntingdon, Cambs
Demonstrations include: ploughing & alternative systems on burnt & unburnt stubble; straw incorporation and disposal systems

date to he advised* SaWMA Field **Meeting**—Straw incorporation on difficultsoils—Humberside area—to be confirmed.
Contact Geoff Baldwin (0484) 29417 for further details

NOVEMBER **1985**

12* "Pollution on the Farm"—SaWMA. MAFE ADAS—East of England Agricultural Societv
One-day Conference—Silsoe College, Silsoe, Beds. 10.30—4.30. See back cover for details.

20 **Better** Soil Management for Cereals and Rape—One Day Conference—MAFF, ADAS
National Agricultural Centre—Kenilworth, Warwick

DECEMBER **1985**

2-5 Royal Smithfield Show—Earls Court, London

17-19 Irrigation; Principles and Practices—Short Course, Silsoe College

JANUARY **1986**

6-9 Soil Management—Short Course, Silsoe College

6-9 Field Management for Effective Drainage—Short Course, Silsoe College

* denotes events at which SaWMA is participating

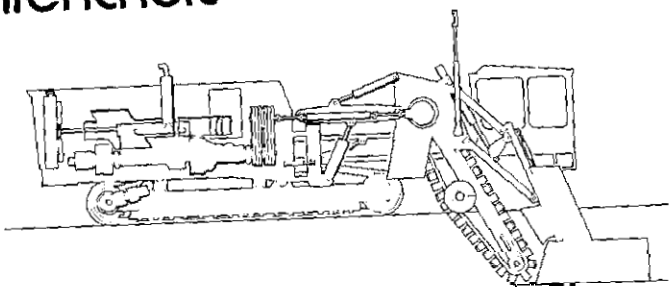
ADVERTISERS INDEX

The best in earth

Inter-Drain

V13

Trenchers

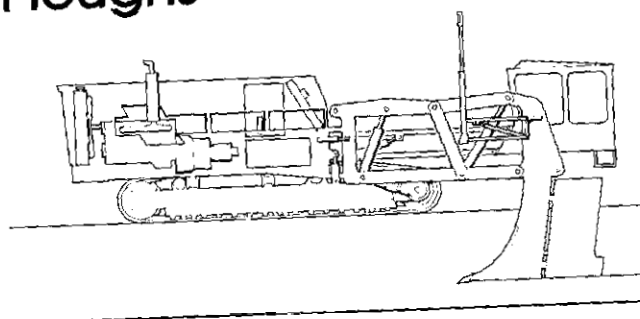


The Inter-Drain trencher concept has proved its qualities and is an example in modern day draining.
The whole range has the same rugged design principles providing clean lines and maximum accessibility and is constructed to perform in the most arduous conditions.
It offers models from 120 Hp – 400 Hp.
Components used are all of the highest quality and of ample capacity to ensure long life, minimum wear and tear and maximum output.
Special attention is paid to achieve accurate grading in all conditions, and automatic grade control can easily be installed.
It is our principle to produce, develop and service machines of the very best quality, tailored for the needs of 'today's contractors'.

Standard features are:

- Independent hydrostatic track drive for infinite speed control, manoeverability and maximum output.
- Turnable digging unit to enable curves and also to facilitate easy steering on slopes.
- Oscillating tracks and the excellent balance of the machines provide a guaranteed even tread and grip.
- Heavy duty gear box and transmissions to the digging chain provide smooth drive, preventing shock or over-loading
- Constant digging angle for maximum performance and also minimum wear in hard conditions
- Quick release parallel lifting pipe chute for easy stock and obstacle dig-out.
- Fully enclosed independent elevating cab

Ploughs



The Inter-Drain Trenchless machines are renowned for their reliability and economy.
Their concept is based on a free floating double-linkage system or single parallelogram, which ensures the best grading capabilities and the transfer of reaction forces resulting in increased pulling capability.
Its rugged, but clean design has proven its worth also in very hard and rocky conditions.
Models are available from 210 Hp to 450 Hp with tractive efforts of over 40 tons.
Accurate installation speeds of up to 4 km/h are possible.
Inter-Drain 'ploughs' ensure the cheapest drainage or cable installation possible per meter.

Standard features are:

- Independent hydrostatic track drive for infinite speed control, manoeverability and maximum output.
- Long and wide oscillating tracks provide maximum soil contact for increased pulling power.
- Free floating double linkage system, prevents 'nose down' in hard conditions and ensures maximum accuracy
- The parallelogram is mounted on a turntable in the middle of the machine ensuring easy steering.
  Option: it is possible to control perpendicularity of the plough unit automatically.
- Engine and transmissions of ample capacity are matched in such a manner that ideal power to weight ratio is created with maximum reliability.
- The linkage system is suitable for single/double leg, V-shape configuration.
- Low angle plough design resulting in low drawbar pull minimal smearing with maximal shatter

Draiëntie . Inter Drain Group

Inter Drain Ltd

Kirkconnel
Dumfriesshire DG4 6RU
Scotland UK
Tel: 06593-312 or 533
Telex 777534 INTERD G

Inter-Drain (England) Ltd

The Laurels
Townstreet
Treswell
nr Retford
DN22 0EN
Tel: 0777 848027

Draiëntie bv

2 Latensteinserondweg
4005 EH Tiel
Holland
Tel: 03440-12746
Telex 70343 DRAIN NL

For further information contact: John Walker 0507 603872
Richard Barth 0777 848027
Bas van Nieuwenhuyzen 0777 83393

SAWMA MAFF ADAS EAST OF ENGLAND AGRICULTURAL SOCIETY

One day Conference
Tuesday 12th November 1985 – Silsoe College

POLLUTION ON THE FARM
Whose problem? Who pays?

Chairman: Mr John North, Chief Agricultural Officer, MAFF **ADAS**

Programme:

10.30	Registration and coffee
11.00	***Introduction by*** the Chairman
11.05	Session 1 – Identification of the real problem areas – pollution caused by farming – pollution suffered by farming **Speaker: Dr Norman Moore, FWAG, Scientific Consultant**
11.35	**Session 2 – Development of the main issues** – slurry and nitrates **Speaker: Dr** Tim **Evans,** Support Services Manager, Thames Water Authority – agrochemicals **Speaker: Mr David Eagle: ADAS Pesticides Residues Unit, Cambridge** – atmospheric pollution Speaker: **Mr** Arthur Staniforth, Reading Agricultural Consultants
12.45	Lunch
2.00	Session 3 – What **farming** can do about it – organic farming **Speaker: Mr David Stickland, Managing Director, Organic Farmers and Growers Ltd.** – clean up techniques **Speaker: Dr Roger Phillips, Head of Waste Engineering Group, N.I.A.E.** – the environmental case **Speaker: Mr Chris Rose, Countryside campaigner for Friends of the Earth** – responsible management Speaker: **Mr** Ralph Baker, **Somerset** farmer and member of Wessex Water Authority
3.30	Session 4 – Discussion
4.00	Summing up by the Chairman
4.15	Tea and disperse

Conference fee: inclusive of coffee, lunch and tea –
SAWMA members £13.00 plus VAT, Guests and non-members £15.00 plus VAT

For further details and registration forms write to:
Geoff Baldwin, 22 Edgerton Grove Road, Huddersfield, West Yorkshire HDI 5QX